74N28759

NASA TECHNICAL NOTE

NASA TN D-7732

NASA TN D-7732

THE NUMERICAL CALCULATION OF LAMINAR BOUNDARY-LAYER SEPARATION

by John M. Klineberg and Joseph L. Steger

Ames Research Center
Moffett Field, Calif. 94035

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • JULY 1974

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
TN D-7732		

4. Title and Subtitle	5. Report Date
THE NUMERICAL CALCULATION OF LAMINAR BOUNDARY-LAYER SEPARATION	JULY 1974
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
John M. Klineberg and Joseph L. Steger	A-5281
9. Performing Organization Name and Address	10. Work Unit No.
NASA-Ames Research Center Moffett Field, Calif. 94035	501-06-01
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
National Aeronautics and Space Administration Washington, D.C. 20546	Technical Note
	14. Sponsoring Agency Code

15. Supplementary Notes

Presented at the AIAA 12th Aerospace Sciences Meeting, Washington, D. C., Jan. 30-Feb. 1, 1974.

16. Abstract

Iterative finite-difference techniques are developed for integrating the boundary-layer equations, without approximation, through a region of reversed flow. The numerical procedures are used to calculate incompressible laminar separated flows and to investigate the conditions for regular behavior at the point of separation. Regular flows are shown to be characterized by an integrable saddle-type singularity that makes it difficult to obtain numerical solutions which pass continuously into the separated region. The singularity is removed and continuous solutions ensured by specifying the wall shear distribution and computing the pressure gradient as part of the solution. Calculated results are presented for several separated flows and the accuracy of the method is verified. A computer program listing and complete solution case are included.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Separated Flow Boundary-Layer Flow Finite-Difference Methods	Unclassified - Unlimited CAT.12

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	101	$4.50

*For sale by the National Technical Information Service, Springfield, Virginia 22151

NOMENCLATURE

A	matrix formed by difference equations
a	local speed of sound
b(x)	function of x, equation (9)
c	constant
C_f	skin friction coefficient, $\frac{2\mu(\partial u^*/\partial y^*)}{\rho_\infty^* u_\infty^{*2}}$
f	transformed stream function, $\int \bar{u}\, d\bar{y}$
$f_1, f_2, f_3, \ldots$	coefficients in Taylor series expansions, see equation (38)
g	$uv - \frac{\partial u}{\partial y}$
H	conditioning matrix, also H_u, H_v
h	parameter for relaxation scheme
I	identity matrix
i	$\sqrt{-1}$
J	maximum j index
j	discrete index in streamwise direction
K	maximum k index
k	discrete index in normal direction
ℓ	typical length scale
M	Mach number
m	normalized velocity gradient, $\frac{x}{u_e}\frac{du_e}{dx}$
$\bar{m}$	normalized Mach number gradient, $\frac{x}{M_e}\frac{dM_e}{dx}$
p	fluid pressure
R	Reynolds number, $\frac{u_\infty^* \ell}{\nu}$
$\vec{R}$	residual vector, also $\vec{R}_u$, $\vec{R}_v$

Re_x	Reynolds number, $\frac{\rho_e u_e x}{\mu_e}$
u	normalized component, $\frac{u^*}{u_\infty^*}$
u*	streamwise velocity component, physical variable
$\bar{u}$	transformed component, $\frac{u}{u_e}$
v	normalized component, $\frac{v^*}{u_\infty^*}\sqrt{R}$
v*	normal velocity component, physical variable
$\bar{v}$	transformed component, $v\sqrt{\frac{x}{u_e}} + \frac{1}{2}(m - 1)\bar{y}\bar{u}$
x	normalized streamwise coordinate, $\frac{x^*}{\ell}$
x*	streamwise coordinate
y	normalized normal coordinate, $\frac{y^*}{\ell}\sqrt{R}$
y*	normal coordinate
$\bar{y}$	transformed normal coordinate, $y\sqrt{\frac{u_e}{x}}$
z	$u_e^2 - u^2$
α	arbitrary parameter
β	$\frac{\Delta y}{2}$
γ	$\frac{\Delta y^2}{2\Delta x}$, also ratio of specific heats
ε	truncation error term or a small parameter
η	$\sqrt{\frac{m+1}{2}}\,\bar{y}$
λ	eigenvalue of iteration matrix (I + hHA); also $\lambda = \int_0^{\bar{y}_e} (1 - \bar{u}^2)d\bar{y}$
μ	coefficient of viscosity
ν	kinematic viscosity, $\frac{\mu}{\rho}$
ρ	fluid density

σ	eigenvalue of HA
$\bar{\tau}$	$\left.\frac{\partial \bar{u}}{\partial \bar{y}}\right\|_0$
ψ	stream function, $\int u\,dy$
ω	relaxation parameter or vorticity

Subscripts

B	backward difference operator
C	central difference operator
e	condition at edge of viscous layer
F	forward difference operator
j,k	location at a grid point or an index
max	with J or K, maximum number of grid points j or k in the field
s	condition at separation
x	partial derivative with respect to x
0	constant value of u or v; also a quantity evaluated at $\bar{y} = 0$
1,2	conditions on either side of a plane in physical space
∞	far upstream condition
$\|\cdot\|_2$	Euclidean vector norm or induced matrix norm

Superscripts

*	physical variable
-	transformed variable, see equation (5)
~	perturbation term
(n)	iteration level
$\rightharpoonup$	vector quantity
'	$\frac{\partial}{\partial y}$, also $\frac{d}{dx}$ with equations (39)-(42)

THE NUMERICAL CALCULATION OF LAMINAR BOUNDARY-LAYER SEPARATION*

John M. Klineberg and Joseph L. Steger

Ames Research Center

SUMMARY

Iterative finite-difference techniques are developed for integrating the boundary-layer equations, without approximation, through a region of reversed flow. The numerical procedures are used to calculate incompressible laminar separated flows and to investigate the conditions for regular behavior at the point of separation. Regular flows are shown to be characterized by an integrable saddle-type singularity that makes it difficult to obtain numerical solutions which pass continuously into the separated region. The singularity is removed and continuous solutions ensured by specifying the wall shear distribution and computing the pressure gradient as part of the solution. Calculated results are presented for several separated flows and the ccuracy of the method is verified. A computer program listing and complete solution case are included.

INTRODUCTION

During the past decade, various approximate methods have been developed to calculate separated flows by using the boundary-layer equations. The most popular schemes have been integral, or moment, methods based on the early work of Abbott, Holt, and Nielsen (refs. 1-3) or Lees and Reeves (refs. 4-8). In the integral approach, the boundary-layer equations are multiplied by a power of u and converted into a system of ordinary differential equations by integrating across the viscous layer. Regions of attached and separated flow are treated similarly because the average convection in the boundary layer is always in the downstream direction.

A second type of approximate method, first proposed by Reyhner and Flügge-Lotz (ref. 9) uses finite-difference techniques (refs. 10 and 11). This approach uses a forward-marching procedure, with all convective derivatives set to zero in regions of reversed flow for numerical stability. The conservation of momentum and energy is therefore violated in the portion of the separated flow bounded by the zero-velocity line, although the errors introduced by this approximation are not expected to be significant for small laminar separation bubbles. Both the finite-difference and integral methods have produced good agreement with experimental data, particularly for compression-corner flows and shock-wave/boundary-layer interactions (see the review in ref. 12).

*Presented at the AIAA 12th Aerospace Sciences Meeting, Washington, D. C., Jan. 30-Feb. 1, 1974.

The first finite-difference integration of the complete boundary-layer equations through a region of reversed flow was performed by Catherall and Mangler (ref. 13). This report provides the best previous numerical evidence of flows that are regular at separation. A continuous solution was obtained by specifying the displacement thickness downstream of an appropriate point near separation and determining the pressure gradient by streamwise integration. The numerical procedure developed instabilities in the reversed-flow region, however, and the integration was continued only by decreasing the convergence criterion at each station. As the authors point out, this difficulty is to be expected because the region of separated flow should actually be integrated in the upstream direction, with boundary conditions provided from downstream.

There have also been several numerical studies of nonlinear parabolic equations of mixed type, where the direction of increasing "time" reverses in some region of the flow field. One of these investigations, by Klemp and Acrivos (ref. 14), considers the flow over a finite, stationary flat plate whose surface moves at a constant velocity opposite that of the free stream (i.e., a rotating belt). The boundary layer is divided into two regions along the unknown zero-velocity line and the equations are integrated in the appropriate flow directions, with the final solution obtained by iterating for the location of the common boundary. It is not evident that this technique would prove effective for calculating boundary-layer separation because the region of reversed flow results only from the upstream motion of the surface of the plate. Also, the pressure gradient is assumed to be zero and the shear stresses remain positive throughout the flow field. The singularities at separation and reattachment are therefore caused by discontinuities in the boundary conditions and are not associated with the vanishing of the surface skin friction.

A more useful numerical procedure for calculating the flow past an impulsively started flat plate has recently been developed by Dennis (ref. 15). For this problem, the motion at short times is given by Rayleigh's error function solution, while the final steady-state condition is given by the Blasius profile. Although the transition from the initial to the final state can be calculated directly in the three independent variables (ref. 16), Dennis formulated the problem in similarity coordinates where the governing equation is parabolic and of mixed type. The convective derivatives were approximated by backward or forward differences where appropriate, and the solution was obtained through a successive overrelaxation procedure. This numerical technique with certain modifications can also be applied to the equations that describe boundary-layer separation. The two problems are, of course, different in many important respects. In particular, there is nothing corresponding to reattachment for the impulsively started flat plate, and the downstream (large time) boundary conditions are given. One of the more interesting features of boundary-layer separation is that although there is an embedded region of reversed flow and of upstream influence, the overall problem remains parabolic in the downstream direction.

The present investigation develops a numerical procedure for integrating the laminar, incompressible boundary-layer equations, without approximation, through a region of reversed flow. Under Development of Numerical Method, a model problem is examined to determine convergence and stability criteria, and iterative finite-difference schemes are developed to solve the nonlinear equations. Under Results and Discussion, the numerical procedures are used to investigate the conditions for regular behavior at the point of separation. The separation (and reattachment) points are shown to be saddle-type singularities in the physical plane, which make it difficult to obtain numerical solutions that pass continuously from the attached region to the separated region. The singularities are effectively removed, however, by specifying the wall shear distribution and determining the pressure as part of the solution. These inverse calculations are used to infer the type of pressure distribution required for the boundary layer to pass smoothly into a region of reversed flow. Where possible, results are compared to relevant analytical or similarity solutions to verify the accuracy of the calculations. The extension of the method to compressible flows and to the solution of complete viscous-inviscid interactions is indicated in a separate section.

DEVELOPMENT OF NUMERICAL METHOD

The Differential Equations

The boundary-layer equations for two-dimensional, laminar, incompressible flow are

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \tag{1a}$$

$$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = u_e\frac{du_e}{dx} + \frac{\partial^2 u}{\partial y^2} \tag{1b}$$

where the Reynolds number has been explicitly removed by introducing the usual scaling $x = x^*/\ell$, $y = (y^*/\ell)\sqrt{R}$, $u = u^*/u_\infty$, $v = (v^*/u_\infty)\sqrt{R}$, $R \equiv u_\infty{}^*\ell/\nu$. Here superscript (*) indicates the physical or untransformed variable. Boundary conditions are $u = v = 0$ and $u \to u_e$ as $y \to \infty$. In a direct problem, u_e is specified as a function of x, while, in an inverse problem, an alternate condition such as $(\partial u/\partial y)_0$ or v_e is given as a function of x. In this case, u_e must be determined as part of the solution process.

The parabolic nature of the equations is evident in von Mises coordinates:

$$\frac{\partial z}{\partial x} = u\frac{\partial^2 z}{\partial \psi^2} \tag{2a}$$

$$u = \frac{\partial \psi}{\partial y} \tag{2b}$$

with $u_e{}^2 - u^2 = z$ and $v = -\partial\psi/\partial x$. Equation (2a) is clearly a heat equation in which the coefficient u changes sign in regions of reversed flow. Because there is no downstream boundary condition, the solution is not unique unless the separated zone is entirely confined within the domain of integration.

The equations can also be written as a system of nonlinear first-order equations in conservative form, for example,

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \tag{3a}$$

$$\frac{\partial}{\partial x}\left(u^2 - \frac{u_e^{\,2}}{2}\right) + \frac{\partial g}{\partial y} = 0 \tag{3b}$$

$$\frac{\partial u}{\partial y} - uv + g = 0 \tag{3c}$$

Because the equations are nonlinear, discontinuities may occur in the flow field even though continuous boundary conditions are specified. Equations (3a), (3b), and (3c) possess the following weak solutions:

$$[u_2 - u_1]\sin\theta = [v_2 - v_1]\cos\theta \tag{4a}$$

$$[u_2{}^2 - u_1{}^2]\sin\theta = [g_2 - g_1]\cos\theta \tag{4b}$$

$$0 = [u_2 - u_1]\cos\theta \tag{4c}$$

where u_e is assumed to be continuous and θ is the angle between the axis and a plane separating conditions 1 and 2. If $\theta < \pi/2$, equation (4c) ensures that $u_2 = u_1$ and, consequently, all the variables are continuous. When $\theta = \pi/2$, the weak solutions are indeterminate. In particular, v may be discontinuous with a jump of indeterminate strength even with u continuous. Furthermore, if u is discontinuous, then, from equation (4a), $[v_2 - v_1] \to \infty$.

Preliminary Numerical Considerations

As equation (2a) in particular shows, in the separated-flow region, information must be allowed to propagate upstream with the reversed flow velocity. A natural way to fulfill this requirement consistent with restrictions of numerical stability is to treat the x-derivatives with backward (upwind) finite-difference formulas in attached flow regions and with forward (downwind) finite-difference formulas in the reversed flow region. However, this means that at least a portion of the difference equations will require simultaneous solution. Furthermore, the extent of the separated region is unknown and, because the equations are nonlinear, an iterative finite-difference method appears to be the most efficient way to find a solution. Here, of course, one can rely on experience obtained with type-dependent relaxation methods employed for transonic flow fields (refs. 17 and 18).

As an alternative to a type-dependent differencing scheme, interpolative (elliptic) finite-difference formulas such as central differencing can be used over the entire flow region. In fact, in the absence of discontinuities, parabolic and hyperbolic problems can be solved with interpolative differencing, provided the boundary conditions are properly satisfied. Of course, for a simple initial-value problem, a marching process that uses backward differencing is generally far more efficient than a simultaneous solution process.

The choice of whether to use backward-forward differencing, central differencing, or some hybrid of these will depend on the efficiency and accuracy obtainable in the iterative finite-difference method. In any case, no downstream boundary conditions can be supplied for the boundary-layer equations, so the last computed profile must be attached to allow the use of backward differencing for the x-derivatives.

The success of a numerical method also depends on the choice of variables into which the equations are cast. Equation (2), for example, is not suitable because the variable ψ is multivalued in the separated region. For the most part, equations (1a) and (1b) appear to be the most appropriate to difference with a high probability of being readily extended to more complex (e.g., three-dimensional) flows.

Because the boundary-layer exhibits extensive growth in the x-direction, it is essential for numerical efficiency that this growth be scaled out. This can be accomplished by introducing a variable, growing grid system or by using a transformation that keeps the viscous layer of nearly uniform thickness. The following transformation is used:

$$\left.\begin{aligned} \bar{y} &= y\sqrt{\frac{u_e}{x}} \\ \bar{v} &= v\sqrt{\frac{x}{u_e}} + \frac{m-1}{2}\bar{y}\bar{u} \end{aligned}\right\} \tag{5}$$

so that equations (1a) and (1b) become

$$x\frac{\partial \bar{u}}{\partial x} + \frac{\partial \bar{v}}{\partial \bar{y}} + \frac{m+1}{2}\bar{u} = 0 \tag{6a}$$

$$x\bar{u}\frac{\partial \bar{u}}{\partial x} + \bar{v}\frac{\partial \bar{u}}{\partial \bar{y}} = m(1 - \bar{u}^2) + \frac{\partial^2 \bar{u}}{\partial \bar{y}^2} \tag{6b}$$

Boundary conditions are indicated in figure 1. These equations can also be written as a single equation for the stream function

$$f''' + \frac{m+1}{2}ff'' + m(1 - f'^2) = x(f'f_x' - f_xf'') \tag{7}$$

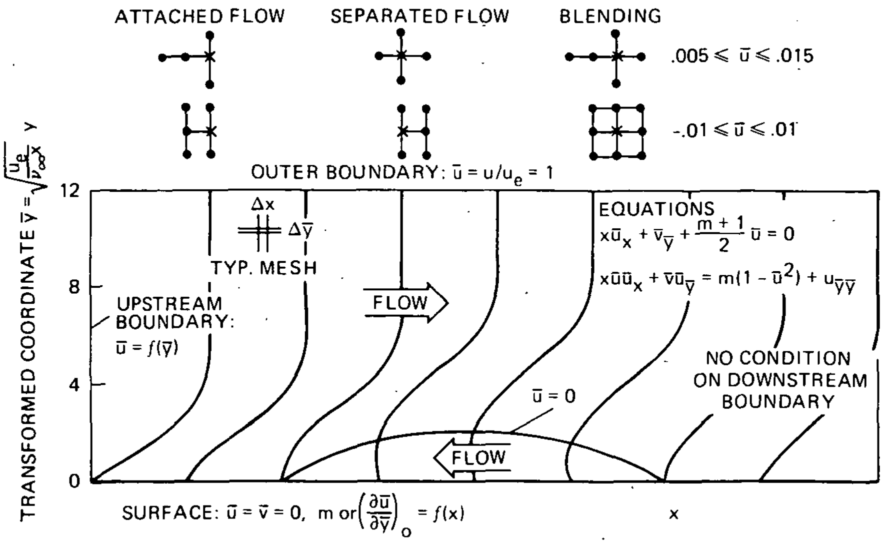

Figure 1.- Difference operators and boundary conditions for relaxation calculation.

Iterative Finte-Difference Method

In the first stages of developing a finite-difference method, it is useful to begin with the study of a model problem. A model equation is obtained here by linearizing equations (1a) and (1b); the iterative convergence criteria are reviewed and an appropriate choice of difference formulas is made so that the simple model equation is iteratively stable. In the following section, the convergence of the difference equations to the differential equation is considered, and iteratively convergent differencing schemes for the nonlinear boundary-layer equations are subsequently given without analysis.

Model problem- Equations (1a) and (1b) are simplified with

$$\left.\begin{aligned} u &= u_0 + \tilde{u} \\ v &= v_0 + \tilde{v} \end{aligned}\right\} \tag{8}$$

so that the model equation becomes

$$\frac{\partial^2 \tilde{u}}{\partial y^2} - u_0 \frac{\partial \tilde{u}}{\partial x} - v_0 \frac{\partial \tilde{u}}{\partial y} = b(x) \tag{9}$$

In any local domain, u_0 and v_0 are treated as constants. Equation (9) also represents the transformed equations, equations (6a) and (6b), if an average value for $x\bar{u}_0$ is substituted for u_0.

If convergent difference algorithms and convergent iterative procedures can be selected for equation (9), subject to all reasonable choices of u_0 and v_0, it is assumed that such schemes can be successfully adapted to equations (1a) and (1b). While explicit and implicit marching procedures have been developed and extensively studied for parabolic equations of standard type, a comparable development does not exist for relaxation schemes. The development of such a scheme is undertaken below where the primary concern is to ensure that the relaxation procedure is valid for both positive and negative values of u_0.

Iterative convergence criteria- Once equation (9) is differenced over a discrete network of grid points, one is left with the task of inverting the linear system of equations

$$A\vec{u} - \vec{c} = 0 \tag{10}$$

where the components of $\vec{u}$ consist of the dependent variables at each grid point. Then the most general first-degree iteration scheme for equation (10) is

$$\vec{u}^{(n+1)} - \vec{u}^{(n)} = hH[A\vec{u}^{(n)} - \vec{c}] \tag{11}$$

where H is a conditioning matrix usually implicitly built into the iterative solution algorithm; here we chose to extract a parameter h from H. It should be understood that this type of iterative solution algorithm can treat nonlinear equations with the same ease as linear equations.

Equation (11) has the recursive solution:

$$\vec{u}^{(n)} = (I + hHA)^n\vec{u}^{(0)} - \sum_{m=0}^{n-1} (I + hHA)^m hH\vec{c} \tag{12}$$

so if the matrix $(I + hHA)$ has a spectral radius (i.e., largest eigenvalue in absolute magnitude) less than 1, then $(I + hHA)^n \to 0$ for n sufficiently large. Furthermore, from the Neumann lemma (ref. 19, p. 26, or ref. 20, p. 82), it is evident that

$$-\sum_{m=0}^{n-1} (I + hHA)^m hH \to A^{-1} \tag{13}$$

or $\vec{u} \to A^{-1}\vec{c}$ as required. Thus the sufficient condition for iterative convergence is that all

$$|\lambda_j| \equiv |1 + h\sigma_j| < 1 \tag{14}$$

where σ_j are the eigenvalues of HA. Hence, if all the real parts of the possibly complex σ_j are of the same sign, h can be chosen to assure convergence. This is an asymptotic convergence criterion for n sufficiently large. For the scheme defined by equation (11) to be efficient, the matrix HA must not have a large condition number (refs. 19 and 21) nor should the imaginary parts of σ_j be large compared to the real parts. The eigenvalue-convergence criterion does not guarantee that the norm of $(I + hHA)^n\vec{u}^{(0)}$ will not grow appreciably during intermediate iterations - a situation likely to occur if the eigenvectors of HA are linearly dependent or almost so.

Convergence of the model problem- The advantage of studying the model problem is that analytic expressions are obtained to describe its behavior for various choices of differencing. It is assumed that the nonlinear problem will share at least some common features. Here, let

$$\left.\frac{\partial^2 u}{\partial y^2}\right|_{jk} = \left(\frac{1}{\Delta y}\right)^2\left(u_{jk-1} - 2u_{jk} + u_{jk+1}\right) + 0(\Delta y^2) \tag{15a}$$

$$\left.\frac{\partial u}{\partial y}\right|_{jk} = \left(\frac{1}{2\Delta y}\right)\left(u_{jk+1} - u_{jk-1}\right) + 0(\Delta y^2) \tag{15b}$$

and

$$\left.\frac{\partial u}{\partial x}\right|_{jk} = \left(\frac{1}{2\Delta x}\right)\left[-(1 + \alpha)u_{j-1,k} + 2\alpha u_{jk} + (1 - \alpha)u_{j+1,k}\right] + 0(\Delta x) \tag{16}$$

where $\alpha = 1$ is first-order backward, $\alpha = 0$ is second-order central, and $\alpha = -1$ is first-order forward. Using these approximations in equation (9) with $\beta = \Delta y/2$ and $\gamma = (\Delta y)^2/2\Delta x$, one obtains

$$(1 + v_0\beta)u_{jk-1} - 2u_{jk} + (1 - v_0\beta)u_{jk+1} + (1 + \alpha)\gamma u_0 u_{j-1,k} - 2\alpha\gamma u_0 u_{jk} - (1 - \alpha)\gamma u_0 u_{j+1,k} = b_j$$

$$(j = 2, 3, 4 \ldots, J_{max}; \quad k = 2, 3, 4 \ldots, K_{max} - 1) \tag{17}$$

If $\vec{u}$ is the vector whose components are the u_{jk} over the ordered grid points, equation (17) can be written as the linear system of equations, equation (10). The eigenvalues of A are given by

$$\sigma_{jk} = -2\left[1 + \sqrt{(1 + v_0\beta)(1 - v_0\beta)}\cos\left(\frac{k\pi}{K + 1}\right)\right] - 2u_0\gamma\left[\alpha + \sqrt{-(1 + \alpha)(1 - \alpha)}\cos\left(\frac{j\pi}{J + 1}\right)\right]$$

$$(k = 1, 2 \ldots, K; \quad j = 1, 2 \ldots, J; \quad K = K_{max} - 2; \quad J = J_{max} - 1) \tag{18}$$

where u is assumed to be given on a boundary as needed. If α is 0 or 1 when $u_0 > 0$ or if α is 0 or -1 when $u_0 < 0$, the σ roots always have negative real parts and A is a stable matrix. Thus the point-iteration scheme with H = I and $h = \omega/(2 + 2u_0\gamma\alpha)$ is proven to be convergent for an appropriate $\omega \leq 1$. As another example, the point successive overrelaxation (SOR) method has the roots

$$\left(1 - \frac{\sigma_{jk}}{\omega}\right)\left(1 + \alpha\gamma u_0\right) = \sqrt{1 - \sigma_{jk}}\left[-\sqrt{(1 + v_0\beta)(1 - v_0\beta)}\ \cos\left(\frac{k\pi}{K + 1}\right)\right.$$

$$\left. -u_0\gamma\ \sqrt{(1 + \alpha)(-1 + \alpha)}\ \cos\left(\frac{j\pi}{J + 1}\right)\right]$$

$$(j = 1, 2 \ldots K; \qquad j = 1, 2 \ldots J) \tag{19}$$

and is also iteratively convergent with h = -1 and a proper choice of the relaxation parameter ω.

Equations (18) and (19) show that the roots will be complex if $\alpha = 0$ or if $|v_0\beta| > 1$. This can be detrimental to the convergence rate of a first-degree iteration scheme if the imaginary parts become large enough, so the central differencing should be restricted to regions where $u_0\gamma$ is small. The product $v_0\beta$ is normally expected to be less than 1 in absolute value and thus has the beneficial effect of reducing the term $\cos k\pi/(K + 1)$.

In place of the complex roots that occur for $\alpha = 0$, when $\alpha = 1$ or -1, the eigenvectors of HA appear in multiples of the number of J grid points. Under these conditions, the norm of an iteration matrix can be expected to grow before it decays; however, study of ℓ_2 and ℓ_∞ induced matrix norms (ref. 19) for the point iteration scheme shows that residual growth cannot occur if the spectral radius is kept less than 1. Conversely, numerical experimentation with the heat equation demonstrates that the SOR forward-differenced scheme ($\alpha = -1$) swept from left to right can experience appreciable residual growth if $\Delta x \ll (\Delta y)^2$. If swept from right to left, the residuals decay rapidly.

Convergence to the Differential Equations

Although the previous analysis shows that iteration algorithms can be used to find a solution to the system of difference equations, it does not prove that the solution of the difference equations will converge to the solution of the differential equations as the grid is refined. However, with the exception of the central differencing scheme, all the schemes to be introduced are known to be stable and consistent for the heat equation (cf. ref. 22).

If one assumes periodic boundary conditions in x and end conditions in y, then sufficient conditions for convergence of the centrally differenced heat equation

$$\pm\left(\frac{\partial u}{\partial x}\right) = \frac{\partial^2 u}{\partial y^2}$$

are $\Delta x \geq 0(\Delta y^2)$ and $\Delta y \geq 0(\Delta x^2)$. (This is not an explicit leap-frog scheme.) Here convergence implies that the difference between the exact solution to the differential equation and the exact solution to the difference equation will vanish as the grid is uniformly refined over a fixed domain. That is, the summation of truncation errors given by $A^{-1}\varepsilon \to 0$ as Δx, $\Delta y \to 0$ where A is the matrix formed by the difference equations over both y and x, and ε is the vector of truncation errors. While the complete convergence proof is too lengthy for this report, note that A is a normal matrix and hence is unitary similar to a diagonal matrix of its eigenvalues (ref. 21). The eigenvalues are

$$\sigma_{jk}(2\Delta xA) = 4\,\frac{\Delta x}{\Delta y^2}\left[1 - \cos\left(\frac{j\pi}{J+1}\right)\right] + 2i(\pm 1)\sin\left(\frac{2k\pi}{K}\right)$$

$$(j = 1, 2 \ldots J; \quad k = 1, 2 \ldots, K) \tag{20}$$

and $||A^{-1}||_2 = (\min |\sigma_{jk}|)^{-1}$ so $||A^{-1}||_2 \; ||\vec{\varepsilon}||_2$ is simply determined.

Finite-Difference Equations and Solution

Two second-order-accurate differencing schemes were developed to solve the boundary-layer equations (6a) and (6b). The first of these proved superior for the separated flows computed in this investigation. The second more conventional method is described because it may prove efficient for certain extensions of the present approach.

The first method employs the central-differencing schemes for $\bar{u}_{yy}$ and $\bar{u}_y$ given by equations (15a) and (15b). The term $x\bar{u}\bar{u}_x$ in equation (6b) is regrouped as $0.5x(\bar{u}^2)_x$ and backward-differenced:

$$\frac{x}{2}\left.\frac{\partial u^2}{\partial x}\right|_{\substack{jk\\(B)}} = \frac{x_j}{2}\left(\frac{3u_{jk}^2 - 4u_{j-1,k}^2 + u_{j-2,k}^2}{2\Delta x}\right) + 0(\Delta x^2) \tag{21}$$

for $\bar{u} > 0.015$ or $j = J_{max}$. When $\bar{u} < 0.005$ or if $j = 2$, central differencing is used:

$$\frac{x}{2}\left.\frac{\partial u^2}{\partial x}\right|_{\substack{jk\\(C)}} = \frac{x_j}{2}\left(\frac{u_{j+1,k}^2 - u_{j-1,k}^2}{2\Delta x}\right) + 0(\Delta x^2) \tag{22}$$

In the intermediate zone, $0.005 \leq \bar{u} \leq 0.015$, the backward and central formulas are combined according to the relation

$$\left.\frac{\partial u^2}{\partial x}\right|_{jk} = \frac{1}{2}\left[(1+\alpha)\left.\frac{\partial u^2}{\partial x}\right|_{\substack{jk\\(B)}} + (1-\alpha)\left.\frac{\partial u^2}{\partial x}\right|_{\substack{jk\\(C)}}\right] \tag{23}$$

with $\alpha \equiv 1 + 200(\bar{u} - 0.015)$. The difference stencils are indicated in figure 1.

We emphasize that the blending defined by equation (23) is used solely to enhance the iteration process and is not otherwise fundamental. It is obvious that when the difference equations are switched at a given value of $\bar{u}$, a different set of data points is sampled and slightly different truncation errors result. The change in the residual error vectors at this point can be large enough to drive $\bar{u}^{(n+1)}$ back across the value at which switching occurs. This can then start an oscillatory mode with little decay. The blending simply modifies the differencing relations in a continuous fashion so that the residuals vary smoothly. In the present scheme, the blending is completed at $\bar{u} = 0.005$ to avoid a special operation at separation and reattachment. The blending can also be used between $0 \leq \bar{u} \leq 0.01$ without changing the results.

The continuity equation is differenced with the modified Euler scheme (i.e., trapezoidal rule or Crank-Nicholson differencing):

$$v_{jk} - v_{jk-1} = \frac{\Delta y}{2}\left(\left.\frac{\partial v}{\partial y}\right|_{jk} + \left.\frac{\partial v}{\partial y}\right|_{jk-1}\right) + O(\Delta y^2) \tag{24}$$

with

$$\left.\frac{\partial v}{\partial y}\right|_{jk} = -\left[x_j\left(\frac{u_{j+1,k} - u_{j-1,k}}{2\Delta x}\right) + \frac{m_j + 1}{2} u_{jk}\right] + O(\Delta x^2) \tag{25a}$$

for $j = 2, J_{max} - 1$, and

$$\left.\frac{\partial v}{\partial y}\right|_{jk} = -\left[x_j\left(\frac{3u_{jk} - 4u_{j-1,k} + u_{j-2,k}}{2\Delta x}\right) + \frac{m_j + 1}{2} u_{jk}\right] + O(\Delta x^2) \tag{25b}$$

at $j = J_{max}$. Note that $x\bar{u}_x$ is central-differenced at all times (except at J_{max}) in both the attached and reversed flow regions. While equation (24) is generally recommended, two schemes implicit in the y direction are presented as alternatives. Either the second-order-accurate "shifted" scheme

$$-3v_{jk-1} + 4v_{jk} - v_{jk+1} = 2\Delta y\left(\left.\frac{\partial v}{\partial y}\right|_{jk-1}\right) + O(\Delta y^2) \tag{26}$$

(where point jk is updated in the relaxation) or the third-order accurate-in-y "abated Hermite" scheme:

$$-5v_{jk-1} + 8v_{jk} - 3v_{jk+1} = 2\Delta y\left(\frac{7}{6}\frac{\partial v}{\partial y}\bigg|_{jk-1} + \frac{4}{6}\frac{\partial v}{\partial y}\bigg|_{jk} - \frac{5}{6}\frac{\partial v}{\partial y}\bigg|_{jk+1}\right) + 0(\Delta y^3) \tag{27}$$

can be used with $\partial v/\partial y|_{jk}$ again defined by equation (25). Both alternative schemes generate diagonally dominant tridiagonal blocks if a backward two-point differencing is used at the edge where $\bar{v}$ varies linearly. Effectively, equations (24), (26), and (27) give the same results.

An additional difference algorithm must be introduced if an inverse problem is solved. To impose a specified shear distribution, the momentum equation is evaluated at the surface:

$$m = -\frac{\partial^2\bar{u}}{\partial\bar{y}^2}\bigg|_{\bar{y}=0} \tag{28}$$

The second derivative is differenced as a function of $\bar{\tau}(x)$ to generate the second-order-accurate relation:

$$\frac{\partial^2 u}{\partial y^2}\bigg|_{j1} = \frac{-7u_{j1} + 8u_{j2} - u_{j3}}{2(\Delta y)^2} - \frac{3\tau|_j}{\Delta y} \tag{29}$$

Wake flow is treated in the same fashion with $\bar{\tau} = 0$ and the centerline velocity $\bar{u}_0$ specified:

$$(1 - \bar{u}_0^2)m = -\left(\frac{\partial^2\bar{u}}{\partial\bar{y}^2}\right)_0 + x\bar{u}_0\frac{d\bar{u}_0}{dx} \tag{30}$$

With the choice of differencing established, the solution procedure is straightforward. An approximate solution is input, usually by assuming a Blasius profile with $m = 0$ everywhere. For an inverse problem, a new distribution of m is then predicted for the specified boundary condition using either equation (28) or (30), with m updated by the relaxation (here written for $\bar{\tau}(x)$ specified):

$$m_j^{(n+1)} = m_j^{(n)} - \omega\left(m_j^{(n)} + \frac{3\tau|_j}{\Delta y} + \frac{-8u_{j2} + u_{j3}}{2(\Delta y)^2}\right) \tag{31}$$

For a poor guess of the initial solution, ω is initially kept small, $\omega = 0(0.05)$. New values of $\bar{u}$ are then found from relaxation of the momentum equation, while new estimates of $\bar{v}$ follow from continuity. This iteration sequence continues (with ω increased as the initial guess is improved) until an equilibrium or converged state is reached.

Solutions are found by both point and line successive underrelaxation (SUR) by using the iterative correspondence:

$$\vec{u}^{(n+1)} = \vec{u}^{(n)} + \omega H_u \vec{R}_u \tag{32a}$$

$$\vec{v}^{(n+1)} = \vec{v}^{(n)} + \omega H_v \vec{R}_v \tag{32b}$$

The residual vectors $\vec{R}_u$ and $\vec{R}_v$ represent the differenced momentum and differenced continuity equations, H_u and H_v are the conditioning matrices of the SUR algorithm, and ω is the relaxation factor. The line method (not used in eq. (32b)), in general, converges faster than the point scheme, but it is more sensitive to changes in m, making it more difficult to control in a computer batch mode. For moderate reversed flows and grid spacings with Δx approximately equal to Δy, the optimum relaxation parameter is slightly less than 1 for point SUR with $\omega = O(0.5)$ for equation (31). For line SUR, the optimum relaxation parameter is O(0.4) and ω is the O(0.15). The point SUR method fully converges in 400 to 800 iterations for a grid of 80 j-points and 50 k-points. Highly separated cases with rapid variations in the flow quantities require the higher iteration counts.

Note that, when $\bar{u}$ is negative, it is possible to blend from the central into a three-point forward difference and that this variant of the relaxation procedure is iteratively convergent. For very large reversed-flow regions, it may be advantageous to program this additional logic. Experience also shows that switching at $\bar{u} = 0$ from a three-point backward differencing into a three-point forward differencing without blending first into the central differencing is not convergent.

The second method developed is patterned after the Crank-Nicholson scheme. Equations (6a) and (6b) are first put into conservative form

$$\frac{\partial \bar{v}}{\partial \bar{y}} + \frac{\partial x\bar{u}}{\partial x} + \frac{(m - 1)\bar{u}}{2} = 0 \tag{33a}$$

$$\frac{\partial (\bar{u}\bar{v})}{\partial \bar{y}} - \frac{\partial^2 \bar{u}}{\partial \bar{y}^2} + \frac{\partial (x\bar{u}^2)}{\partial x} + \frac{3m - 1}{2}\bar{u}^2 - m = 0 \tag{33b}$$

The continuity equation is treated as before, and the y derivatives in the momentum equation are again centrally differenced by use of relations (15a) and (15b). The x-differencing is Crank-Nicholson

$$(xu^2)_{jk} - (xu^2)_{j-1k} = \frac{\Delta x}{2}\left[\left.\frac{\partial (xu^2)}{\partial x}\right|_{jk} + \left.\frac{\partial xu^2}{\partial x}\right|_{j-1,k}\right]$$

$$(\bar{u} > 0.01 \quad \text{or} \quad j = J_{max}) \tag{34}$$

with

$$\left.\frac{\partial (xu^2)}{\partial x}\right|_{jk} = \left.\frac{\partial^2 u}{\partial y^2}\right|_{jk} + m_j - \left(\frac{3m_j - 1}{2}\right)u_{jk} - \left.\frac{\partial uv}{\partial y}\right|_{jk} \tag{35}$$

where the appropriate central-difference formulas are substituted for the y derivatives. For reversed flow, forward differencing is used

$$(xu^2)_{j+1k} - (xu^2)_{jk} = \frac{\Delta x}{2}\left[\left.\frac{\partial(xu^2)}{\partial x}\right|_{j+1k} + \left.\frac{\partial(xu^2)}{\partial x}\right|_{jk}\right]$$

$$(\bar{u} < -0.01) \tag{36}$$

and the two schemes are linearly blended in the interval $-0.01 \leq \bar{u} \leq 0.01$ (see fig. 1). As before, the blending is used solely to enhance the iteration process.

The Crank-Nicholson scheme has been solved by both point and line SUR, and for either process the relaxation parameters are approximately those described for the previous point method. This second method requires slightly more algebra per step and, in general, has a slower rate of convergence than the first method.

The conservation-law form of the Crank-Nicholson method is not considered to be an advantage, and the procedure generally predicts m distributions that are slightly oscillatory. The oscillations decay as $\Delta x/\Delta y$ decreases, and they are confined to the relatively uninteresting attached flow regions. Of course, m is a sensitive function of the solution and the $\bar{u}$ and $\bar{v}$ distributions are much smoother. A nonconservative version of the Crank-Nicholson scheme was also programmed. In this case, the oscillations in m were negligible in attached-flow regions but observable in the separated zone.

Finally, we remark that a very stable first-order-accurate method can be developed by replacing the x differencing by

$$\left.\frac{x}{2}\frac{\partial u^2}{\partial x}\right|_{\substack{jk\\(B)}} = \frac{x_j}{2}\left(\frac{u_{jk}^2 - u_{j-1,k}^2}{\Delta x}\right) \qquad (\bar{u} > 0.01) \tag{37a}$$

$$\left.\frac{x}{2}\frac{\partial u^2}{\partial x}\right|_{\substack{jk\\(F)}} = \frac{x_j}{2}\left(\frac{u_{j+1,k}^2 - u_{jk}^2}{\Delta x}\right) \qquad (\bar{u} < -0.01) \tag{37b}$$

and

$$\left.\frac{x}{2}\frac{\partial u^2}{\partial x}\right|_{jk} = \frac{x_j}{4}\left[(1+\alpha)\left.\frac{\partial u^2}{\partial x}\right|_{\substack{jk\\(B)}} + (1-\alpha)\left.\frac{\partial u^2}{\partial x}\right|_{\substack{jk\\(F)}}\right]$$

$$(-0.01 \leq \bar{u} \leq 0.01; \qquad \alpha = 100\bar{u})$$

This scheme, with $x\bar{u}_x$ of continuity also first-order-accurate and switched in an identical fashion, will generally give "computational results" for the first problem, m specified. This first-order method is not recommended because a much finer x-grid spacing is required to maintain accuracy. This method proved useful for the numerical experiments described in the next section.

RESULTS AND DISCUSSION

In this section, the iterative finite-difference procedure is used to integrate the boundary-layer equations through a region of reversed flow. The separation-point singularity is investigated and conditions for regular behavior are determined. Calculated results are presented for a number of separated flows and the accuracy of the method is verified. Possible indications of the breakdown of the boundary-layer assumptions are also examined.

Direct Solutions

One of the most extensively studied problems in separating boundary-layer flows is the response of a flat-plate boundary layer to a linearly retarded external stream. This problem has been investigated by Howarth (ref. 23), Hartree (ref. 24), and many others; recent solutions have also been obtained by Briley (ref. 25) and Leal (ref. 26) using the full Navier-Stokes equations.

A sequence of calculations for different mesh spacings is shown in figure 2. The external velocity was specified to decrease linearly from the origin and the first-order-accurate difference scheme was used because of stability considerations. As the mesh is refined, the separation point moves upstream, with the last calculation in exact agreement with the accurate results of Smith and Clutter (ref. 27) for the flow upstream of separation. In the limit of zero-mesh spacing, it is evident that the solution is singular, with the wall shear approaching zero as the square root of the distance upstream of the separation point and the normal velocity unbounded. This type of behavior has been discussed in detail by Goldstein (ref. 28) and by Landau and Lifshitz (ref. 29) among others.

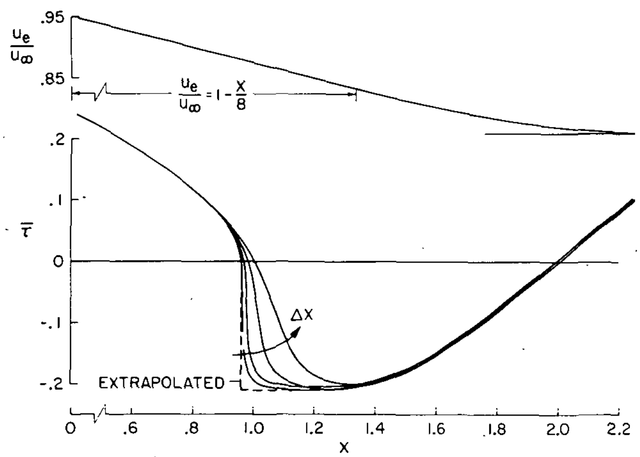

Figure 2.- Calculation for linearly retarded flow.

The interesting result here is that the use of an iterative finite-difference scheme which contains type-dependent operators allows the solution to be "continued" in the downstream direction. As the mesh is refined, it becomes evident that the flow fields upstream and downstream of separation are essentially independent, and the solution is therefore not meaningful. The wall shear jumps discontinuously to a negative value at separation and the normal velocity $\bar{v}$ becomes unbounded; all flow quantities subsequently remain continuous downstream of the jump and through reattachment. The magnitude of the discontinuity is determined by the specified pressure distribution in the separated zone. In a set of simple numerical experiments, a constant external velocity distribution was smoothly joined to the linearly retarded flow at different values of x. As the joining point was moved downstream, the magnitude of the jump and the extent of the reversed-flow region increased monotonically, with separation remaining at $x = 0.96$.

Singular behavior at the point of separation is thus related to the fact that the wall shear $\bar{\tau} \equiv (\partial\bar{u}/\partial\bar{y})_0$ is nonanalytic; in particular, $\bar{\tau} \sim (x_s - x)^{1/2}$ and $\partial\bar{\tau}/\partial x \to \infty$ as $x \to x_s$, the separation point. Therefore, the most obvious means of ensuring regular solutions at separation is to specify a continuous wall-shear distribution. The pressure distribution can then be determined as part of the solution by satisfying the momentum equation at the surface. Note that because the equations are nonlinear, it is not possible to guarantee that discontinuities will not occur in the flow field even with analytic boundary conditions prescribed (see ref. 30 for hyperbolic equations, or the weak solutions, eqs. (4a), (4b), and (4c)).

Inverse Solutions

With the wall-shear distribution specified, m can be determined from equation (31) and the second-order-accurate differencing scheme generates continuous solutions that give no indication of singular behavior at either separation or reattachment. These solutions are demonstrated to be regular under Accuracy Check. An inverse calculation cannot be duplicated by the direct method, however. Starting with a fully converged inverse solution, the calculation diverges if the iteration is continued with m fixed, that is, the relaxation parameter ω is set to zero in equation (31). Two examples of this type of inverse ($\bar{\tau}$ specified) and direct (m given) calculation sequences are shown in figure 3. After as many as 500 iterations (less if the solution is initially perturbed), the residuals begin to grow and the relaxation procedure either becomes unstable or converges to a different "solution" of the difference equations. As the mesh is refined, the second-order scheme fails to converge while the first-order method, for moderate grid spacing, generates computational results containing a discontinuity.

The fact that the direct calculation fails to duplicate a converged inverse solution cannot be ascribed to instabilities in the numerical scheme. The only difference between the two calculations is the value of the relaxation parameter ω in equation (31), and the solution processes are essentially identical. The numerical evidence therefore strongly suggests the existence of a saddle-type singularity at the separation point. Because of this critical point, roundoff and residual errors are sufficient to cause a completely converged solution to diverge when the pressure-gradient parameter is held

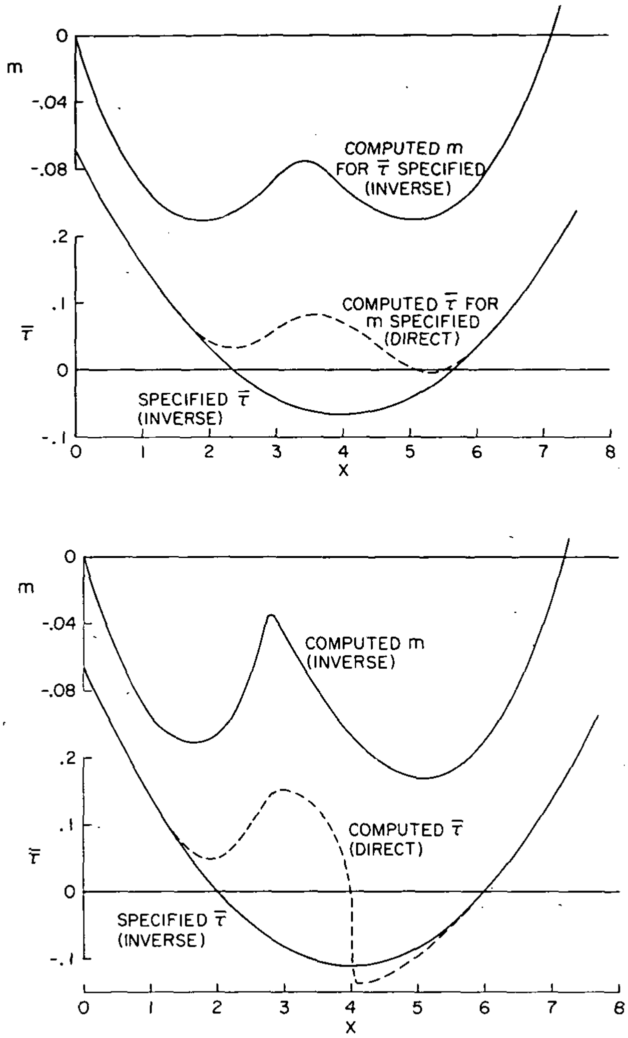

Figure 3.- Inverse/direct calculations that indicate existence of saddle point.

fixed. There are no other possible sources of error in the calculations: the variation of m is determined to arbitrarily high accuracy by the inverse solution, and no interpolation or differentiation is required as for computations with experimentally determined pressure distributions. With the pressure gradient corresponding to a completely regular flow field prescribed, the equations contain a saddle-type singularity at separation that makes a continuous numerical solution difficult to obtain. The saddle point is removed from the domain of integration, however, by specifying the wall shear rather than the pressure gradient as a boundary condition. A discussion of the essential differences between the two types of calculations is presented below. In the following section, the conditions for regular behavior at the point of separation are examined.

Saddle Point

The difference between the direct- and inverse-calculation procedures can best be illustrated by examining the boundary-layer equations near the surface. Expanding the velocity profile in a Taylor series in y yields

$$u(x,y) = f_1 y + f_2 \frac{y^2}{2!} + f_3 \frac{y^3}{3!} + \ . \ . \ . \qquad (38)$$

where $f_3 = 0$ and the notation is used

$$f_1 = \tau, \quad f_2 = p_x$$

Either f_1 or f_2 (but not both) is prescribed and all other f_i are determined as functions of x by the differential equations. The coefficients must satisfy the following set of relations:

$$
\left.\begin{aligned}
f_4 - f_1 f_1' &= 0 \\
f_5 - 2f_1 f_2' &= 0 \\
f_6 - 2f_2 f_2' &= 0 \\
f_7 - 4f_1 f_4' + 5f_4 f_1' &= 0 \\
f_8 - 5f_1 f_5' - 9f_2 f_4' + 5f_4 f_2' + 9f_5 f_1' &= 0 \\
&\vdots
\end{aligned}\right\} \tag{39}
$$

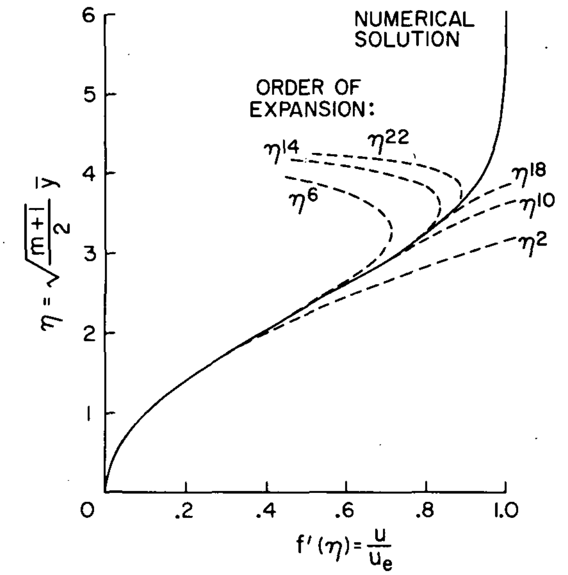

Figure 4.- Series expansion for similar separation profile.

where the prime denotes differentiation with respect to x. One of the f_i is given by the outer boundary condition that $u \to u_e$ as $y \to \infty$ (see ref. 28). The validity of the expansion procedure near the separation point is demonstrated in figure 4 for the particular case of similar flow with $m = -0.09044$, corresponding to zero shear (see eq. (7)). For this case, the only nonzero coefficients multiply terms of the order η^{4n-2} $(n = 1, 2, \ldots)$, and the expansion has been continued through the twenty-second power of the normal coordinate.

Direct calculations- For the pressure gradient specified, the coefficients in equations (39) must be determined by integrating the following system of first-order differential equations:

$$
f_1 f_1' = f_4 \tag{40a}
$$

$$
\left.\begin{aligned}
4f_1{}^2 f_4' &= f_1 f_7 + 5f_4{}^2 \\
14f_1{}^3 f_7' &= 2f_1{}^2[f_{10} + 8p_x(2p_{xx}^2 - 5p_x p_{xx})] \\
&\quad + 33f_1 f_4 f_7 - 35f_4{}^2 \\
&\vdots
\end{aligned}\right\} \tag{40b}
$$

The remaining coefficients are given by the algebraic relations:

$$\left.\begin{aligned} f_5 &= 2p_{xx}f_1 \\ f_6 &= 2p_xp_{xx} \\ 4f_1^2f_8 &= 9p_x(f_1f_7 + 5f_4^2) + 4f_1^2(10p_{xxx}f_1^2 - 13p_{xx}f_4) \\ f_9 &= 8f_1(5p_xp_{xxx} - 2p_{xx}^2) \end{aligned}\right\} \tag{41}$$

If one arbitarily terminates the expansions at this point and assumes that f_{10} can be correctly specified, then equations (40) and (41) provide relations for all coefficients of the lower-order terms. Given the velocity profile at a particular station, standard numerical techniques can be used to integrate equations (40a) and (40b) to determine the adjacent profile provided f_1 is nonzero. As $f_1 \to 0$, however, the solution becomes increasingly sensitive to the calculated value of f_1, and numerical errors are propagated in the direction of integration. The equations are highly nonlinear, with the coefficient f_1 of the derivatives determined by f_4, which in turn depends on f_7, f_{10}, etc., and on the outer boundary condition. Even for a pressure distribution corresponding to a regular solution at separation, the numerical integration of equations (40a) and (40b) is unlikely to result in values of f_1 and f_4 that vanish simultaneously. In that event, either f_1' will be infinite, leading to a square-root singularity, or f_1 will remain positive and the calculation will fail to show boundary-layer separation.

We emphasize that with the pressure gradient specified, the nonlinear equation for the wall shear (eq. (40a)) is inherent to the system of differential equations. Even with special procedures that would guarantee that f_4 vanishes at $\tau = 0$, the saddle point would remain to confound the numerical solution process. The behavior shown in figure 3 is to be expected because a converged solution perturbed by small roundoff and residual errors cannot remain converged in the presence of the saddle-point singularity.

Inverse calculations- For the wall shear specified and the pressure distribution determined as part of the solution, a different system of ordinary differential equations results:

$$2\tau f_2' = f_5 \tag{42a}$$

$$\left.\begin{aligned} 10\tau f_5' &= 2f_8 + 23\tau_x f_5 - 18f_2(\tau\tau_{xx} + \tau_x^2) \\ 40\tau f_8' &= 5f_{11} + 93\tau_x f_8 + 3f_5(160\tau\tau_{xx} - 201\tau_x^2) \\ &\quad + 27f_2(19\tau_x^3 - 16\tau\tau_x\tau_{xx} - 20\tau^2\tau_{xxx}) \\ &\ \vdots \end{aligned}\right\} \tag{42b}$$

including the algebraic relations

$$
\left.\begin{aligned}
f_4 &= \tau\tau_x \\
\tau f_6 &= f_2 f_5 \\
f_7 &= \tau(4\tau\tau_{xx} - \tau_x^2) \\
\tau f_9 &= 4(f_2 f_8 - f_5^2) + 26\tau_x f_2 f_5 - 36 f_2^2(\tau\tau_{xx} + \tau_x^2) \\
\tau^2 f_{10} &= 4f_2(f_2 f_8 - f_5^2) + 26\tau_x f_2^2 f_5 - 36 f_2^3(\tau\tau_{xx} + \tau_x^2) \\
&\quad + \tau^3(27\tau_x^3 - 24\tau\tau_x\tau_{xx} + 28\tau^2\tau_{xxx})
\end{aligned}\right\} \qquad (43)
$$

These equations are linear, with the coefficient of the derivatives τ specified as a function of x. The system is therefore less susceptible to numerical error, and although the matrix of coefficients still vanishes at $\tau = 0$, the saddle-point singularity has been effectively removed. If the numerical integration is accurate enough to ensure that $f_5 = 0$ when τ vanishes, the solution will pass smoothly through the separation point.

The basic difference between the inverse and direct problems is that, for the pressure gradient prescribed, the unknown shear distribution is determined by a nonlinear equation that contains a saddle-type singularity at separation. For the wall shear specified, on the other hand, the pressure gradient is given by a linear equation that is much less sensitive to numerical error. This is probably also the case when the displacement thickness is prescribed (see ref. 13). The fact that most numerical evidence indicates a singularity at separation is therefore misleading because of the difficulty in numerically integrating through the saddle point. Of course, not all pressure distributions admit a regular solution (as discussed in the following section).

An interesting point is that, provided the correct numerical procedures are used, no difficulties are encountered at reattachment (see fig. 2 or 3). The reason for this is that any numerical errors made at the reattachment point are either integrated out of the downstream boundary or upstream toward separation. The direction of the flow, and therefore the differencing scheme, results in a solution process that allows integration away from the saddle point at reattachment but that requires integration into the singularity at separation.

Several numerical experiments were performed to verify these conclusions. In one set of computations, the velocity profiles at separation and in the immediate vicinity of that point were held fixed after converging the inverse calculation. For these cases, the inverse and direct procedures gave identical solutions. Similar results were obtained when an artificial-viscosity term equal to εu_{xx} was introduced into the difference equations. As the coefficient ε was decreased, however, the direct calculation would again diverge from the inverse solution.

Pressure Gradient at Separation

As shown in the previous section, the existence of a regular solution requires that $f_4 = 0$ at the point of separation (see also refs. 31 and 32). The coefficients f_5, f_7, and f_9 must also vanish at the point of zero shear, and the pressure gradient must therefore satisfy certain specific conditions to permit the flow to pass smoothly through separation. The constraints on the pressure distribution cannot be determined directly because of the saddle point, but must be obtained from the inverse, or shear-specified, calculations.

It is reasonable to expect that only certain pressure distributions will admit regular solutions. The separation profile, for example, is determined by both the upstream and downstream flows so that some compatibility relation must be satisfied at this station. Also, from kinematic considerations, the boundary-layer approximation to the vorticity transport equation is

$$u \frac{\partial \omega}{\partial x} + v \frac{\partial \omega}{\partial y} = \frac{\partial^2 \omega}{\partial y^2} \tag{44}$$

where $\omega = \partial u/\partial y$ and $p_x = \partial \omega/\partial y$ at $y = 0$. The restriction on the pressure gradient at separation can thus be interpreted as a constraint on allowable boundary conditions: the normal gradient of vorticity at the surface is required to satisfy some local condition for the vorticity to remain continuous at the singular point.

From physical considerations, a constraint on the allowable pressure gradient implies that the interaction between the inner viscous layer and the outer fluid essentially determines the conditions at separation. Prandtl (ref. 33) recognized this in 1938 when he stated that the pressure field could not be chosen arbitrarily for the flow downstream of separation "to agree with observation." Most numerical solutions of the Navier-Stokes equations, including the recent investigation by Leal (ref. 26) in particular, also indicate that, when the interaction with the outer flow is included, there is no evidence of singular behavior at separation.

Because of the nonlinearity of the boundary-layer equations, it is not possible to determine the precise pressure-gradient condition that permits a regular solution. Certain restrictions on the pressure distribution can be inferred from the Taylor series expansion and from the numerical solutions, however. The acceleration of a fluid particle near the surface, for example, can be approximated as follows:

$$u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} = \frac{y^2}{2} \left[\tau\tau_x + 2\tau p_{xx} \frac{y}{3} + p_x p_{xx} \frac{y^2}{6} + \tau(4\tau\tau_{xx} - \tau_x^{\,2}) \frac{y^3}{60} + \ldots \right] \tag{45}$$

Immediately upstream of separation, τ and p_x are positive and τ_x is negative. As $\tau \to 0$, the fluid in a stream tube near the surface continues to decelerate, and the streamlines continue to move away from the wall provided

$$p_{xx}\left(p_x \frac{y^2}{6} + 2\tau \frac{y}{3}\right) < |\tau\tau_x| + |\tau\tau_x{}^2| \frac{y^3}{60} + \ldots \tag{46}$$

For the flow to separate smoothly, then, a restriction on the pressure field is that

$$p_{xx} < 0 \quad \text{as} \quad \tau \to 0 \tag{47}$$

There will therefore be an inflection on the pressure distribution upstream of the separation point. This requirement is consistent with experimental evidence, and the existence of a "knee" in the pressure curve is often taken to indicate boundary-layer separation.

The numerical evidence suggests that this condition is not sufficient, however. All regular solutions, in fact, satisfy the requirement:

$$\frac{dm}{dx} \geq 0 \quad \text{at} \quad \tau = 0 \tag{48}$$

This is a more restrictive condition than that given by equation (47) because m_x can be negative for p_{xx} negative. The linearly retarded flow considered under Direct Solutions, for example, satisfies equation (47) but not equation (48). In a series of papers, Meksyn (refs. 34 and 35) has contended that the existence of a minimum in m_x was a necessary condition for regular separation. He cited Schubauer's (ref. 36) measurements of the flow over an elliptic cylinder as experimental verification of this requirement. Similar arguments have also been advanced as a result of the use of approximate methods to calculate supersonic viscous-inviscid interactions (see, e.g., ref. 37).

The most useful means of examining the numerical results is in the $\bar{\tau}$ - m phase space (fig. 5). Several typical computations are presented, including the locus of solutions for similar flow. In these coordinates, x is a parameter that varies along the curves, with $\Delta x \to \infty$ for the similarity solutions. For this limiting curve, $dm/d\bar{\tau}$, and therefore dm/dx, is zero at the point of zero shear. All nonsimilar trajectories, on the other hand, have positive m_x at both the separation and reattachment points. This condition was never violated in approximately 30 different calculations using various specified shear distributions. Note that the locus of similar flows is sometimes taken to indicate singular behavior at separation because $\bar{\tau} \sim (m_0 - m)^{1/2}$ and $d\bar{\tau}/dm \to \infty$ at $\bar{\tau} = 0$. The similarity solutions are obtained for $m_x = 0$, however, and the limiting value of $d\bar{\tau}/dx$ (= $m_x \, d\bar{\tau}/dm$) must be carefully determined if an actual flow is replaced by a sequence of similar flows. In any event, the condition for regular separation, that $m_x \geq 0$ at the point of zero shear, is satisfied by both the similar and the nonsimilar flows.

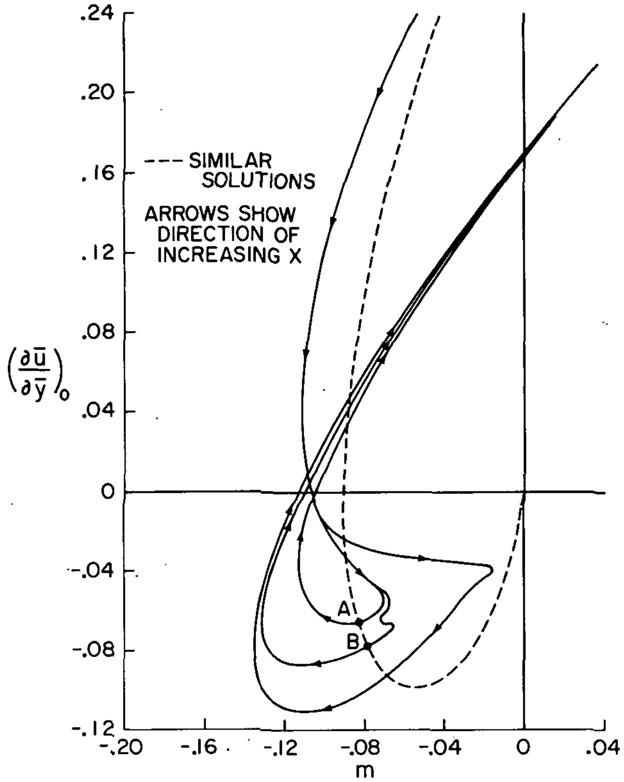

Figure 5.- Phase space representation.

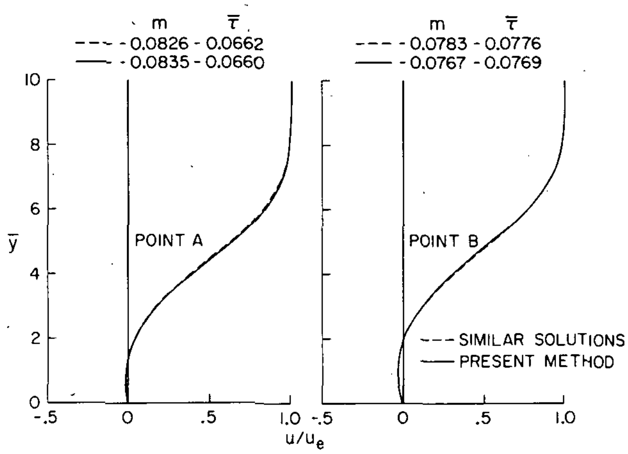

Figure 6.- Comparison with similar solutions.

Accuracy Check

The phase-space representation of solutions presents an opportunity to verify the accuracy of the numerical procedure. The points labeled A and B in figure 5, for example, have the same value of $\bar{\tau}$ and m as a corresponding similarity solution. The left-hand side of equation (7), which is completely determined by $\bar{\tau} = f''(0)$ and m, is therefore zero. The local x variation vanishes and the similar and nonsimilar profiles must be identical at those points. The velocity profiles calculated by the present scheme are compared to adjacent solutions of the similarity equation (obtained by fourth-order Runge-Kutta integration in ref. 38) in figure 6. There are essentially no differences in the results obtained by the two methods.

With a continuous shear distribution specified, the solution is constrained to be regular at both separation and reattachment. This result can be verified by comparing the calculated streamline pattern with the local solution of the Navier-Stokes equations obtained by Oswatitsch (ref. 39) (see also Dean (ref. 40) and Legendre (ref. 41)). At the point of zero shear, a regular solution of the Navier-Stokes equations requires that the angle of the dividing streamline be proportional to the ratio of the x derivative of the shear and the pressure gradient. In the transformed variables, the precise condition is

$$\sqrt{R} \tan \theta = -3\left(\sqrt{\frac{x}{u_e}}\frac{\bar{\tau}_x}{m}\right)_{\bar{\tau}=0} \quad (49)$$

where θ is the angle of the dividing streamline. For a prescribed shear distribution, the calculated values of m can be integrated in x to obtain u_e. The flow in the vicinity of separation and reattachment for a refined-mesh calculation ($\Delta x = \Delta y = 0.1$) is compared with equation (49) in figure 7. The calculated results agree exactly with the local Navier-Stokes solution at the point of zero shear, again demonstrating that the boundary-layer solution is regular.

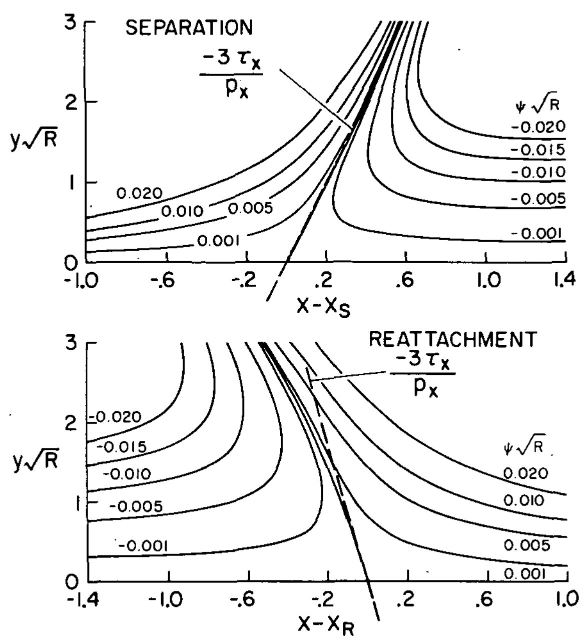

Figure 7.- Detailed flow field in the vicinity of $\tau = 0$.

Flow-Field Solutions

As previously mentioned, a number of different shear distributions were specified in an effort to determine the behavior of the boundary-layer equations in separated flow. Some of those results are presented in this section and the following one. Figure 8, for example, shows the streamlines and skin-friction variation, in physical coordinates, for a typical parabolic shear distribution. The relation between the physical and transformed variables is

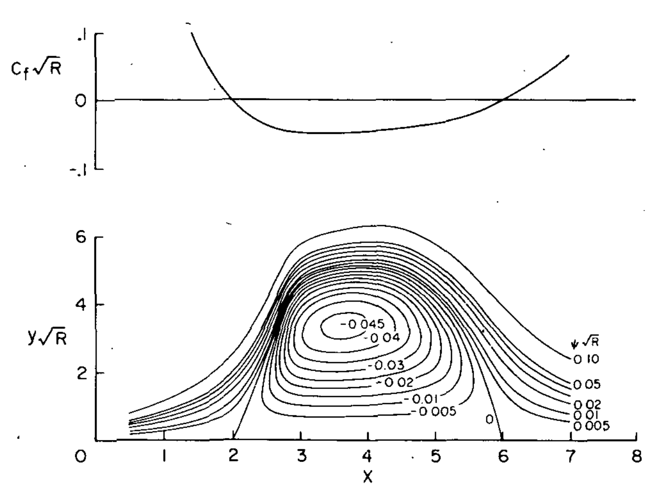

Figure 8.- Streamlines for specified shear distribution.

$$C_f \sqrt{R} = 2u_e \sqrt{\frac{u_e}{x}}\, \bar{\tau}$$

and

$$\psi \sqrt{R} = \sqrt{x u_e} \int_0^{\bar{y}} \bar{u}\, d\bar{y} \qquad (50)$$

In figure 9, the skin friction and streamline patterns for a different shear distribution are shown. For this case, the maximum reversed flow

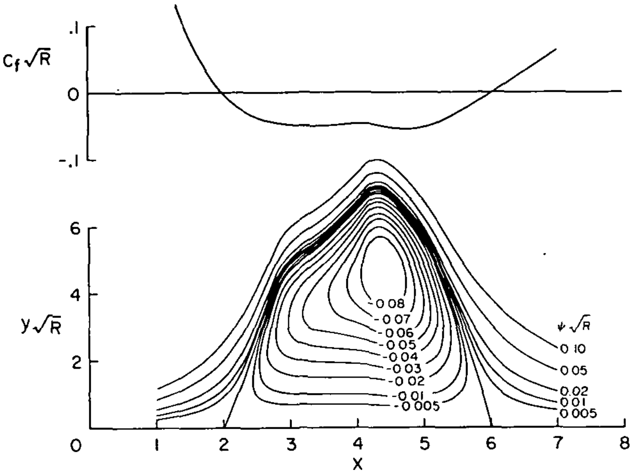

Figure 9.- Streamlines for specified shear distribution.

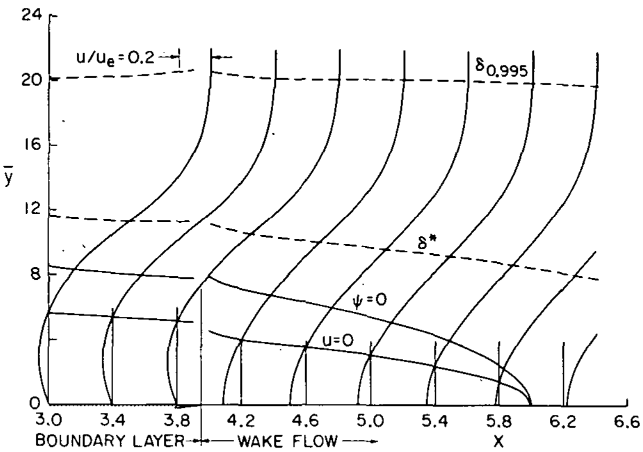

Figure 10.- Velocity profiles for trailing-edge flow.

occurs toward the reattachment side of the separation bubble. The dividing streamline has several rapid changes in slope, and this solution would be difficult to obtain if it were necessary to explicitly iterate for the location of the $u = 0$ line. Note that in all cases the normal coordinate is multiplied by the square root of the Reynolds number and that these solutions represent shallow separated regions confined to the interior of the viscous layer.

The present method can also be used to calculate flows where reattachment occurs in a wake rather than on a solid surface. The details of this type of flow field in the immediate vicinity of the trailing edge are shown in figure 10. Here, the transition from boundary-layer flow to wake flow is assumed to occur on a scale that is small compared to the thickness of the viscous layer (see ref. 42). The prescribed boundary conditions of zero velocity and negative wall shear were thus discontinuously changed to zero shear and specified reversed-flow velocity at the trailing edge. Based on order-of-magnitude considerations, the initial reversed-flow velocity was taken to be equal to the value of the wall shear at the joining point. No attempt was made to ensure continuity of the dividing streamline or displacement thickness, although mass and momentum are conserved in the solution to the differential equations.

Indications of Breakdown

In the previous sections, it was demonstrated that the boundary-layer equations have regular solutions at separation and reattachment. The flow structure at the separation point agrees with the limiting form of the Navier-Stokes equations, and the Goldstein solution does not appear to be relevant for real flows. The square-root singularity in the boundary-layer equations is a consequence of specifying an external pressure distribution based on an inviscid solution determined as though there were no separation. In practice, the pressure gradient is locally modified near the separation point such that the boundary-layer solution remains regular. The question that arises then concerns the manner in which the boundary-layer equations eventually break down. Real flows tend to separate toward the rear of a closed body and vorticity is transported into the outer fluid. In some cases, the vorticity is confined to a relatively narrow region, or wake, downstream of the body. In other situations, behind a circular cylinder, for example, a large region of the fluid becomes rotational. The vorticity is no longer restricted to a thin viscous layer and the normal component of velocity ceases to be small compared with the tangential component. In the present investigation, the region of separated flow is, of course, constrained to remain close to the surface, inside a layer of order $1/\sqrt{R}$. The numerical solutions may, however, suggest when this approximation is no longer realistic.

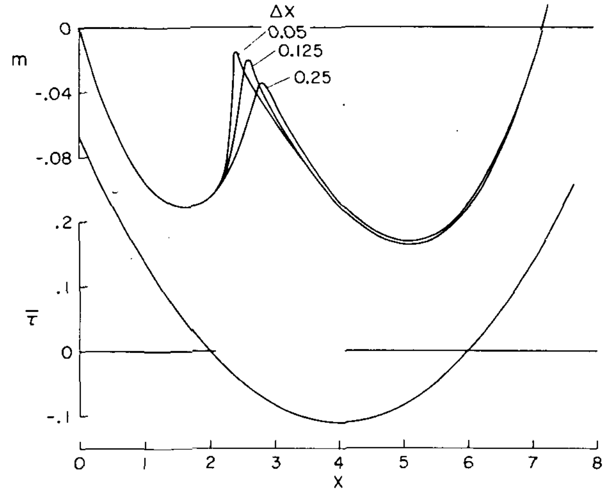

Figure 11.- Evidence of weak solutions for highly separated flow.

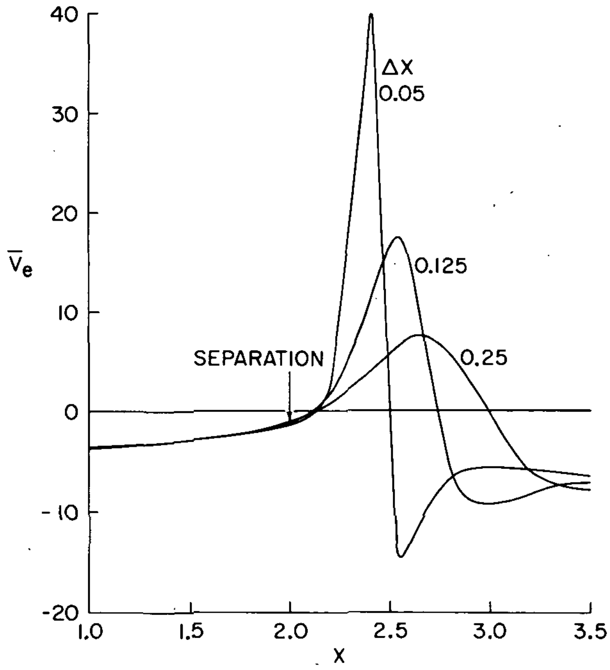

Figure 12.- Normal velocity distribution for highly separated flow.

An indication of the possible breakdown in the boundary-layer equations is shown in figure 11 for a highly separated flow. As the mesh is refined, the computed values of m appear to become discontinuous at a point downstream of separation. Apparently, there are two solutions, one associated with separation and the other with reattachment, that are joined in the reversed-flow region.

The distribution of $\bar{v}_e$, the transformed normal velocity, is shown on an expanded scale in figure 12. The normal velocities increase rapidly downstream of the separation point, and the viscous layer begins to break away from the surface. Because of constraints imposed by the boundary conditions, however, a discontinuity in $\bar{v}$ (and in $\partial\bar{u}/\partial x$) occurs at the maximum value of $\bar{v}_e$, and the remaining solution is continuous. Although there is a certain degree of smoothing in the numerical results, the discontinuity in $\bar{v}_e$ is evident in figure 12. A jump in $\bar{v}$ is an allowable weak solution of the differential equations and is apparently required for certain boundary conditions (e.g., large negative shears). If strong discontinuities occur when the shear distribution corresponding to a real flow is prescribed, however, this can be taken to indicate the breakdown of the boundary-layer assumptions.

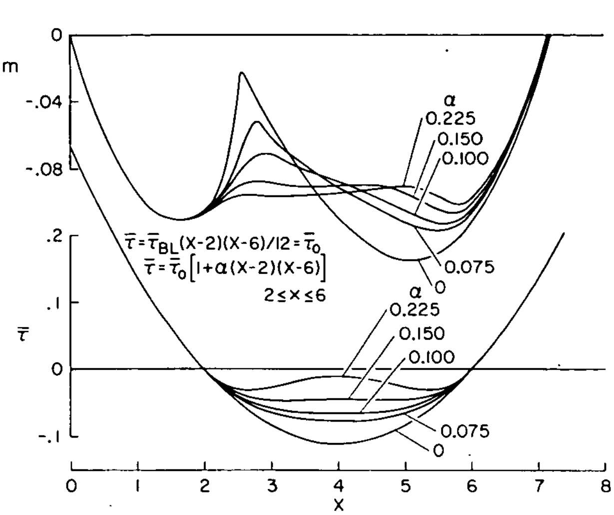

Figure 13.- Effect of shear variation in separated region.

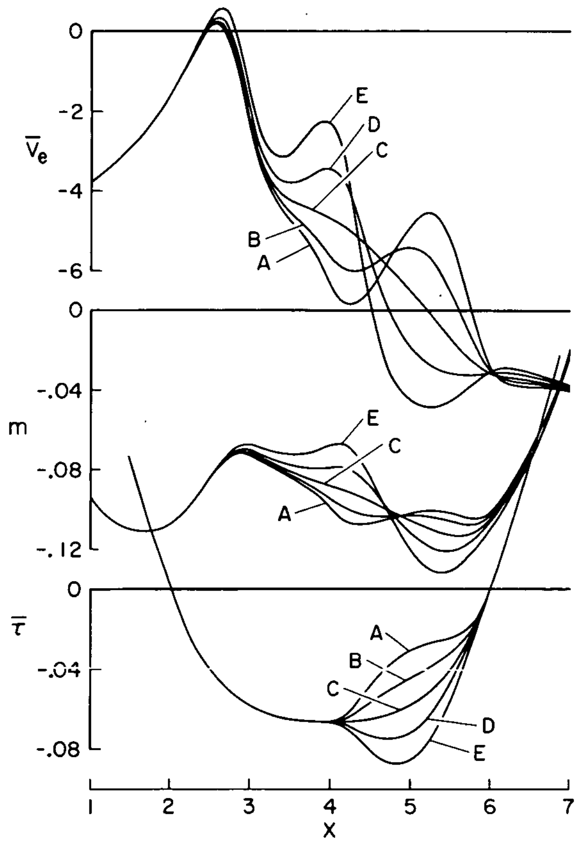

Figure 14.- Effect of shear variation in vicinity of reattachment.

The rapid variation of m, $\bar{v}_e$, and of the other flow quantities depends on the amount of reversed flow. This is illustrated in figure 13 for a sequence of solutions where the specified shear distribution was modified in the separated region. As the values of the shear become less negative, the solutions become increasingly smooth and continuous. The streamlines corresponding to $\alpha = 0.1$ were previously shown in figure 8. Even for this relatively mild case, the separating flow appears to undergo a rapid transition to the reattaching portion of the flow field at $x = 2.7$ approximately.

The results of an additional numerical experiment are shown in figure 14. For this case, the wall shear was varied only in the downstream portion of the separated zone and kept constant elsewhere. The nonlinearity and upstream influence of the boundary-layer equations is evident in the computed distributions of m and $\bar{v}_e$. Note also, however, that the flow in the immediate vicinity of separation ($x < 2.5$) is not significantly affected by relatively large changes near reattachment.

Upstream Influence

Part of the success of approximate methods that use forward-marching schemes (e.g., refs. 9 and 13) may be related to the limited upstream influence discussed above, particularly for flows with small separated zones. For the cases shown in figure 14, of course, it would not be possible to obtain accurate solutions downstream of $x = 2.5$ without including the boundary conditions at reattachment. To investigate this question, calculations were made with the convective term

$\bar{u}\bar{u}_x$ set to zero for $\bar{u} \le 0$ with both the first- and second-order-accurate difference schemes used in a marching mode. Only backward differencing was employed for both momentum and continuity, and the equations were completely relaxed at each x station before proceeding.

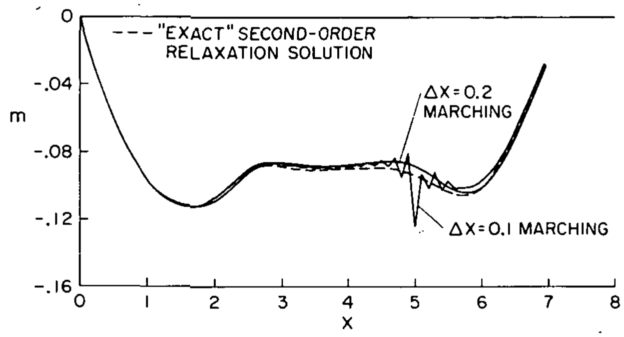

Figure 15.- Comparison with forward-marching procedure.

The three point backward second-order scheme could be marched accurately a short distance into the separated zone. It always diverged rapidly, however, at approximately the location where m_x became negative. The first-order scheme, with moderate grid spacing, could be used for small bubbles but diverged for more separated flows. A typical calculation for a mildly separated flow is compared in figure 15 with an "exact" solution obtained using the correctly differenced second-order scheme with smaller step size. As the grid spacing was refined in x, the first-order marching began to diverge from the correct solution. The instability could be delayed by keeping $\Delta y \le \Delta x$ and by accepting a less stringent iterative convergence criterion at each x station, but overall, the difference equations failed to converge to a solution as the grid was refined.

This experiment indicates that backward differencing, even with $\bar{u}\bar{u}_x = 0$ for $\bar{u} \le 0$, is always unstable. For mild separation, the eigenvalues in the unstable range are small and dominate the numerical calculation only after a sufficient number of steps is taken. It is probable that the schemes of references 9 through 11 and 13 are also divergent, although they are useful for certain applications.

To determine the effect of neglecting the upstream convection of momentum, additional calculations were performed with the term $\bar{u}\bar{u}_x$ set to zero for $\bar{u} \le 0$, but with the term $\bar{u}_x$ in the continuity equation centrally differenced. In this manner, upstream influence is retained and the solution must again be obtained by relaxation methods. The results were essentially identical to the exact second-order solution, verifying that the upstream convection of momentum is not significant for laminar flows with limited separated regions.

POSSIBLE EXTENSIONS

An important extension of the present method is to match an inner, boundary-layer solution to an outer inviscid flow to calculate complete viscous-inviscid interactions. It would also be useful to compare results of the present method to experimental measurements of laminar separating and reattaching flows. Because low-speed boundary layers rarely remain laminar through reattachment, the computations must be extended to supersonic flows.

There are, for example, a number of reliable experiments for compression-corner interactions at supersonic speeds, as well as several different approximate solutions and Navier-Stokes calculations available for comparison (e.g., refs. 43 and 44). It is indicated below how the method can be adapted to compressible flows, and an integral relation is proposed that offers promise of allowing the treatment of complete viscous-inviscid interactions.

Compressible Flows

To apply the method to compressible boundary layers, the following transformation can be used:

$$\left.\begin{aligned} \bar{y} &= \sqrt{\frac{\rho_e u_e}{\mu_e x}} \int_0^y \frac{\rho}{\rho_e}\, dy \\ \bar{v} &= \sqrt{\frac{x}{\rho_e \mu_e u_e}}\, \rho v + x\bar{u}\left(\frac{\partial \bar{y}}{\partial x}\right)_y \end{aligned}\right\} \qquad (51)$$

If it is assumed that the density-viscosity product is constant through the layer, the following equations result:

$$\left.\begin{aligned} x\bar{u}\frac{\partial \bar{u}}{\partial x} + \bar{v}\frac{\partial \bar{u}}{\partial \bar{y}} &= \bar{m}(1 - \bar{u}^2) + \frac{\partial^2 \bar{u}}{\partial \bar{y}^2} \\ x\frac{\partial \bar{u}}{\partial x} + \frac{\partial \bar{v}}{\partial \bar{y}} + \frac{\bar{u}}{2}\left(1 + \left\{\frac{1 - \gamma M_e^2}{1 + [(\gamma - 1)/2]M_e^2}\right\}\bar{m} = 0\right) \end{aligned}\right\} \qquad (52)$$

where

$$\bar{m} = \frac{x}{M_e}\frac{dM_e}{dx} \quad \text{and} \quad M_e = \frac{u_e}{a_e}$$

These equations can then be solved in exactly the same fashion as equations (6a) and (6b), with M_e calculated by integrating $\bar{m}$.

Viscous-Inviscid Interations

The solution for a complete interaction is complicated by the fact that $\bar{\tau}$ is specified. The following integral relation can, however, be used:

$$\bar{\tau} + \sqrt{Re_x}\,\frac{v_e}{u_e} = \left(1 + \frac{\gamma - 1}{2} M_e^2\right)\left(x\,\frac{d\lambda}{dx} + \frac{\lambda}{2}\right) + \left[\left(1 + \gamma M_e^2\right)\frac{\lambda}{2} + \frac{M_e^2 - 1}{1 + [(\gamma - 1)/2]M_e^2}\int_0^{\bar{y}_e} \bar{u}^2\, d\bar{y}\right]\bar{m} \tag{53}$$

For an assumed $\bar{\tau}$ distribution, the solution of equations (52) gives calculated values of $\bar{m}$ and hence of M_e and p_e. Using an inverse inviscid procedure, the distribution M_e can be specified to obtain a new effective body shape, that is, the streamline slopes v_e/u_e. Then, from equation (53), a new estimate for $\bar{\tau}$ can be determined and the procedure continued until convergence is achieved. Based on recent experience with an integral scheme (ref. 8), it will probably not be advantageous to precisely match the intermediate iterations for v_e/u_e.

It would, of course, be easier to specify v_e directly for the viscous solution. For similar flows, an efficient scheme was developed by differentiating the continuity equation with respect to $\bar{y}$ and using standard second-order central differencing for $\bar{v}$. The value of m was then updated by evaluating the continuity equation at the edge of the layer. This approach failed, however, for the complete boundary-layer equations with separated regions and was much slower for attached flows than the $\bar{\tau}$ specified schemes. An alternate approach, perhaps using the vorticity equation, may be required. All analytical and numerical evidence indicates, however, that the wall shear is the optimum boundary condition for calculating separated flows.

CONCLUDING REMARKS

The numerical procedures developed in the investigation provide an exact means for integrating the boundary-layer equations through separation and reattachment. The approach appears to be adaptable to the treatment of complete viscous-inviscid interactions for flow fields where the boundary layer remains confined to a narrow region: compression-corner flows or separation at the trailing edge of a streamlined body, for example. The method may also prove useful in evaluating different turbulence models for separated flows. As compared to complete Navier-Stokes solutions, the present approach allows an order-of-magnitude better resolution of the viscous region and requires considerably less computation time. Finally, a method based on the boundary-layer equations provides the most promising means for investigating the important problem of three-dimensional flow separation.

Ames Research Center
National Aeronautics and Space Administration
Moffett Field, Calif., 94035, March 8, 1974

REFERENCES

1. Abbott, D. E.; Holt, M.; and Nielsen, J. N.: Investigation of Hypersonic Flow Separation and Its Effects on Aerodynamic Control Characteristics. Vidya Rept. 81, 1962; also Studies of Separated Laminar Boundary Layers at Hypersonic Speed With Some Low Reynolds Number Data, AIAA Paper 63-172, 1963.

2. Nielsen, J. N.; Lynes, L. L.; and Goodwin, F. K.: Calculation of Laminar Separation With Free Interaction by the Method of Integral Relations: Part I - Two-Dimensional Supersonic Adiabatic Flows. AFFDL-TR-65-107, Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio, Oct. 1965.

3. Nielsen, J. N.; Lynes, L. L.; and Goodwin, F. K.: Calculation of Laminar Separation With Free Interaction by the Method of Integral Relations: Part II - Two-Dimensional Supersonic Nonadiabatic Flow and Axisymmetric Supersonic Adiabatic and Nonadiabatic Flows. AFFDL-TR-65-107, Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio, Jan. 1966.

4. Lees, L.; and Reeves, B. L.: Supersonic Separated and Reattaching Laminar Flows: I. General Theory and Application to Adiabatic Boundary-Layer/Shock-Wave Interactions. AIAA J., vol. 2, no. 11, Nov. 1964, pp. 1907-1920.

5. Reeves, B. L.; and Lees, L.: Theory of Laminar Near Wake of Blunt Bodies in Hypersonic Flow. AIAA J., vol. 3, no. 11, Nov. 1965, pp. 2061-2074.

6. Holden, M. S.: An Analytical Study of Separated Flows Induced by Shock Wave - Boundary-Layer Interaction. Rept. AI-1972-A-3, Cornell Aeronautical Lab., 1965.

7. Klineberg, J. M.; and Lees, L.: Theory of Laminar Viscous - Inviscid Interactions in Supersonic Flow. AIAA J., vol. 7, no. 12, Dec. 1969, pp. 2211-2221.

8. Klineberg, J. M.; and Steger, J. L.: Calculation of Separated Flows at Subsonic and Transonic Speeds. Proceedings of the Third International Conference on Numerical Methods in Fluid Mechanics, Springer-Verlag, vol. II, 1973, pp. 161-168.

9. Reyhner, T. A.; and Flügge-Lotz, I.: The Interaction of a Shock Wave With a Laminar Boundary Layer. Tech. Rept. 163, Div. of Engineering Mechanics, Stanford Univ., Nov. 1966; see also Internatl. J. Nonlinear Mech., vol. 3, June 1966, pp. 173-199.

10. Werle, M. J.; Polak, A.; and Bertke, S. D.: Supersonic Boundary Layer Separation and Reattachment Finite-Difference Solutions. Rept. AFL 72-12-1, Dept. of Aeronautical Engineering, Univ. of Cincinnati, Jan. 1973.

11. Dwoyer, D. L.: Supersonic and Hypersonic Two-Dimensional Laminar Flow Over a Compression Corner. Proceedings of AIAA Computational Fluid Dynamics Conference, Palm Springs, Calif., July 19-20, 1973, pp. 69-83.

12. Murphy, J. D.: A Critical Evaluation of Analytic Methods for Predicting Laminar Boundary-Layer, Shock-Wave Interaction. NASA TN D-7044, 1971.

13. Catherall, D.; and Mangler, K. W.: The Integration of the Two-Dimensional Laminar Boundary-Layer Equations Past the Point of Vanishing Skin Friction. J. Fluid Mech., vol. 26, pt. 1, 1966, pp. 163-182.

14. Klemp, J. B.; and Acrivos, A.: A Method for Integrating the Boundary-Layer Equations Through a Region of Reverse Flow. J. Fluid Mech., vol. 53, pt. 1, 1972, pp. 177-191.

15. Dennis, S. C. R.: The Motion of a Viscous Fluid Past an Impulsively Started Semi-Infinite Flat Plate. J. Inst. Math. Applications, vol. 10, Aug. 1972, pp. 105-117.

16. Hall, M. G.: The Boundary Layer Over an Impulsively Started Flat Plate. Proc. Roy. Soc. A, vol. 310, 1969, pp. 401-414.

17. Murman, E. M.; and Cole, J. D.: Calculation of Plane Steady Transonic Flows. AIAA J., vol. 9, no. 1, Jan. 1971, pp. 114-121.

18. Steger, J. L.; and Lomax, H.: Generalized Relaxation Methods Applied to Problems in Transonic Flow. Proceedings of the Second International Conference on Numerical Methods in Fluid Dynamics, Springer-Verlag, 1971, pp. 193-198.

19. Ortega, J.: Numerical Analysis, Academic Press, Inc., 1972.

20. Varga, R.: Matrix Iterative Analysis, Prentice-Hall, Inc., 1962.

21. Franklin, J.: Matrix Theory, Prentice-Hall, Inc., 1968.

22. Richtmyer, R. D.; and Morton, K. W.: Difference Methods for Initial-Value Problems, 2nd ed., John Wiley & Sons, New York, 1967, Ch. 8.

23. Howarth, L.: On the Solution of the Laminar Boundary Layer Equations. Proc. Roy. Soc. A, vol. 164, Feb. 15, 1938, pp. 547-579.

24. Hartree, D. R.: A Solution of the Laminar Boundary-Layer Equation for Retarded Flow. ARC Reports and Memoranda 2426, England, March 1939, pp. 156-182.

25. Briley, W. R.: A Numerical Study of Laminar Separation Bubbles Using the Navier-Stokes Equations. J. Fluid Mech., vol. 47, pt. 4, 1971, pp. 713-736.

26. Leal, L. G.: Steady Separated Flow in a Linearly Decelerated Free Stream. J. Fluid Mech., vol. 59, pt. 3, 1973, pp. 513-535.

27. Smith, A. M. O.; and Clutter, D. W.: Solution of the Incompressible Laminar Boundary-Layer Equations. AIAA J., vol. 1, no. 9, Sept. 1963, pp. 2062-2071.

28. Goldstein, S.: On Laminar Boundary-Layer Flow Near a Position of Separation. Quart. J. Mech. Appl. Math., vol. 1, March 1948, pp. 43-69.

29. Landau, L. D.; and Lifshitz, E. M.: Fluid Mechanics, Pergamon Press Ltd., Oxford, 1959, pp. 151-156.

30. Courant, R.; and Hilbert, D.: Methods of Mathematical Physics, vol. II, Interscience Publishers, New York, 1962, pp. 486-490.

31. Curle, N.: The Laminar Boundary Layer Equations, Oxford Mathematical Monographs, Oxford at the Claredon Press, 1962, pp. 34.

32. Brown, S. N.; and Stewartson, K.: Laminar Separation. Ann. Rev. Fluid Mech., Annual Reviews Inc., 1969, pp. 45-72.

33. Prandtl, L.: On the Calculation of the Boundary Layer. From Z. angew. Math. Mech., vol. 18, no. 1, 1938, pp. 77-82; translated as NACA TM 959, 1940.

34. Meksyn, D.: Integration of the Laminar Boundary Layer Equation. I - Motion of an Elliptic Cylinder. Separation. II - Retarded Flow Along a Semi-Infinite Plane. Proc. Roy. Soc. A, vol. 201, March 1950, pp. 268-283.

35. Meksyn, D.: Integration of the Boundary Layer Equations. Proc. Roy. Soc. A., vol. 237, Nov. 1956, pp. 543-559.

36. Schubauer, G. B.: Air Flow in a Separating Laminar Boundary Layer. NACA TR 527, 1935.

37. Lees, L.: Viscous-Inviscid Flow Interactions at Supersonic Speeds. First Annual Dean's Lecture, Dept. of Mechanical Engineering, Univ. of Notre Dame, April 10-11, 1967.

38. Klineberg, J. M.: Theory of Laminar Viscous-Inviscid Interactions in Supersonic Flow. Ph.D. Thesis, Calif. Inst. of Technology, Pasadena, Calif., 1968.

39. Oswatitsch, K.: Die Ablösungsbedingung von Grenzschichten. Boundary Layer Research, edited by H. Görtler, Springer-Verlag, 1958, pp. 357-367.

40. Dean, N. L.: Note on the Motion of a Liquid Near a Position of Separation. Proc. Camb. Phil. Soc., vol. 46, 1950, pp. 293-306.

41. Legendre, R.: Décollement Laminaire Régulier. Comptes Rendus, vol. 241, Sept. 1955, pp. 732-734.

42. Riley, N.; and Stewartson, K.: Trailing Edge Flows. J. Fluid Mech., vol. 39, pt. 1, 1969, pp. 193-207.

43. Lewis, J. E.; Kubota, T.; and Lees, L.: Experimental Investigation of Supersonic Laminar Two-Dimensional Boundary-Layer Separation in a Compression Corner With and Without Cooling. AIAA J., vol. 6, no. 1, Jan. 1968, pp. 7-14.

44. Carter, J. E.: Numerical Solutions of the Navier-Stokes Equations for the Supersonic, Laminar Flow Over a Two-Dimensional Compression Corner. NASA TR R-385, 1972.

APPENDIX

A program listing for the point-relaxation version of the first method is included. Only a description of the input and output is given; however, program variable names are the same as used in the text and should be self-explanatory. No effort was made to optimize the code or even to use a very efficient procedure for solving the attached region of the flow. A solution case corresponding to $\alpha = 0.1$ in figure 13 is included.

INPUT PARAMETERS

(Subroutine INIT)

JMAX = maximum number of points in x, $3 \leq$ JMAX ≤ 120
KMAX = maximum number of points in y, $4 \leq$ KMAX ≤ 100
DX = Δx
DY = Δy
XO = x-location of initial profile
UEXO = u_e at XO
SMO = m at XO
ALPHU, ALPHV, ALPHM - relaxation parameters to update u, v, m

(Subroutine PROFL)

DYO = Δy in which initial profile is given
KMAXO = number of data points to specify initial profile
U(K),V(K) = u and v of initial profile

(Main)

ITERM = maximum number of iterations permitted
RMAX = calculation is terminated if the maximum residual exceeds RMAX
RMIN = residual at which iteration ceases and the converged solution is printed
ALPHM2 = after an initial number of iterations, ALPHM is reset to this value
ADDAL = increment to ALPHU and ALPHV after an initial number of iterations

Wall Shear is analytically input in the present program.

OUTPUT

- The input parameters and the initial profile are printed.

- Minimum output from a marching routine that calculates the attached flow region is printed.

- Maximum residuals and their locations are printed every 10 iterations.

- The basic solution as a function of x is printed; data include j, x, m, u_e, $\bar{v}_e$, and $\bar{\tau}$.

- The solution profiles are printed at each x station. Data include k, $\bar{y}$, $\bar{u}$, $\bar{v}$, y, u, v, and $\psi/\sqrt{R}$ and interpolated values of y at constant values of $\psi/\bar{R}$.

PROGRAM LISTING

AND

CASE RUN

```
      PROGRAM FLOSEP (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
C
C           MAIN PROGRAM
C           AN ITERATIVE FINITE-DIFFERENCE METHOD FOR INTEGRATING THE
C           LAMINAR INCOMPRESSIBLE BOUNDARY-LAYER EQUATIONS THROUGH
C           SEPARATION AND REATTACHMENT

      COMMON                 SM(120) , SMC(120),U(120,100),V(120,100),XB(120)
      COMMON /PARAM/  JMAX     , KMAX      , DX        , DY    , UEXO ,
     1                ALPHU    , ALPHV     , ALPHM     , RMAX , RMIN
      COMMON /RESID/  ITER      , JREST    , KREST    , RESU , RESV,JU, KU
C
      DIMENSION  TAU(120)
C
C     CONSTANTS

      ITERM = 1000
      RMAX = 10.
      RMIN = 0.00005
      ALPHM2 = 0.5
      ADDAL  = 0.08
C
C           INITIALIZATION

      CALL INIT
      SY2 = 1./(DY*DY)
C
C           INPUT WALL SHEAR INTO TAU(J) ARRAY
C                 EXAMPLE CASE

      ALF = 0.1
      T0 = 0.33238/12.
      DO 10 J=1,JMAX
      X2 = XB(J)-2.
      X6 = X2-4.
      IF(X2) 9,9,5
    5 IF(X6) 7,9,9
    7 TAU(J) = T0*X2*X6*(1.+ALF*X2*X6)
      GO TO 10
    9 TAU(J) = T0*X2*X6
   10 CONTINUE

C           INITIALIZATION COMPLETE
C
C     MARCHING IN ATTACHED FLOW REGIONS

      CALL MARCH (J1, J2, TAU)
```

```
      IF(J1-J2) 12,50,50
   12 CONTINUE
C
C        RELAXATION PART
C
      WRITE(6,500)
C
      ITER = 0
   15 CONTINUE
      RMTST = 0.0
      JRM = 1

C        UPDATE M, EQ. 31

      DO 25 J=J1,J2
      RM = SM(J)+SY2*(4.*U(J,2)-0.5*U(J,3)-3.*DY*TAU(J))
      SM(J) = SM(J)-ALPHM*RM
      SMC(J) = 0.5*(SM(J)+1.0)
      RMP = ABS(RM)
      IF(RMP-RMTST) 25,24,24
   24 RESM = RM
      RMTST = RMP
      JRM = J
   25 CONTINUE
   30 CONTINUE

C        CALL RELAXATION ROUTINE, METHOD ONE

      ITER = ITER +1
      CALL RELAX (J1, J2)
      IF (ITER - (ITER/10)*10) 32,31,32

C                            PRINT MAXIMUM RESIDUALS AND LOCATION
C                            EVERY 10 ITERATIONS.

   31 CONTINUE
      WRITE (6,501) ITER,RESV,JREST,KREST,RESU,JU,KU, RESM,JRM
   32 REST = ABS(RESV)
      IF (ITER - 200) 38,34,38

C                            CHANGE RELAXATION PARAMETER AFTER 200 ITER

   34 ALPHM = ALPHM2
      ALPHU = ALPHU + ADDAL
      ALPHV = ALPHV + ADDAL
      IF (ALPHV - 1.0) 36,35,35
   35 CONTINUE
      ALPHU = 0.98
      ALPHV = 0.98
   36 CONTINUE
      WRITE(6,508) ALPHV,ALPHU,ALPHM

C        TEST WHETHER TO TERMINATE CALCULATION

   38 IF(REST-RMAX) 40,40,80
```

```
   40 IF (ITER - ITERM) 45,45,42
   42 CONTINUE
      WRITE (6,502)
      GO TO 50
   45 IF (REST - RMIN) 46,46,15
   46 CONTINUE
      WRITE (6,507)
C
   50 CONTINUE

C        TERMINATION WITH PRINT OUT

      CALL PRNT
C
   80 CONTINUE
      STOP

  500 FORMAT(1H0,35X22HRELAXATION CALCULATION //
     1          7X,4HITER,5X,5HRES V,7X,7HJV    KV,6X,5HRES U,7X,
     2       7HJU    KU,6X,5HRES M,7X,2HJM)
  501 FORMAT(5X,I5,3(E15.5,2I5))
  502 FORMAT(34H0  MAXIMUM ITERATIONS COMPUTED....)
  507 FORMAT(25H0  CONVERGED SOLUTION....)
  508 FORMAT(1H0, 17HALPHV,ALPHU,ALPHM ,3F13.5)

      END
C
      SUBROUTINE INIT

C            INPUT DATA SUBROUTINE

      COMMON           SM(120) , SMC(120),U(120,100),V(120,100),XB(120)
      COMMON /PARAM/   JMAX    , KMAX    , DX       , DY    , UEX0 ,
     1                 ALPHU   , ALPHV   , ALPHM    , RMAX , RMIN

      DIMENSION  U1(100) , V1(100)
C
      READ (5,500) JMAX,KMAX,DX,DY,X0,UEX0,SM0
      READ (5,501) ALPHU, ALPHV, ALPHM
      WRITE (6,505) JMAX, DX, X0, ALPHV, KMAX, DY, UEX0,ALPHU,SM0,ALPHM

C        INTERPOLATION OF INITIAL PROFILE IF NEEDED

      CALL PROFL (KMAX, DY, U1, V1)

      DO 30 J=1,JMAX
      XB(J) = X0+(J-1)*DX
      SM(J) = SM0
      SMC(J) = 0.5*(SM0+1.)
      DO 20 K=1,KMAX
      U(J,K) = U1(K)
      V(J,K) = V1(K)
   20 CONTINUE
   30 CONTINUE
```

```
      RETURN
  500 FORMAT(2I5,5F10.0)
  501 FORMAT(8F10.0)
  505 FORMAT(1H1,35X,12HINPUT VALUES//
     14X,6HJMAX =,I5,4X,4HDX =,F10.5,6X,4HX0 =,F10.5,4X,7HALPHV =,F10.5/
     24X,6HKMAX =,I5,4X,4HDY =,F10.5,4X,6HUEX0 =,F10.5,4X,7HALPHU =,
     3F10.5/ 39X,4HM0 =,F10.5,4X,7HALPHM =,F10.5)
      END
C
      SUBROUTINE PROFL (KMAX1, DY1, U1, V1)

C            INTERPOLATION OF INITIAL PROFILE.

      DIMENSION  Y(60),U(60),V(60), C(5), S(5), T(5) ,
     1              Y1(100), U1(100) , V1(100)

      INT = 2

C         INPUT INITIAL PROFILE

      READ(5,501) DY0,KMAX0
      WRITE(6,510)
      DO 2 K=1,KMAX0
      READ(5,500) U(K),V(K)
      Y(K) = (K-1)*DY0
      WRITE (6,511) K, Y(K), U(K), V(K)
    2 CONTINUE
      IF( KMAX1 - KMAX0) 30,30,3
    3 CONTINUE
      KSAVE = 1
      DO 20 K1=1,KMAX1
      Y1(K1) = (K1-1)*DY1
    4 DO 5 K=KSAVE,KMAX0
      KK = K
      IF(Y(K)-Y1(K1)) 5,5,6
    5 CONTINUE
    6 IF(KSAVE-1) 9,9,7
    7 IF(Y(KK-1)-Y1(K1)) 9,9,8
    8 KSAVE = 1
      GO TO 4
    9 KK = KK-(INT+1)/2
      IF(KK) 10,10,11
   10 KK = 1
      GO TO 13
   11 M = KK+INT
      IF(M-KMAX0) 13,13,12
   12 KK = KK-1
      GO TO 11
   13 INT1 = INT+1
      KSAVE = KK
      DO 14 L=1,INT1
      C(L) = Y1(K1)-Y(KK)
      S(L) = U(KK)
      T(L) = V(KK)
   14 KK = KK+1
```

```
      DO 16 KK=1,INT
      I = KK+1
   15 D = C(KK)-C(I)
      S(I) = (C(KK)*S(I)-C(I)*S(KK))/D
      T(I) = (C(KK)*T(I)-C(I)*T(KK))/D
      I = I+1
      IF(I-INT1) 15,15,16
   16 CONTINUE
      U1(K1) = S(INT1)
      V1(K1) = T(INT1)
   20 CONTINUE
      RETURN

C  NO INTERPOLATION

   30 DO 31 K=1,KMAX1
      U1(K) = U(K)
      V1(K) = V(K)
   31 CONTINUE

      RETURN

  500 FORMAT(8F10.0)
  501 FORMAT(F10.0,I5)
  510 FORMAT(1H0,15X,14HINITIAL VALUES//4X,1HK,7X,1HY,11X,1HU,11X,1HV)
  511 FORMAT(2X,I3,3F12.6)
      END
C
      SUBROUTINE MARCH (J1, J2, TAU)

C        MARCHING IN ATTACHED REGION

      COMMON             SM(120) , SMC(120),U(120,100),V(120,100),XB(120)
      COMMON /PARAM/  JMAX     , KMAX     , DX       , DY   , UEX0 ,
     1                ALPHU    , ALPHV    , ALPHM    , RMAX , RMIN

      DIMENSION  TAU(120) , UX(100)

      TAUWT = 0.02
      ALPHM2 = .5
      SY = .5*DY
      SYY = DY*DY
      SX2 = .5/DX
      SY2 = 1./(DY*DY)
C
      N = 2
      JINT = -1
      KM = KMAX-1
      IF(TAU(3) - TAUWT) 50,50,5
C
    5 N = N +1
      J = N
      J1 = J + JINT
      J2 = J
      JINT = 0
```

```
      IF( J - JMAX) 6,6,50
C    TEST TO SEE IF PROFILE IS ATTACHED
    6 IF(TAU(J) - TAUWT) 50,50,7
    7 CONTINUE
C   OBTAIN GOOD GUESS BY USING EXTRAPOLATION OF LAST COMPUTED PROFILES
      DO 8 K=2,KM
      U(J,K) = 2.*U(J-1,K) -U(J-2,K)
    8 V(J,K) = 2.*V(J-1,K) - V(J-2,K)
      SM(J) = SM(J-1)
C
      ITER = 0
      UX(1) = 0.
C
   10 ITER = ITER + 1
      DO 20 J=J1,J2
      JR = J-1
      JRR = J-2
      REST = 0.
      RM = SM(J)+SY2*(4.*U(J,2)-0.5*U(J,3)-3.*DY*TAU(J))
      SM(J) = SM(J)-ALPHM*RM
      SMC(J) = 0.5*(SM(J)+1.0)
      DO 18 K=2,KM
      KR = K-1
      KP = K +1
C
      IF( J-2) 12,12,13
   12 UX(K) = SX2*( U(J+1,K) - U(JR,K))
      U2X = UX(K) *( U(J+1,K) + U(JR,K))
      DIAX = 0.
      GO TO 14
   13 UX(K) = SX2* ( 3.*U(J,K) -4.*U(JR,K) +U(JRR,K))
      U2X = SX2*( 3.*U(J,K)**2 -4.*U(JR,K)**2 + U(JRR,K)**2)
      DIAX = 3.*XB(J) *SX2
   14 CONTINUE
      UY = SY*(U(J,KP)-U(J,KR))
      FU = UY*V(J,K)+SYY*(0.5*XB(J)*U2X-SM(J)*(1.-U(J,K)**2))
      RU = U(J,KR)-2.*U(J,K)+U(J,KP)-FU
      RV = V(J,K)-V(J,KR)+SY*(XB(J)*(UX(K)+UX(KR))+SMC(J)*(U(J,K)+
     1 U(J,KR)))
      DT = 2. + SYY*U(J,K)*DIAX
      DU = RU/DT
      DV = - RV
      U(J,K) = U(J,K) + DU
      V(J,K) = V(J,K) + DV
      RT = ABS(RV)
      IF(RT - REST) 18,18,15
   15 REST = RT
   18 CONTINUE
   20 CONTINUE
C
      IF( ITER - 20) 26,26,25
```

```
   25 ALPHM = ALPHM2
   26 CONTINUE
      IF( REST - RMAX) 27,100,100
   27 IF( REST - RMIN) 30,30,28
   28 IF( ITER - 600)  10,100,100
   30 CONTINUE
      IF(N-3) 35,35,40
   35 WRITE(6,501)

      IZ = 0
      RZ = 0.
      DO 36 J = 1,2
      V(J,KMAX) = V(J,KM) - DY*SMC(J)
      TAUW = .5*( -3.*U(J,1) +4.*U(J,2) -U(J,3))/DY
      WRITE(6,500) J,IZ,RZ,V(J,KMAX),TAUW,SM(J)
   36 CONTINUE
   40 J = N
      TAUW = .5*( -3.*U(J,1) +4.*U(J,2) -U(J,3))/DY
      V(J,KMAX) = V(J,KM) - DY*SMC(J)
      WRITE(6,500) J,ITER,REST,V(J,KMAX),TAUW,SM(J)
      GO TO 5
C
   50 J1 = N
      J2 = JMAX
      RETURN

  100 J = N
      TAUW = .5*( -3.*U(J,1) +4.*U(J,2) -U(J,3))/DY
      V(J,KMAX) = V(J,KM) - DY*SMC(J)
      WRITE(6,500) J,ITER,REST,V(J,KMAX),TAUW,SM(J)
      STOP

  500 FORMAT(1H ,2I5,4F13.5)
  501 FORMAT(1H1, 35X18HMARCHING PROCEDURE // 5X1HJ, 2X4HITER,
     1 7X5HRES V, 8X4HVMAX, 10X3HTAU,10X1HM )

      END
C
      SUBROUTINE RELAX (J1, J2)

C           RELAXATION FOR REVERSED FLOW

      COMMON          SM(120) , SMC(120),U(120,100),V(120,100),XB(120)
      COMMON /PARAM/  JMAX    , KMAX    , DX      , DY    , UEXO ,
     1                ALPHU   , ALPHV   , ALPHM   , RMAX , RMIN
      COMMON /RESID/  ITER     , JREST   , KREST   , RESU , RESV,JU, KU

      DIMENSION UX(100)
C
      EPS1 = .015
      EPS2 = 0.005
      KM = KMAX -1
C
      EPS = EPS1-EPS2
      RESU = 0.
```

```
      RESV = 0.0
      RTEST = 0.
      REST = 0.0
      SY = 0.5*DY
      SYY = DY*DY
      SX2 = 0.5/DX
      DO 50 J=J1,J2
      JR = J-1
      JP = J+1
      UX(1) = 0.0
      DO 30 K= 2,KM
      KR = K-1
      KP = K+1
C
C
      IF(J-JMAX) 10,13,13
   10 UX(K) = SX2*(U(JP,K)-U(JR,K))
      IF(J-2) 11,11,12
   11 U2X = SX2*(U(JP,K)**2-U(JR,K)**2)
      DIAX = 0.
      GO TO 20
   12 T = U(J,K)
      IF(T-EPS1) 16,16,14
   13 UX(K)  = SX2*(3.*U(J,K)-4.*U(JR,K)+U(JR-1,K))
C
C     ATTACHED FLOW
C
   14 JQ = J-2
      U2X = SX2*(U(JQ,K)**2-4.*U(JR,K)**2+3.*U(J,K)**2)
      DIAX = 3.*XB(J)*SX2
      GO TO 20
C
C     SEPARATED FLOW
C
   16 U2X = SX2*(U(JP,K)**2-U(JR,K)**2)
      DIAX = 0.
      IF(T-EPS2) 20,20,18
C
C     SEPARATION POINT
C     REATTACHMENT POINT
C
   18 JQ = J-2
      U2P = U2X
      U2X = SX2*(U(JQ,K)**2-4.*U(JR,K)**2+3.*U(J,K)**2)
      TA = (T-EPS2)/EPS
      U2X = TA*U2X+(1.-TA)*U2P
      DIAX = 3.*TA*XB(J)*SX2
C
   20 CONTINUE
      UY = SY*(U(J,KP)-U(J,KR))
      FU = UY*V(J,K)+SYY*(0.5*XB(J)*U2X-SM(J)*(1.-U(J,K)**2))
      RU = U(J,KR)-2.*U(J,K)+U(P,KP)-FU
      RV = V(J,K)-V(J,KR)+SY*(XB(J)*(UX(K)+UX(KR))+SMC(J)*(U(J,K)+
     1 U(J,KR)))
      DT = 2. + SYY*U(J,K)*DIAX
```

```
      DU = RU/DT
      DV = - RV
      U(J,K) = U(J,K)+ALPHU*DU
      V(J,K) = V(J,K)+ALPHV*DV
C
      RT = ABS(RU)
      IF(RT-RTEST) 22,22,21
   21 RESU = RU
      RTEST = RT
      JU = J
      KU = K
   22 CONTINUE
      RTT = ABS(RV)
      IF(RTT-REST) 27,27,26
   26 RESV = RV
      REST = RTT
      JREST = J
      KREST = K
      IF(REST-RMAX) 27,27,100
   27 CONTINUE
   30 CONTINUE
      K = KMAX
      RV = V(J,KMAX)-V(J,KM)+SY*(XB(J)*UX(KM)+SMC(J)*(1.+U(J,KM)))
      V(J,KMAX) = V(J,KMAX)-ALPHV*RV
      RTT = ABS(RV)
      IF(RTT-REST) 35,35,34
   34 RESV = RV
      REST = RTT
      JREST = J
      KREST = K
   35 CONTINUE
   50 CONTINUE
  100 RETURN
      END
C
      SUBROUTINE PRNT

C             OUTPUT SUBROUTINE

      COMMON           SM(120) , SMC(120),U(120,100),V(120,100),XB(120)
      COMMON /PARAM/   JMAX    , KMAX    , DX      , DY   , UEXO ,
     1                 ALPHU   , ALPHV   , ALPHM   , RMAX , RMIN
      COMMON /RESID/   ITER     , JREST   , KREST   , RESU , RESV,JU, KU
      COMMON /STRM/   PSI(100) , YST(100) , POUT(60) , Y1(60) , Y2(60) ,
     1                K1M      , K2M

      DIMENSION UY(120) , UE(120) , F(120) , FX(120) , UST(100) ,
     1          VST(100), ETA(100)

      HY = 0.5/DY
      KEND = KMAX
      SX = 0.5*DX
      DO 10 J=1,JMAX
      UY(J) = HY*(-3.*U(J,1)+4.*U(J,2)-U(J,3))
   10 CONTINUE
```

```
      REST = RESV
      WRITE(6,500) ITER,JREST,KREST,REST
C
C   INTEGRATION FOR UE(X)
C
      UE(1) = UEXO
      F(1) = ALOG(UEXO)
      IF( XB(1) -.00001) 12,13,13
   12 XB(1) = .00001
   13 CONTINUE
      FX(1) = SM(1)/XB(1)
      DO 15 J=2,JMAX
      FX(J) = SM(J)/XB(J)
      F(J) = F(J-1)+SX*(FX(J)+FX(J-1))
      UE(J) = EXP(F(J))
   15 CONTINUE

      WRITE (6,502)
      WRITE (6,503) (J,XB(J),SM(J),UE(J),V(J,KMAX),UY(J),J=1,JMAX)
      DO 20 K=1,KMAX
      ETA(K) = (K-1)*DY
   20 CONTINUE
      YST(1) = 0.
      VST(1) = 0.
      PSI(1) = 0.

      DO 50 J=1,JMAX
      C1 = SQRT(XB(J)/UE(J))
      C2 = 1./C1
      C3 = SQRT(XB(J)*UE(J))
      S1 = 0.5*(SM(J)-1.)
      S2 = 0.5*DY*C3
      UST(1) = UE(J)*U(J,1)

      DO 30 K=2,KMAX
      Y = ETA(K)
      YST(K) = C1*Y
      UST(K) = U(J,K)*UE(J)
      VST(K) = (V(J,K)-S1*Y*U(J,K))*C2
      PSI(K) = PSI(K-1)+S2*(U(J,K)+U(J,K-1))
   30 CONTINUE

      DSTR = YST(KMAX)-PSI(KMAX)/UE(J)
      WRITE(6,510) XB(J),DSTR
C
      CALL STREAM (KEND)
C
      WRITE (6,511)
      IF (K1M .EQ. 0) GO TO 40
      WRITE (6,512) (K,ETA(K),U(J,K),V(J,K),YST(K),UST(K), VST(K),
     1  PSI(K), POUT(K), Y1(K), Y2(K), K=1,K1M)

C                                  K1M - NUMBER OF POINTS WITH SEPARATION

   40 CONTINUE
```

```
      K2 = K1M + 1
      WRITE (6,514) (K,ETA(K),U(J,K),V(J,K),YST(K),UST(K), VST(K),
     1  PSI(K), POUT(K), Y1(K), K=K2,K2M)
C                                K2M - TOTAL NUMBER OF INTERPOLATED POINTS,
C                                       (SEPARATED PLUS SINGLE VALUED) .
      K3 = K2M + 1
      WRITE (6,513) (K,ETA(K),U(J,K),V(J,K),YST(K),UST(K), VST(K),
     1  PSI(K) , K=K3,KMAX)
   50 CONTINUE
      RETURN

  500 FORMAT(9H1  ITER =,I5,9H  JRESV =,I5,9H  KRESV =,I5,8H  RESV =,
     1      F13.5)
  502 FORMAT(5H0    J,6X,4HX(J),8X,2HSM,9X,6HU EDGE,7X,6HV EDGE,6X,
     1     10HDU/DY WALL)
  503 FORMAT(2X,I3,F10.3,4F13.6)
  510 FORMAT(1H1,6HX(J) = F12.5,2X8HDELSTR = F12.6 )
  511 FORMAT(102X,12HINTERPOLATED/
     13X,1HK,4X,3HETA,9X,1HU,10X,1HV,15X,1HY,11X,3HUST,9X,3HVST,9X,
     2  3HPSI,15X,3HPSI,7X,1HY,9X,1HY)
  512 FORMAT(I4,F8.3,2F12.6,4X,4F12.6,10X,F7.4,2F10.5)
  513 FORMAT(I4,F8.3,2F12.6,4X,4F12.6)
  514 FORMAT(I4,F8.3,2F12.6,4X,4F12.6,10X,F7.4,F10.5)

      END
C
      SUBROUTINE STREAM (KMAX)

C             INTERPOLATION FOR STREAM FUNCTION

      COMMON /STRM/  PSI(100) , YST(100) , POUT(60) , Y1(60) , Y2(60) ,
     1                K1M       , K2M

      DIMENSION     C(4)      , S(4)

C
      PSMIN = -0.10
      PSMAX =    10.0
C
      N0 = -200.*PSMIN
      N0 = N0+1
      N1 = N0+9
      N2 = N1+10
      N3 = N2+10
      DO 8 N=1,60
      IF(N-N3) 2,1,1
    1 POUT(N) = 6+N-N3
      NMAX = N
      IF(POUT(N)-PSMAX) 8,9,9
    2 IF(N-N2) 4,3,3
    3 POUT(N) = 0.5*(N-N2+1)
      GO TO 8
```

```
    4 IF(N-N1) 6,6,5
    5 POUT(N) = 0.05*(N-N1)
      GO TO 8
    6 POUT(N) = 0.005*(N-N0)
    8 CONTINUE
    9 CONTINUE
C
C*****FIND MINIMUM PSI

      INT = 2
      DO 10 K=2,KMAX
      KK = K
      IF(PSI(KK)-PSI(KK-1)) 10,10,11
   10 CONTINUE
   11 KPMIN = KK-1
      IF(KPMIN-INT) 12,12,15
   12 NMIN = N0
      KPMIN = 1
      GO TO 40
   15 PMIN = PSI(KPMIN)
C
C*****FIND INITIAL PRINTOUT VALUE

      DO 17 N=1,NMAX
      NN = N
      IF(POUT(N)-PMIN) 17,17,18
   17 CONTINUE
   18 NMIN = NN
      N1 = N0-NMIN
C
C*****INTERPOLATION...PSI FROM WALL TO U = 0

      DO 30 L=1,N1
      NN = N0-L
      DO 20 K=1,KPMIN
      KK = K
      IF(POUT(NN)-PSI(KK)) 20,20,21
   20 CONTINUE
   21 KK = KK-(INT+1)/2
      IF(KK) 22,22,23
   22 KK = 1
      GO TO 25
   23 M = KK+INT
      IF(M-KPMIN) 25,25,24
   24 KK = KK-1
      GO TO 23
   25 INT1 = INT+1
      DO 26 J=1,INT1
      C(J) = POUT(NN)-PSI(KK)
      S(J) = YST(KK)
   26 KK = KK+1
      DO 28 J = 1,INT
      I = J+1
   27 S(I) = (C(J)*S(I)-C(I)*S(J))/(C(J)-C(I))
      I = I+1
```

```
      IF(I-INT1) 27,27,28
   28 CONTINUE
      Y2(NN) = S(INT1)
   30 CONTINUE
      KPMIN = KPMIN+1
   40 CONTINUE
      KSAVE = KPMIN
C
C*****INTERPOLATION...PSI FROM U = 0 TO EDGE

      DO 60 N=NMIN,NMAX
      NN = N
      DO 45 K=KSAVE,KMAX
      KK = K
      IF(PSI(KK)-POUT(NN)) 45,45,46
   45 CONTINUE
   46 KK = KK-1
      IF(KK-KPMIN) 47,47,48
   47 KK = KPMIN
      GO TO 49
   48 M = KK+2
      IF(M-KMAX) 49,49,46
   49 KSAVE = KK
      DO 50 J=1,3
      C(J) = POUT(NN)-PSI(KK)
      S(J) = YST(KK)
   50 KK = KK+1
      S(2) = (C(1)*S(2)-C(2)*S(1))/(C(1)-C(2))
      S(3) = (C(1)*S(3)-C(3)*S(1))/(C(1)-C(3))
      Y1(NN) = (C(2)*S(3)-C(3)*S(2))/(C(2)-C(3))
   60 CONTINUE
      K1 = 0
      IF(NO-NMIN) 75,75,65
   65 NO1 = NO-1
      DO 70 L=NMIN,NO1
      K1 = K1 + 1
      POUT(K1) = POUT(L)
      Y1(K1)   = Y1(L)
      Y2(K1)   = Y2(L)
   70 CONTINUE
   75 CONTINUE
      K1M = K1
      K2  = K1M
      DO 80 L = NO,NMAX
      K2 = K2 + 1
      POUT(K2) = POUT(L)
      Y1(K2)   = Y1(L)
   80 CONTINUE
      K2M = K2
      RETURN

      END

   52   52.125      .24       0.        1.        0.
 0.9      0.9       0.05
```

```
.25           50
   0,00000   0,00000
   0,08304  -0,00519
   0,16597  -0,02075
   0,24848  -0,04665
   0,33003  -0,08281
   0,40991  -0,12906
   0,48726  -0,18513
   0,56111  -0,25065
   0,63047  -0,32513
   0,69442  -0,40793
   0,75216  -0,49834
   0,80313  -0,59555
   0,84704  -0,69869
   0,88390  -0,80687
   0,91400  -0,91924
   0,93790  -1,03498
   0,95632  -1,15337
   0,97010  -1,27377
   0,98010  -1,39566
   0,98712  -1,51861
   0,99191  -1,64230
   0,99506  -1,76649
   0,99708  -1,89100
   0,99832  -2,01571
   0,99906  -2,14055
   0,99949  -2,26546
   0,99973  -2,39041
   0,99986  -2,51538
   0,99993  -2,64037
   0,99996  -2,76537
   0,99998  -2,89036
   0,99999  -3,01536
   0,99999  -3,14036
   0,99999  -3,26536
   0,99999  -3,39036
   0,99999  -3,51536
   0,99999  -3,64036
   0,99999  -3,76536
   0,99999  -3,89036
   0,99999  -4,01536
   0,99999  -4,14036
   0,99999  -4,26536
   1,00000  -4,39036
   1,00000  -4,51535
   1,00000  -4,64035
   1,00000  -4,76535
   1,00000  -4,89035
   1,00000  -5,01535
   1,00000  -5,14035
   1,00000  -5,26535
     %ENDDS
```

INPUT VALUES

JMAX =	52	DX =	.12500	X0 =	0.00000	ALPHV =	.90000
KMAX =	52	DY =	.24000	UEX0 =	1.00000	ALPHU =	.90000
				M0 =	0.00000	ALPHM =	.05000

INITIAL VALUES

K	Y	U	V
1	0.000000	0.000000	0.000000
2	.250000	.083040	-.005190
3	.500000	.165970	-.020750
4	.750000	.248480	-.046650
5	1.000000	.330030	-.082810
6	1.250000	.409910	-.129060
7	1.500000	.487260	-.185130
8	1.750000	.561110	-.250650
9	2.000000	.630470	-.325130
10	2.250000	.694420	-.407930
11	2.500000	.752160	-.498340
12	2.750000	.803130	-.595550
13	3.000000	.847040	-.698690
14	3.250000	.883900	-.806870
15	3.500000	.914000	-.919240
16	3.750000	.937900	-1.034980
17	4.000000	.956320	-1.153370
18	4.250000	.970100	-1.273770
19	4.500000	.980100	-1.395660
20	4.750000	.987120	-1.518610
21	5.000000	.991910	-1.642300
22	5.250000	.995060	-1.766490
23	5.500000	.997080	-1.891000
24	5.750000	.998320	-2.015710
25	6.000000	.999060	-2.140550
26	6.250000	.999490	-2.265460
27	6.500000	.999730	-2.390410
28	6.750000	.999860	-2.515380
29	7.000000	.999930	-2.640370
30	7.250000	.999960	-2.765370
31	7.500000	.999980	-2.890360
32	7.750000	.999990	-3.015360
33	8.000000	.999990	-3.140360
34	8.250000	.999990	-3.265360
35	8.500000	.999990	-3.390360
36	8.750000	.999990	-3.515360
37	9.000000	.999990	-3.640360
38	9.250000	.999990	-3.765360
39	9.500000	.999990	-3.890360
40	9.750000	.999990	-4.015360
41	10.000000	.999990	-4.140360
42	10.250000	.999990	-4.265360
43	10.500000	1.000000	-4.390360
44	10.750000	1.000000	-4.515350
45	11.000000	1.000000	-4.640350
46	11.250000	1.000000	-4.765350
47	11.500000	1.000000	-4.890350
48	11.750000	1.000000	-5.015350
49	12.000000	1.000000	-5.140350
50	12.250000	1.000000	-5.265350

MARCHING PROCEDURE

J	ITER	RES V	VMAX	TAU	M
1	0	0.00000	-5.26035	.33236	0.00000
2	0	0.00000	-5.07140	.30525	-.01708
3	56	.00005	-4.88474	.27885	-.03267
4	31	.00005	-4.70010	.25331	-.04660
5	31	.00005	-4.51669	.22864	-.05902
6	32	.00004	-4.33307	.20482	-.06999
7	32	.00005	-4.14790	.18188	-.07956
8	33	.00005	-3.95947	.15980	-.08779
9	34	.00005	-3.76588	.13858	-.09471
10	36	.00004	-3.56470	.11822	-.10038
11	37	.00005	-3.35294	.09874	-.10483
12	40	.00005	-3.12640	.08012	-.10807
13	43	.00004	-2.87958	.06236	-.11014
14	46	.00005	-2.60430	.04547	-.11103
15	52	.00005	-2.28780	.02945	-.11073

RELAXATION CALCULATION

ITER	RES V	JV	KV	RES U	JU	KU	RES M	JM
10	-4.16649E-01	16	31	-5.43484E-02	20	12	-6.15891E-02	17
20	-2.11569E-01	16	52	-3.51207E-02	30	14	-1.81099E-02	19
30	-1.18811E-01	17	52	-2.77957E-02	39	14	-9.12830E-03	23
40	-8.18500E-02	18	36	-2.12829E-02	40	14	-5.76730E-03	29
50	-6.46309E-02	18	52	-1.78675E-02	39	15	-4.07726E-03	34
60	-5.34018E-02	19	38	-1.54402E-02	38	16	-3.06157E-03	35
70	-4.48915E-02	20	34	-1.33710E-02	38	17	-2.40243E-03	34
80	-3.96451E-02	20	37	-1.16703E-02	38	17	-1.93385E-03	35
90	-3.44836E-02	20	52	-1.02022E-02	37	18	-1.58735E-03	35
100	-3.12453E-02	21	36	-8.99933E-03	37	18	-1.32220E-03	35
110	-2.82128E-02	21	38	-7.93777E-03	37	18	-1.11392E-03	35
120	-2.53065E-02	21	40	-7.02794E-03	36	19	-9.47902E-04	35
130	-2.29850E-02	22	37	-6.26095E-03	36	19	-8.11696E-04	34
140	-2.12445E-02	22	38	-5.58132E-03	36	19	-7.00234E-04	34
150	-1.95801E-02	22	39	-4.97984E-03	36	19	-6.07534E-04	34
160	-1.80142E-02	22	40	-4.45886E-03	35	20	-5.30024E-04	34
170	-1.65604E-02	22	41	-4.00944E-03	35	20	-4.64554E-04	33
180	-1.52083E-02	22	42	-3.60754E-03	35	20	-4.09054E-04	33
190	-1.39623E-02	22	47	-3.24813E-03	35	20	-3.61656E-04	33
200	-1.28854E-02	23	39	-2.92890E-03	34	20	-3.20575E-04	32
ALPHV,ALPHU,ALPHM		.98000		.98000	.50000			
210	-1.31174E-02	23	38	-2.89506E-03	34	21	-3.23661E-04	32
220	-1.18878E-02	23	38	-2.55973E-03	34	21	-2.89295E-04	32
230	-1.09330E-02	23	38	-2.26111E-03	33	21	-2.57218E-04	31
240	-1.00819E-02	23	38	-2.01019E-03	33	21	-2.28298E-04	31
250	-9.30313E-03	23	38	-1.79535E-03	32	21	-2.02100E-04	30
260	-8.58974E-03	23	38	-1.60659E-03	31	21	-1.79308E-04	29
270	-7.92777E-03	23	39	-1.44229E-03	31	21	-1.60298E-04	27
280	-7.31741E-03	23	39	-1.29790E-03	30	21	-1.43829E-04	26
290	-6.74747E-03	23	39	-1.17138E-03	29	21	-1.29751E-04	26
300	-6.22276E-03	23	39	-1.05965E-03	29	21	-1.17349E-04	26
310	-5.74420E-03	23	39	-9.61477E-04	28	21	-1.06311E-04	26
320	-5.30489E-03	23	39	-8.73367E-04	28	21	-9.64234E-05	26
330	-4.90008E-03	23	39	-7.93587E-04	28	21	-8.75450E-05	26
340	-4.52562E-03	23	39	-7.22661E-04	27	21	-7.97481E-05	25
350	-4.16982E-03	23	39	-6.59688E-04	27	21	-7.28638E-05	25
360	-3.85032E-03	23	39	-6.02396E-04	27	21	-6.66721E-05	25
370	-3.55636E-03	23	39	-5.50186E-04	27	22	-6.10558E-05	25
380	-3.28395E-03	23	39	-5.02733E-04	27	22	-5.59199E-05	25
390	-3.03129E-03	23	39	-4.59337E-04	27	22	-5.12266E-05	25

400	-2,79691E-03	23	39	-4.19651E-04	27	22	-4,69350E-05	25
410	-2,57834E-03	23	39	-3.83337E-04	27	22	-4,30080E-05	25
420	-2,37211E-03	23	39	-3,50748E-04	26	21	-3,94065E-05	25
430	-2,18319E-03	23	39	-3,21217E-04	26	21	-3,60921E-05	25
440	-2,00907E-03	23	39	-2,94136E-04	26	21	-3,30561E-05	25
450	-1,84829E-03	23	39	-2,69302E-04	26	21	-3,02774E-05	25
460	-1,69976E-03	23	39	-2,46588E-04	26	22	-2,77316E-05	25
470	-1,56275E-03	23	39	-2,25785E-04	26	22	-2,54032E-05	25
480	-1,43650E-03	23	39	-2,06681E-04	26	22	-2,32780E-05	25
490	-1,31983E-03	23	39	-1,89150E-04	26	22	-2,13217E-05	25
500	-1,21200E-03	23	39	-1,73069E-04	26	22	-1,95227E-05	25
510	-1,11244E-03	23	39	-1,58323E-04	26	22	-1,78712E-05	25
520	-1,02060E-03	23	39	-1,44806E-04	26	22	-1,63560E-05	25
530	-9,35955E-04	23	40	-1,32418E-04	26	22	-1,49665E-05	25
540	-8,58001E-04	23	40	-1,21067E-04	26	22	-1,36925E-05	25
550	-7,86252E-04	23	40	-1,10670E-04	26	22	-1,25246E-05	25
560	-7,20256E-04	23	40	-1,01149E-04	26	22	-1,14889E-05	24
570	-6,59586E-04	23	40	-9,24329E-05	26	22	-1,05360E-05	24
580	-6,03841E-04	23	40	-8,44545E-05	26	22	-9,65932E-06	24
590	-5,52647E-04	23	40	-7,71536E-05	26	22	-8,85310E-06	24
600	-5,05656E-04	23	40	-7,04740E-05	26	22	-8,11195E-06	24
610	-4,62543E-04	23	39	-6,43642E-05	26	22	-7,43087E-06	24
620	-4,23006E-04	23	39	-5,87743E-05	26	22	-6,80522E-06	24
630	-3,87296E-04	23	39	-5,36484E-05	26	22	-6,23392E-06	24
640	-3,54526E-04	23	39	-4,89652E-05	26	22	-5,71744E-06	24
650	-3,24194E-04	23	39	-4,47269E-05	25	21	-5,23859E-06	24
660	-2,96289E-04	23	39	-4,08797E-05	25	21	-4,79580E-06	24
670	-2,70697E-04	23	39	-3,73562E-05	25	21	-4,38847E-06	24
680	-2,47256E-04	23	39	-3,41305E-05	25	21	-4,01443E-06	24
690	-2,25802E-04	23	39	-3,11784E-05	25	21	-3,67128E-06	24
700	-2,06177E-04	23	39	-2,84773E-05	25	21	-3,35667E-06	24
710	-1,88230E-04	23	39	-2,60066E-05	25	21	-3,06837E-06	24
720	-1,71823E-04	23	39	-2,37471E-05	25	21	-2,80429E-06	24
730	-1,56827E-04	23	39	-2,16812E-05	25	21	-2,56247E-06	24
740	-1,43124E-04	23	39	-1,97927E-05	25	21	-2,34112E-06	24
750	-1,30606E-04	23	39	-1,80667E-05	25	21	-2,13854E-06	24
760	-1,19171E-04	23	39	-1,64895E-05	25	21	-1,95321E-06	24
770	-1,08727E-04	23	39	-1,50485E-05	25	21	-1,78369E-06	24
780	-9,91907E-05	23	39	-1,37322E-05	25	21	-1,62866E-06	24
790	-9,04837E-05	23	39	-1,25298E-05	25	21	-1,48693E-06	24
800	-8,25349E-05	23	39	-1,14319E-05	25	21	-1,35737E-06	24
810	-7,52794E-05	23	39	-1,04293E-05	25	21	-1,23897E-06	24
820	-6,86572E-05	23	39	-9,51390E-06	25	21	-1,13077E-06	24
830	-6,26139E-05	23	39	-8,67827E-06	25	21	-1,03193E-06	24
840	-5,70993E-05	23	39	-7,91552E-06	25	21	-9,41632E-07	24
850	-5,20676E-05	23	39	-7.21935E-06	25	21	-8,59164E-07	24

CONVERGED SOLUTION....

ITER = 855 JRESV = 23 KRESV = 39 RESV = -.00005

J	X(J)	SM	U EDGE	V EDGE	DU/DY WALL
1	.000	0.000000	1.000000	-5.260350	.332356
2	.125	-.017085	.991494	-5.071399	.305247
3	.250	-.032671	.975064	-4.884745	.278848
4	.375	-.046602	.959649	-4.700095	.253310
5	.500	-.059022	.945225	-4.516694	.228636
6	.625	-.069988	.931733	-4.333065	.204825
7	.750	-.079561	.919121	-4.147900	.181878
8	.875	-.087787	.907340	-3.959468	.159795
9	1.000	-.094713	.896347	-3.765882	.138577
10	1.125	-.100381	.886101	-3.564696	.118224
11	1.250	-.104826	.876567	-3.352937	.098737
12	1.375	-.108073	.867712	-3.126399	.080115
13	1.500	-.110141	.859506	-2.879578	.062360
14	1.625	-.111033	.851925	-2.604296	.045470
15	1.750	-.110726	.844946	-2.287798	.029447
16	1.875	-.109203	.838554	-1.904166	.014291
17	2.000	-.106600	.832728	-1.499420	.000001
18	2.125	-.102479	.827461	-1.073748	-.012772
19	2.250	-.096883	.822753	-.627825	-.023542
20	2.375	-.090467	.818591	-.176912	-.032546
21	2.500	-.083681	.814938	.178891	-.040002
22	2.625	-.077332	.811739	.226370	-.046114
23	2.750	-.072739	.808907	-.245570	-.051068
24	2.875	-.070946	.806326	-1.199522	-.055036
25	3.000	-.071764	.803881	-2.294485	-.058172
26	3.125	-.073913	.801494	-3.181970	-.060614
27	3.250	-.076369	.799136	-3.751391	-.062485
28	3.375	-.078695	.796801	-4.071965	-.063890
29	3.500	-.080805	.794494	-4.249721	-.064917
30	3.625	-.082727	.792217	-4.363420	-.065640
31	3.750	-.084523	.789974	-4.459691	-.066116
32	3.875	-.086262	.787766	-4.563236	-.066385
33	4.000	-.088007	.785589	-4.686242	-.066471
34	4.125	-.089808	.783443	-4.834206	-.066383
35	4.250	-.091707	.781323	-5.008978	-.066112
36	4.375	-.093731	.779226	-5.210049	-.065634
37	4.500	-.095890	.777148	-5.435166	-.064908
38	4.625	-.098179	.775084	-5.680942	-.063878
39	4.750	-.100567	.773033	-5.943720	-.062470
40	4.875	-.103003	.770992	-6.220015	-.060595
41	5.000	-.105416	.768961	-6.506003	-.058148
42	5.125	-.107716	.766940	-6.797497	-.055006
43	5.250	-.109764	.764933	-7.091314	-.051034
44	5.375	-.111395	.762945	-7.384874	-.046075
45	5.500	-.112437	.760985	-7.674294	-.039962
46	5.625	-.112619	.759063	-7.953989	-.032507
47	5.750	-.111678	.757194	-8.212966	-.023510
48	5.875	-.109199	.755397	-8.430882	-.012753
49	6.000	-.104564	.753699	-8.581881	-.000001
50	6.125	-.098154	.752124	-8.659040	.014260
51	6.250	-.090805	.750690	-8.692821	.029383
52	6.375	-.082313	.749403	-8.717319	.045368

X(J) = .00001 DELSTR = .005437

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	.079721	-.004783	.000759	.079721	1.512570	.000030
3	.480	.159351	-.019125	.001518	.159351	6.046137	.000121
4	.720	.238629	-.043000	.002277	.238629	13.568177	.000272
5	.960	.317094	-.076346	.003036	.317094	23.988683	.000483
6	1.200	.394136	-.119024	.003795	.394136	37.143304	.000753
7	1.440	.469015	-.170811	.004554	.469015	52.771958	.001080
8	1.680	.540885	-.231401	.005313	.540885	70.500395	.001464
9	1.920	.608863	-.300391	.006072	.608863	89.845902	.001900
10	2.160	.672113	-.377245	.006831	.672113	110.248742	.002386
11	2.400	.729876	-.461360	.007589	.729876	131.073778	.002918
12	2.640	.781573	-.552047	.008348	.781573	151.672110	.003492
13	2.880	.826843	-.648554	.009107	.826843	171.427126	.004102
14	3.120	.865576	-.750093	.009866	.865576	189.801730	.004744
15	3.360	.897908	-.855898	.010625	.897908	206.366305	.005413
16	3.600	.924218	-.965218	.011384	.924218	220.845149	.006105
17	3.840	.945066	-1.077369	.012143	.945066	233.109622	.006814
18	4.080	.961141	-1.191736	.012902	.961141	243.176456	.007537
19	4.320	.973200	-1.307792	.013661	.973200	251.186190	.008271
20	4.560	.981988	-1.425101	.014420	.981988	257.356443	.009013
21	4.800	.988209	-1.543308	.015179	.988209	261.961209	.009761
22	5.040	.992490	-1.662149	.015938	.992490	265.291613	.010513
23	5.280	.995344	-1.781421	.016697	.995344	267.619265	.011267
24	5.520	.997198	-1.900972	.017456	.997198	269.202597	.012023
25	5.760	.998356	-2.020702	.018215	.998356	270.236148	.012780
26	6.000	.999060	-2.140550	.018974	.999060	270.890191	.013538
27	6.240	.999476	-2.260463	.019733	.999476	271.292966	.014297
28	6.480	.999715	-2.380413	.020492	.999715	271.533033	.015055
29	6.720	.999848	-2.500383	.021251	.999848	271.672945	.015814
30	6.960	.999921	-2.620371	.022009	.999921	271.752181	.016573
31	7.200	.999955	-2.740371	.022768	.999955	271.787165	.017332
32	7.440	.999976	-2.860361	.023527	.999976	271.813465	.018091
33	7.680	.999988	-2.980360	.024286	.999988	271.827718	.018850
34	7.920	.999990	-3.100360	.025045	.999990	271.829514	.019609
35	8.160	.999990	-3.220360	.025804	.999990	271.829135	.020368
36	8.400	.999990	-3.340360	.026563	.999990	271.828755	.021127
37	8.640	.999990	-3.460360	.027322	.999990	271.828376	.021886
38	8.880	.999990	-3.580360	.028081	.999990	271.827996	.022644
39	9.120	.999990	-3.700360	.028840	.999990	271.827617	.023403
40	9.360	.999990	-3.820360	.029599	.999990	271.827237	.024162
41	9.600	.999990	-3.940360	.030358	.999990	271.826858	.024921
42	9.840	.999990	-4.060360	.031117	.999990	271.826478	.025680
43	10.080	.999989	-4.180360	.031876	.999989	271.824365	.026439
44	10.320	.999994	-4.300361	.032635	.999994	271.831614	.027198
45	10.560	1.000000	-4.420357	.033394	1.000000	271.843084	.027957
46	10.800	1.000000	-4.540350	.034153	1.000000	271.845199	.028716
47	11.040	1.000000	-4.660350	.034912	1.000000	271.845199	.029475
48	11.280	1.000000	-4.780350	.035670	1.000000	271.845199	.030234
49	11.520	1.000000	-4.900350	.036429	1.000000	271.845199	.030993
50	11.760	1.000000	-5.020350	.037188	1.000000	271.845199	.031752
51	12.000	1.000000	-5.140350	.037947	1.000000	271.845199	.032511
52	12.240	1.000000	-5.260350	.038706	1.000000	271.845199	.033270

INTERPOLATED PSI	Y	Y
0.0000	0.00000	
.0050	.01016	
.0100	.01542	
.0150	.02044	
.0200	.02544	
.0250	.03044	
.0300	.03544	
.0350	.04044	
.0400	.04544	
.0450	.05044	
.0500	.05544	
.1000	.10544	
.1500	.15544	
.2000	.20544	
.2500	.25544	
.3000	.30544	
.3500	.35544	
.4000	.40544	
.4500	.45544	
.5000	.50544	
1.0000	1.00544	
1.5000	1.50544	
2.0000	2.00544	
2.5000	2.50544	
3.0000	3.00544	
3.5000	3.50544	
4.0000	4.00544	
4.5000	4.50544	
5.0000	5.00544	
6.0000	6.00544	
7.0000	7.00544	
8.0000	8.00544	
9.0000	9.00544	
10.0000	10.00544	

X(J) = .50000 DELSTR = 1,453258

K	ETA	U	V	Y	UST	VST	PSI	INTERPOLATED PSI	INTERPOLATED Y
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0000	0.00000
2	,240	,056527	-,000561	,174554	,053431	,009105	,004663	,0050	,17929
3	,480	,116364	-,002757	,349107	,109990	,036875	,018926	,0100	,24613
4	,720	,179239	-,007601	,523661	,169421	,083505	,043312	,0150	,30639
5	,960	,244691	-,016082	,698214	,231289	,148908	,078285	,0200	,35771
6	1,200	,312080	-,029144	,872768	,294986	,232578	,124216	,0250	,39664
7	1,440	,380587	-,047664	1,047321	,359741	,333466	,181359	,0300	,43375
8	1,680	,449249	-,072425	1,221875	,424642	,449903	,249817	,0350	,46904
9	1,920	,516991	-,104092	1,396428	,488673	,579553	,329528	,0400	,50250
10	2,160	,582683	-,143179	1,570982	,550767	,719451	,420247	,0450	,53291
11	2,400	,645210	-,190028	1,745535	,609869	,866102	,521544	,0500	,55982
12	2,640	,703540	-,244790	1,920089	,665004	1,015659	,632810	,1000	,78454
13	2,880	,756804	-,307412	2,094642	,715351	1,164170	,753283	,1500	,95478
14	3,120	,804353	-,377641	2,269196	,760295	1,307853	,882073	,2000	1,09711
15	3,360	,845803	-,455041	2,443749	,799474	1,443373	1,018204	,2500	1,22230
16	3,600	,881051	-,539021	2,618303	,832792	1,568079	1,160663	,3000	1,33408
17	3,840	,910268	-,628874	2,792856	,860408	1,680163	1,308440	,3500	1,43732
18	4,080	,933853	-,723823	2,967410	,882701	1,778723	1,460573	,4000	1,53352
19	4,320	,952385	-,823070	3,141963	,900218	1,863723	1,616181	,4500	1,62380
20	4,560	,966551	-,925837	3,316517	,913608	1,935865	1,774486	,5000	1,70966
21	4,800	,977081	-1,031404	3,491070	,923562	1,996403	1,934828	1,0000	2,42085
22	5,040	,984690	-1,139132	3,665624	,930754	2,046930	2,096666	1,5000	3,01192
23	5,280	,990034	-1,248481	3,840177	,935806	2,089181	2,259574	2,0000	3,56150
24	5,520	,993681	-1,359008	4,014731	,939253	2,124858	2,423223	2,5000	4,09642
25	5,760	,996099	-1,470367	4,189284	,941538	2,155512	2,587372	3,0000	4,62680
26	6,000	,997655	-1,582295	4,363838	,943009	2,182467	2,751849	3,5000	5,15604
27	6,240	,998629	-1,694602	4,538391	,943929	2,206796	2,916535	4,0000	5,68505
28	6,480	,999220	-1,807153	4,712945	,944488	2,229325	3,081350	4,5000	6,21403
29	6,720	,999569	-1,919857	4,887498	,944818	2,250665	3,246242	5,0000	6,74300
30	6,960	,999769	-2,032653	5,062052	,945007	2,271244	3,411180	6,0000	7,80095
31	7,200	,999879	-2,145504	5,236605	,945111	2,291353	3,576143	7,0000	8,85890
32	7,440	,999939	-2,258386	5,411159	,945168	2,311181	3,741121	8,0000	9,91685
33	7,680	,999971	-2,371285	5,585712	,945198	2,330847	3,906106	9,0000	10,97480
34	7,920	,999987	-2,484193	5,760266	,945213	2,350423	4,071095	10,0000	12,03275
35	8,160	,999995	-2,597106	5,934819	,945220	2,369950	4,236086		
36	8,400	,999998	-2,710021	6,109373	,945224	2,389451	4,401077		
37	8,640	1,000000	-2,822937	6,283926	,945225	2,408939	4,566070		
38	8,880	1,000001	-2,935854	6,458480	,945226	2,428421	4,731062		
39	9,120	1,000001	-3,048771	6,633033	,945226	2,447899	4,896055		
40	9,360	1,000001	-3,161687	6,807587	,945226	2,467376	5,061047		
41	9,600	1,000000	-3,274604	6,982140	,945226	2,486852	5,226040		
42	9,840	1,000000	-3,387521	7,156694	,945226	2,506328	5,391032		
43	10,080	1,000000	-3,500438	7,331247	,945226	2,525804	5,556024		
44	10,320	1,000000	-3,613356	7,505801	,945225	2,545280	5,721017		
45	10,560	1,000000	-3,726273	7,680354	,945225	2,564756	5,886009		
46	10,800	1,000000	-3,839190	7,854908	,945225	2,584232	6,051002		
47	11,040	1,000000	-3,952108	8,029461	,945225	2,603708	6,215994		
48	11,280	1,000000	-4,065025	8,204015	,945225	2,623184	6,380986		
49	11,520	1,000000	-4,177942	8,378568	,945225	2,642661	6,545979		
50	11,760	1,000000	-4,290860	8,553122	,945225	2,662137	6,710971		
51	12,000	1,000000	-4,403777	8,727675	,945225	2,681613	6,875964		
52	12,240	1,000000	-4,516694	8,902229	,945225	2,701090	7,040956		

Y

X(J) = 1.00000 DELSTR = 2.458977

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	.035955	.002658	.253497	.032229	.006989	.004085
3	.480	.077305	.009985	.506994	.069292	.028682	.016952
4	.720	.123854	.020670	.760492	.111016	.065781	.039806
5	.960	.175262	.033375	1.013989	.157095	.118788	.073789
6	1.200	.231024	.046720	1.267486	.207078	.187896	.119947
7	1.440	.290468	.059294	1.520983	.260360	.272891	.179195
8	1.680	.352747	.069661	1.774481	.316184	.373053	.252271
9	1.920	.416857	.076392	2.027978	.373649	.487085	.339706
10	2.160	.481664	.078095	2.281475	.431738	.613082	.441787
11	2.400	.545944	.073470	2.534972	.489355	.748554	.558535
12	2.640	.608448	.061361	2.788470	.545380	.890501	.689686
13	2.880	.667973	.040816	3.041967	.598736	1.035562	.834701
14	3.120	.723437	.011142	3.295464	.648450	1.180219	.992780
15	3.360	.773949	-.028057	3.548961	.693727	1.321034	1.162899
16	3.600	.818872	-.076859	3.802458	.733993	1.454894	1.343861
17	3.840	.857852	-.135024	4.055956	.768933	1.579238	1.534355
18	4.080	.890828	-.202028	4.309453	.798491	1.692216	1.733023
19	4.320	.918008	-.277109	4.562950	.822853	1.792772	1.938527
20	4.560	.939822	-.359342	4.816447	.842406	1.880639	2.149596
21	4.800	.956863	-.447707	5.069945	.857681	1.956253	2.365080
22	5.040	.969815	-.541167	5.323442	.869290	2.020604	2.583971
23	5.280	.979391	-.638729	5.576939	.877874	2.075055	2.805421
24	5.520	.986277	-.739493	5.830436	.884046	2.121161	3.028742
25	5.760	.991090	-.842677	6.083934	.888361	2.160504	3.253392
26	6.000	.994363	-.947638	6.337431	.891294	2.194568	3.478961
27	6.240	.996525	-1.053861	6.590928	.893232	2.224662	3.705147
28	6.480	.997913	-1.160956	6.844425	.894476	2.251871	3.931737
29	6.720	.998780	-1.268633	7.097922	.895253	2.277057	4.158582
30	6.960	.999306	-1.376689	7.351420	.895724	2.300871	4.385586
31	7.200	.999616	-1.484983	7.604917	.896002	2.323784	4.612685
32	7.440	.999793	-1.593423	7.858414	.896161	2.346126	4.839839
33	7.680	.999892	-1.701949	8.111911	.896250	2.368116	5.067025
34	7.920	.999945	-1.810525	8.365409	.896298	2.389898	5.294228
35	8.160	.999973	-1.919128	8.618906	.896323	2.411559	5.521440
36	8.400	.999987	-2.027747	8.872403	.896335	2.433153	5.748657
37	8.640	.999994	-2.136373	9.125900	.896341	2.454711	5.975876
38	8.880	.999997	-2.245004	9.379398	.896344	2.476250	6.203097
39	9.120	.999999	-2.353636	9.632895	.896346	2.497779	6.430318
40	9.360	1.000000	-2.462270	9.886392	.896346	2.519304	6.657539
41	9.600	1.000000	-2.570904	10.139889	.896347	2.540826	6.884760
42	9.840	1.000000	-2.679538	10.393386	.896347	2.562348	7.111982
43	10.080	1.000000	-2.788173	10.646884	.896347	2.583869	7.339203
44	10.320	1.000000	-2.896807	10.900381	.896347	2.605390	7.566425
45	10.560	1.000000	-3.005441	11.153878	.896347	2.626911	7.793646
46	10.800	1.000000	-3.114076	11.407375	.896347	2.648432	8.020867
47	11.040	1.000000	-3.222710	11.660873	.896347	2.669953	8.248089
48	11.280	1.000000	-3.331345	11.914370	.896347	2.691474	8.475310
49	11.520	1.000000	-3.439979	12.167867	.896347	2.712994	8.702532
50	11.760	1.000000	-3.548614	12.421364	.896347	2.734515	8.929753
51	12.000	1.000000	-3.657248	12.674862	.896347	2.756036	9.156975
52	12.240	1.000000	-3.765882	12.928359	.896347	2.777557	9.384196

INTERPOLATED

PSI	Y
0.0000	0.00000
.0050	.27416
.0100	.37994
.0150	.47367
.0200	.54466
.0250	.60387
.0300	.65990
.0350	.71272
.0400	.76210
.0450	.80291
.0500	.84249
.1000	1.16396
.1500	1.40144
.2000	1.59702
.2500	1.76717
.3000	1.91702
.3500	2.05489
.4000	2.18130
.4500	2.30016
.5000	2.41115
1.0000	3.30652
1.5000	4.01099
2.0000	4.63731
2.5000	5.22654
3.0000	5.79789
3.5000	6.36103
4.0000	6.92073
4.5000	7.47914
5.0000	8.03713
6.0000	9.15281
7.0000	10.26846
8.0000	11.38409
9.0000	12.49973
10.0000	13.61537

X(J) = 1.50000 DELSTR = 3.606936

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	.018125	.004952	.317053	.015578	.005576	.002470
3	.480	.042565	.019336	.634107	.036585	.023221	.010739
4	.720	.073229	.042178	.951160	.062941	.054081	.026516
5	.960	.109938	.072422	1.268214	.094492	.099166	.051474
6	1.200	.152406	.108893	1.585267	.130994	.159273	.087219
7	1.440	.200222	.150259	1.902320	.172092	.234886	.135266
8	1.680	.252822	.195018	2.219374	.217302	.326087	.196996
9	1.920	.309481	.241482	2.536427	.266001	.432463	.273612
10	2.160	.369307	.287794	2.853481	.317421	.553024	.366100
11	2.400	.431250	.331964	3.170534	.370662	.686165	.475180
12	2.640	.494132	.371927	3.487588	.424709	.829656	.601268
13	2.880	.556692	.405630	3.804641	.478480	.980700	.744447
14	3.120	.617647	.431130	4.121694	.530871	1.136049	.904456
15	3.360	.675767	.446709	4.438748	.580826	1.292178	1.080690
16	3.600	.729951	.450978	4.755801	.627397	1.445515	1.272226
17	3.840	.779302	.442970	5.072855	.669815	1.592688	1.477868
18	4.080	.823180	.422192	5.389908	.707529	1.730767	1.696214
19	4.320	.861236	.388647	5.706961	.740238	1.857462	1.925724
20	4.560	.893413	.342805	6.024015	.767893	1.971257	2.164803
21	4.800	.919919	.285532	6.341068	.790676	2.071456	2.411878
22	5.040	.941186	.217997	6.658122	.808955	2.158136	2.665462
23	5.280	.957798	.141558	6.975175	.823233	2.232037	2.924207
24	5.520	.970427	.057643	7.292229	.834087	2.294393	3.186937
25	5.760	.979770	-.032346	7.609282	.842118	2.346745	3.452660
26	6.000	.986496	-.127113	7.926335	.847899	2.390766	3.720573
27	6.240	.991206	-.225524	8.243389	.851947	2.428102	3.990044
28	6.480	.994415	-.326625	8.560442	.854705	2.460262	4.260594
29	6.720	.996542	-.429655	8.877496	.856533	2.488555	4.531871
30	6.960	.997912	-.534023	9.194549	.857712	2.514053	4.803625
31	7.200	.998772	-.639294	9.511602	.858451	2.537597	5.075682
32	7.440	.999296	-.745156	9.828656	.858901	2.559819	5.347928
33	7.680	.999607	-.851393	10.145709	.859168	2.581174	5.620288
34	7.920	.999786	-.957860	10.462763	.859322	2.601980	5.892715
35	8.160	.999887	-1.064466	10.779816	.859409	2.622447	6.165180
36	8.400	.999942	-1.171153	11.096869	.859456	2.642712	6.437666
37	8.640	.999971	-1.277884	11.413923	.859481	2.662860	6.710163
38	8.880	.999986	-1.384641	11.730976	.859494	2.682943	6.982666
39	9.120	.999993	-1.491410	12.048030	.859500	2.702990	7.255173
40	9.360	.999997	-1.598187	12.365083	.859503	2.723018	7.527681
41	9.600	.999999	-1.704967	12.682137	.859505	2.743037	7.800189
42	9.840	.999999	-1.811749	12.999190	.859505	2.763050	8.072698
43	10.080	1.000000	-1.918531	13.316243	.859506	2.783062	8.345208
44	10.320	1.000000	-2.025314	13.633297	.859506	2.803073	8.617717
45	10.560	1.000000	-2.132097	13.950350	.859506	2.823083	8.890226
46	10.800	1.000000	-2.238880	14.267404	.859506	2.843092	9.162735
47	11.040	1.000000	-2.345663	14.584457	.859506	2.863102	9.435245
48	11.280	1.000000	-2.452446	14.901510	.859506	2.883112	9.707754
49	11.520	1.000000	-2.559229	15.218564	.859506	2.903122	9.980263
50	11.760	1.000000	-2.666012	15.535617	.859506	2.923131	10.252773
51	12.000	1.000000	-2.772795	15.852671	.859506	2.943141	10.525282
52	12.240	1.000000	-2.879578	16.169724	.859506	2.963151	10.797791

INTERPOLATED

PSI	Y	Y
0.0000	0.00000	
.0050	.42509	
.0100	.61000	
.0150	.72864	
.0200	.83116	
.0250	.92461	
.0300	1.00014	
.0350	1.06776	
.0400	1.13223	
.0450	1.19353	
.0500	1.25168	
.1000	1.67561	
.1500	1.98299	
.2000	2.23273	
.2500	2.44397	
.3000	2.63140	
.3500	2.80147	
.4000	2.95626	
.4500	3.10087	
.5000	3.23575	
1.0000	4.29660	
1.5000	5.10568	
2.0000	5.80654	
2.5000	6.45196	
3.0000	7.06700	
3.5000	7.66544	
4.0000	8.25507	
4.5000	8.84028	
5.0000	9.42343	
6.0000	10.58761	
7.0000	11.75114	
8.0000	12.91461	
9.0000	14.07807	
10.0000	15.24153	

X(J) = 1.87500 DELSTR = 4.652430

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	.006572	.006111	.358878	.005511	.004672	.000989
3	.480	.019427	.024310	.717755	.016290	.019716	.004901
4	.720	.038542	.054297	1.076633	.032320	.046604	.013623
5	.960	.063861	.095669	1.435511	.053551	.086717	.029032
6	1.200	.095273	.147865	1.794389	.079891	.141288	.052976
7	1.440	.132590	.210108	2.153266	.111184	.211324	.087263
8	1.680	.175518	.281347	2.512144	.147181	.297516	.133623
9	1.920	.223632	.360212	2.871022	.187528	.400143	.193683
10	2.160	.276352	.444984	3.229899	.231736	.518976	.268916
11	2.400	.332929	.533586	3.588777	.279179	.653189	.360594
12	2.640	.392444	.623604	3.947655	.329085	.801298	.469740
13	2.880	.453822	.712353	4.306532	.380554	.961144	.597077
14	3.120	.515864	.796967	4.665410	.432579	1.129919	.742984
15	3.360	.577300	.874534	5.024288	.484097	1.304273	.907472
16	3.600	.636858	.942257	5.383166	.534039	1.480472	1.090165
17	3.840	.693336	.997622	5.742043	.581400	1.654624	1.290318
18	4.080	.745688	1.038561	6.100921	.625299	1.822939	1.506847
19	4.320	.793084	1.063589	6.459799	.665043	1.981993	1.738384
20	4.560	.834965	1.071886	6.818676	.700162	2.128968	1.983355
21	4.800	.871061	1.063327	7.177554	.730432	2.261830	2.240060
22	5.040	.901392	1.038439	7.536432	.755866	2.379420	2.506759
23	5.280	.926228	.998312	7.895310	.776691	2.481456	2.781759
24	5.520	.946036	.944461	8.254187	.793302	2.568444	3.063477
25	5.760	.961423	.878667	8.613065	.806205	2.641525	3.350491
26	6.000	.973060	.802823	8.971943	.815963	2.702280	3.641571
27	6.240	.981627	.718793	9.330820	.823147	2.752530	3.935691
28	6.480	.987768	.628308	9.689698	.828296	2.794154	4.232024
29	6.720	.992052	.532887	10.048576	.831888	2.828942	4.529925
30	6.960	.994960	.433809	10.407454	.834328	2.858499	4.828909
31	7.200	.996883	.332102	10.766331	.835940	2.884181	5.128620
32	7.440	.998119	.228561	11.125209	.836976	2.907086	5.428806
33	7.680	.998894	.123778	11.484087	.837626	2.928064	5.729295
34	7.920	.999365	.018179	11.842964	.838021	2.947745	6.029971
35	8.160	.999645	-.087942	12.201842	.838256	2.966581	6.330760
36	8.400	.999807	-.194387	12.560720	.838391	2.984881	6.631616
37	8.640	.999897	-.301027	12.919597	.838467	3.002852	6.932510
38	8.880	.999947	-.407782	13.278475	.838509	3.020628	7.233424
39	9.120	.999973	-.514602	13.637353	.838531	3.038290	7.534350
40	9.360	.999987	-.621458	13.996231	.838543	3.055888	7.835283
41	9.600	.999994	-.728333	14.355108	.838548	3.073452	8.136218
42	9.840	.999997	-.835219	14.713986	.838551	3.090998	8.437155
43	10.080	.999999	-.942109	15.072864	.838552	3.108534	8.738092
44	10.320	.999999	-1.049003	15.431741	.838553	3.126065	9.039030
45	10.560	1.000000	-1.155897	15.790619	.838553	3.143594	9.339968
46	10.800	1.000000	-1.262793	16.149497	.838553	3.161122	9.640906
47	11.040	1.000000	-1.369688	16.508375	.838553	3.178650	9.941844
48	11.280	1.000000	-1.476584	16.867252	.838554	3.196177	10.242782
49	11.520	1.000000	-1.583479	17.226130	.838554	3.213704	10.543721
50	11.760	1.000000	-1.690375	17.585008	.838554	3.231231	10.844659
51	12.000	1.000000	-1.797271	17.943885	.838554	3.248758	11.145597
52	12.240	1.000000	-1.904166	18.302763	.838554	3.266285	11.446535

INTERPOLATED PSI	Y	Y
0.0000	0.00000	
.0050	.72247	
.0100	.94123	
.0150	1.11277	
.0200	1.23730	
.0250	1.35129	
.0300	1.45175	
.0350	1.53329	
.0400	1.61095	
.0450	1.68473	
.0500	1.75462	
.1000	2.25897	
.1500	2.61637	
.2000	2.90339	
.2500	3.14513	
.3000	3.35746	
.3500	3.54999	
.4000	3.72381	
.4500	3.88625	
.5000	4.03679	
1.0000	5.20978	
1.5000	6.08992	
2.0000	6.84235	
2.5000	7.52747	
3.0000	8.17390	
3.5000	8.79786	
4.0000	9.40886	
4.5000	10.01258	
5.0000	10.61239	
6.0000	11.80720	
7.0000	13.00009	
8.0000	14.19266	
9.0000	15.38520	
10.0000	16.57773	

X(J) = 2.00000 DELSTR = 5.055079

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	.003070	.006252	.371942	.002556	.004297	.000475
3	.480	.012279	.025039	.743883	.010225	.018261	.002852
4	.720	.027624	.056396	1.115825	.023003	.043491	.009032
5	.960	.049082	.100251	1.487766	.040872	.081511	.020911
6	1.200	.076598	.156364	1.859708	.063786	.133713	.040374
7	1.440	.110056	.224264	2.231649	.091647	.201291	.069280
8	1.680	.149253	.303183	2.603591	.124287	.285155	.109437
9	1.920	.193872	.391997	2.975532	.161443	.385837	.162575
10	2.160	.243453	.489178	3.347474	.202730	.503392	.230300
11	2.400	.297374	.592769	3.719415	.247631	.637299	.314054
12	2.640	.354839	.700387	4.091357	.295485	.786385	.415058
13	2.880	.414883	.809259	4.463298	.345485	.948779	.534260
14	3.120	.476390	.916307	4.835240	.396703	1.121917	.672285
15	3.360	.538136	1.018277	5.207181	.448121	1.302604	.829397
16	3.600	.598846	1.111895	5.579123	.498676	1.487152	1.005474
17	3.840	.657266	1.194064	5.951064	.547324	1.671578	1.199999
18	4.080	.712245	1.262055	6.323006	.593106	1.851853	1.412086
19	4.320	.762806	1.313687	6.694947	.635210	2.024182	1.640517
20	4.560	.808213	1.347467	7.066889	.673022	2.185264	1.883810
21	4.800	.848008	1.362667	7.438830	.706160	2.332521	2.140297
22	5.040	.882024	1.359330	7.810772	.734486	2.464238	2.408215
23	5.280	.910369	1.338211	8.182713	.758090	2.579621	2.685790
24	5.520	.933387	1.300651	8.554655	.777257	2.678753	2.971320
25	5.760	.951595	1.248421	8.926596	.792420	2.762474	3.263234
26	6.000	.965624	1.183540	9.298538	.804102	2.832198	3.560141
27	6.240	.976150	1.108105	9.670479	.812867	2.889712	3.860849
28	6.480	.983839	1.024146	10.042421	.819270	2.936968	4.164379
29	6.720	.989308	.933518	10.414362	.823825	2.975912	4.469947
30	6.960	.993095	.837834	10.786304	.826978	3.008351	4.776948
31	7.200	.995648	.738430	11.158245	.829104	3.035866	5.084931
32	7.440	.997324	.636372	11.530187	.830500	3.059775	5.393569
33	7.680	.998395	.532475	11.902128	.831391	3.081126	5.702632
34	7.920	.999061	.427341	12.274070	.831946	3.100719	6.011964
35	8.160	.999464	.321399	12.646011	.832282	3.119138	6.321461
36	8.400	.999702	.214944	13.017953	.832480	3.136800	6.631058
37	8.640	.999838	.108172	13.389894	.832593	3.153985	6.940713
38	8.880	.999914	.001210	13.761836	.832657	3.170880	7.250401
39	9.120	.999956	-.105863	14.133777	.832691	3.187603	7.560107
40	9.360	.999978	-.212998	14.505719	.832710	3.204228	7.869823
41	9.600	.999989	-.320169	14.877660	.832719	3.220798	8.179544
42	9.840	.999995	-.427358	15.249602	.832724	3.237338	8.489267
43	10.080	.999998	-.534556	15.621543	.832726	3.253861	8.798992
44	10.320	.999999	-.641760	15.993485	.832727	3.270377	9.108718
45	10.560	1.000000	-.748966	16.365426	.832728	3.286889	9.418444
46	10.800	1.000000	-.856173	16.737368	.832728	3.303399	9.728170
47	11.040	1.000000	-.963380	17.109309	.832728	3.319908	10.037896
48	11.280	1.000000	-1.070588	17.481251	.832728	3.336417	10.347622
49	11.520	1.000000	-1.177796	17.853192	.832728	3.352925	10.657348
50	11.760	1.000000	-1.285004	18.225134	.832728	3.369434	10.967074
51	12.000	1.000000	-1.392212	18.597075	.832728	3.385942	11.276800
52	12.240	1.000000	-1.499420	18.969017	.832728	3.402451	11.586527

INTERPOLATED

PSI	Y	Y
0.0000	0.00000	
.0050	.88699	
.0100	1.15025	
.0150	1.31643	
.0200	1.46314	
.0250	1.57402	
.0300	1.67363	
.0350	1.76678	
.0400	1.85348	
.0450	1.92509	
.0500	1.99326	
.1000	2.52321	
.1500	2.89388	
.2000	3.18894	
.2500	3.44014	
.3000	3.66102	
.3500	3.85775	
.4000	4.03921	
.4500	4.20526	
.5000	4.36121	
1.0000	5.56806	
1.5000	6.46876	
2.0000	7.23730	
2.5000	7.93489	
3.0000	8.59147	
3.5000	9.22358	
4.0000	9.84130	
4.5000	10.45082	
5.0000	11.05576	
6.0000	12.25969	
7.0000	13.46110	
8.0000	14.66205	
9.0000	15.86293	
10.0000	17.06380	

X(J) = 2.12500 DELSTR = 5.488996

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.000112	.006051	.384607	-.000093	.003767	-.000018
3	.480	.005683	.024449	.769214	.004702	.016195	.000869
4	.720	.017395	.055656	1.153820	.014393	.039038	.004541
5	.960	.035043	.100044	1.538427	.028996	.074001	.012885
6	1.200	.058622	.157813	1.923034	.048507	.122676	.027789
7	1.440	.088089	.228908	2.307641	.072890	.186475	.051134
8	1.680	.123333	.312956	2.692248	.102053	.266561	.084776
9	1.920	.164145	.409191	3.076855	.135823	.363749	.130521
10	2.160	.210191	.516392	3.461461	.173925	.478407	.190086
11	2.400	.260985	.632840	3.846068	.215955	.610358	.265062
12	2.640	.315869	.756295	4.230675	.261370	.758783	.356853
13	2.880	.374009	.884017	4.615282	.309478	.922157	.466629
14	3.120	.434400	1.012824	4.999889	.359449	1.098224	.595266
15	3.360	.495896	1.139207	5.384496	.410335	1.284026	.743298
16	3.600	.557256	1.259481	5.769102	.461107	1.476001	.910879
17	3.840	.617207	1.369990	6.153709	.510715	1.670154	1.097764
18	4.080	.674523	1.467323	6.538316	.558142	1.862285	1.303308
19	4.320	.728102	1.548536	6.922923	.602476	2.048266	1.526499
20	4.560	.777037	1.611344	7.307530	.642968	2.224325	1.766002
21	4.800	.820677	1.654261	7.692136	.679078	2.387309	2.020236
22	5.040	.858653	1.676666	8.076743	.710501	2.534878	2.287457
23	5.280	.890884	1.678788	8.461350	.737172	2.665628	2.565849
24	5.520	.917553	1.661620	8.845957	.759239	2.779102	2.853614
25	5.760	.939059	1.626766	9.230564	.777035	2.875711	3.149045
26	6.000	.955955	1.576256	9.615171	.791016	2.956589	3.450586
27	6.240	.968886	1.512348	9.999777	.801716	3.023384	3.756874
28	6.480	.978525	1.437347	10.384384	.809691	3.078054	4.066753
29	6.720	.985522	1.353450	10.768991	.815481	3.122658	4.379279
30	6.960	.990469	1.262640	11.153598	.819574	3.159194	4.693706
31	7.200	.993874	1.166622	11.538205	.822392	3.189479	5.009461
32	7.440	.996156	1.066795	11.922812	.824280	3.215077	5.326122
33	7.680	.997646	.964267	12.307418	.825513	3.237273	5.643383
34	7.920	.998594	.859878	12.692025	.826297	3.257074	5.961032
35	8.160	.999180	.754243	13.076632	.826782	3.275242	6.278925
36	8.400	.999534	.647798	13.461239	.827075	3.292328	6.596967
37	8.640	.999741	.540840	13.845846	.827247	3.308719	6.915099
38	8.880	.999860	.433568	14.230452	.827345	3.324677	7.233283
39	9.120	.999926	.326108	14.615059	.827400	3.340371	7.551496
40	9.360	.999962	.218538	14.999666	.827429	3.355911	7.869725
41	9.600	.999981	.110907	15.384273	.827445	3.371362	8.187963
42	9.840	.999991	.003241	15.768880	.827453	3.386764	8.506206
43	10.080	.999996	-.104443	16.153487	.827457	3.402140	8.824450
44	10.320	.999998	-.212136	16.538093	.827459	3.417501	9.142697
45	10.560	.999999	-.319834	16.922700	.827460	3.432855	9.460943
46	10.800	1.000000	-.427534	17.307307	.827460	3.448206	9.779190
47	11.040	1.000000	-.535236	17.691914	.827461	3.463555	10.097437
48	11.280	1.000000	-.642938	18.076521	.827461	3.478903	10.415684
49	11.520	1.000000	-.750641	18.461128	.827461	3.494251	10.733931
50	11.760	1.000000	-.858343	18.845734	.827461	3.509599	11.052178
51	12.000	1.000000	-.966046	19.230341	.827461	3.524946	11.370425
52	12.240	1.000000	-1.073748	19.614948	.827461	3.540294	11.688672

INTERPOLATED

PSI	Y	Y
0.0000	.39345	
.0050	1.17815	
.0100	1.41920	
.0150	1.59961	
.0200	1.73556	
.0250	1.85930	
.0300	1.96359	
.0350	2.05213	
.0400	2.13624	
.0450	2.21592	
.0500	2.29118	
.1000	2.82885	
.1500	3.21033	
.2000	3.51595	
.2500	3.77389	
.3000	3.99923	
.3500	4.20394	
.4000	4.38804	
.4500	4.56036	
.5000	4.71956	
1.0000	5.95666	
1.5000	6.87858	
2.0000	7.66219	
2.5000	8.37149	
3.0000	9.03749	
3.5000	9.67752	
4.0000	10.30181	
4.5000	10.91685	
5.0000	11.52670	
6.0000	12.73918	
7.0000	13.94847	
8.0000	15.15711	
9.0000	16.36564	
10.0000	17.57416	

X(J) = 2.25000 DELSTR = 5.954823

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.002856	.005651	.396888	-.002350	.003190	-.000466
3	.480	-.000126	.023045	.793775	-.000103	.013915	-.000953
4	.720	.008215	.053037	1.190663	.006759	.034033	.000367
5	.960	.022204	.096425	1.587551	.018268	.065378	.005334
6	1.200	.041895	.153876	1.984439	.034469	.109723	.015800
7	1.440	.067313	.225818	2.381326	.055382	.168700	.033630
8	1.680	.098435	.312355	2.778214	.080988	.243727	.060692
9	1.920	.135165	.413191	3.175102	.111207	.335926	.098832
10	2.160	.177297	.527538	3.571989	.145872	.446012	.149847
11	2.400	.224489	.654050	3.968877	.184699	.574189	.215447
12	2.640	.276234	.790779	4.365765	.227273	.720044	.297200
13	2.880	.331848	.935165	4.762653	.273029	.882460	.396482
14	3.120	.390463	1.084065	5.159540	.321254	1.059564	.514414
15	3.360	.451043	1.233847	5.556428	.371097	1.248724	.651807
16	3.600	.512420	1.380529	5.953316	.421596	1.446603	.809112
17	3.840	.573343	1.519972	6.350204	.471720	1.649297	.986385
18	4.080	.632546	1.648118	6.747091	.520429	1.852532	1.183271
19	4.320	.688832	1.761238	7.143979	.566739	2.051925	1.399013
20	4.560	.741146	1.856180	7.540867	.609780	2.243278	1.632486
21	4.800	.788647	1.930566	7.937754	.648862	2.422869	1.882256
22	5.040	.830758	1.982936	8.334642	.683509	2.587698	2.146657
23	5.280	.867187	2.012791	8.731530	.713481	2.735665	2.423881
24	5.520	.897923	2.020563	9.128418	.738769	2.865657	2.712071
25	5.760	.923208	2.007492	9.525305	.759573	2.977525	3.009408
26	6.000	.943482	1.975452	9.922193	.776253	3.071975	3.314183
27	6.240	.959323	1.926737	10.319081	.789286	3.150395	3.624855
28	6.480	.971382	1.863846	10.715968	.799208	3.214637	3.940081
29	6.720	.980325	1.789290	11.112856	.806565	3.266800	4.258737
30	6.960	.986785	1.705435	11.509744	.811881	3.309033	4.579908
31	7.200	.991331	1.614393	11.906632	.815621	3.343377	4.902875
32	7.440	.994446	1.517963	12.303519	.818184	3.371658	5.227094
33	7.680	.996526	1.417613	12.700407	.819895	3.395427	5.552161
34	7.920	.997879	1.314495	13.097295	.821008	3.415942	5.877788
35	8.160	.998736	1.209476	13.494183	.821713	3.434182	6.203776
36	8.400	.999265	1.103191	13.891070	.822148	3.450878	6.529990
37	8.640	.999583	.996084	14.287958	.822410	3.466557	6.856343
38	8.880	.999769	.888460	14.684846	.822563	3.481586	7.182778
39	9.120	.999875	.780518	15.081733	.822651	3.496211	7.509260
40	9.360	.999934	.672387	15.478621	.822699	3.510592	7.835770
41	9.600	.999966	.564146	15.875509	.822726	3.524830	8.162294
42	9.840	.999983	.455843	16.272397	.822739	3.538986	8.488827
43	10.080	.999992	.347506	16.669284	.822747	3.553097	8.815363
44	10.320	.999996	.239151	17.066172	.822750	3.567183	9.141902
45	10.560	.999998	.130786	17.463060	.822752	3.581256	9.468442
46	10.800	.999999	.022417	17.859947	.822753	3.595323	9.794982
47	11.040	1.000000	-.085956	18.256835	.822753	3.609386	10.121523
48	11.280	1.000000	-.194329	18.653723	.822753	3.623448	10.448063
49	11.520	1.000000	-.302702	19.050611	.822753	3.637509	10.774604
50	11.760	1.000000	-.411076	19.447498	.822753	3.651570	11.101145
51	12.000	1.000000	-.519450	19.844386	.822753	3.665630	11.427685
52	12.240	1.000000	-.627825	20.241274	.822753	3.679691	11.754226

INTERPOLATED

PSI	Y	Y
0.0000	1.15596	
.0050	1.56507	
.0100	1.77948	
.0150	1.95840	
.0200	2.08762	
.0250	2.20266	
.0300	2.30925	
.0350	2.40372	
.0400	2.48336	
.0450	2.55974	
.0500	2.63285	
.1000	3.18506	
.1500	3.57299	
.2000	3.88171	
.2500	4.14434	
.3000	4.37774	
.3500	4.58398	
.4000	4.77524	
.4500	4.94920	
.5000	5.11382	
1.0000	6.37871	
1.5000	7.31872	
2.0000	8.11671	
2.5000	8.83753	
3.0000	9.51289	
3.5000	10.16026	
4.0000	10.79083	
4.5000	11.41120	
5.0000	12.02563	
6.0000	13.24612	
7.0000	14.46263	
8.0000	15.67824	
9.0000	16.89370	
10.0000	18.10913	

X(J) = 2.37500 DELSTR = 6.453745

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.005201	.005219	.408799	-.004258	.002665	-.000870
3	.480	-.005183	.021457	.817598	-.004243	.011801	-.002608
4	.720	.000084	.049859	1.226396	.000069	.029291	-.003461
5	.960	.010652	.091526	1.635195	.008720	.057007	-.001665
6	1.200	.026601	.147491	2.043994	.021775	.096808	.004569
7	1.440	.048018	.218616	2.452793	.039307	.150480	.017054
8	1.680	.074960	.305473	2.861591	.061361	.219650	.037631
9	1.920	.107430	.408257	3.270390	.087942	.305707	.068148
10	2.160	.145351	.526683	3.679189	.118983	.409706	.110443
11	2.400	.188524	.659895	4.087988	.154324	.532247	.166307
12	2.640	.236605	.806377	4.496786	.193683	.673359	.237440
13	2.880	.289074	.963915	4.905585	.236633	.832394	.325396
14	3.120	.345224	1.129588	5.314384	.282597	1.007944	.431526
15	3.360	.404164	1.299827	5.723183	.330845	1.197801	.556914
16	3.600	.464832	1.470528	6.131981	.380507	1.398978	.702313
17	3.840	.526041	1.637230	6.540780	.430612	1.607794	.868106
18	4.080	.586533	1.795351	6.949579	.480131	1.820040	1.054261
19	4.320	.645053	1.940455	7.358378	.528035	2.031211	1.260329
20	4.560	.700430	2.068536	7.767176	.573366	2.236792	1.485455
21	4.800	.751652	2.176281	8.175975	.615296	2.432559	1.728416
22	5.040	.797936	2.261277	8.584774	.653183	2.614872	1.987693
23	5.280	.838766	2.322136	8.993573	.686606	2.780910	2.261545
24	5.520	.873914	2.358531	9.402371	.715378	2.928820	2.548109
25	5.760	.903428	2.371126	9.811170	.739538	3.057769	2.845493
26	6.000	.927594	2.361430	10.219969	.759320	3.167895	3.151859
27	6.240	.946884	2.331594	10.628768	.775111	3.260169	3.465496
28	6.480	.961890	2.284173	11.037566	.787395	3.336198	3.784871
29	6.720	.973267	2.221895	11.446365	.796708	3.398004	4.108661
30	6.960	.981671	2.147465	11.855164	.803587	3.447801	4.435760
31	7.200	.987721	2.063398	12.263963	.808539	3.487805	4.765278
32	7.440	.991963	1.971921	12.672761	.812012	3.520084	5.096517
33	7.680	.994862	1.874915	13.081560	.814385	3.546466	5.428952
34	7.920	.996792	1.773902	13.490359	.815965	3.568485	5.762195
35	8.160	.998044	1.670071	13.899158	.816990	3.587375	6.095970
36	8.400	.998836	1.564311	14.307956	.817638	3.604087	6.430087
37	8.640	.999324	1.457269	14.716755	.818037	3.619327	6.764418
38	8.880	.999616	1.349399	15.125554	.818277	3.633601	7.098879
39	9.120	.999787	1.241007	15.534353	.818417	3.647261	7.433418
40	9.360	.999885	1.132297	15.943151	.818497	3.660538	7.768003
41	9.600	.999939	1.023396	16.351950	.818541	3.673586	8.102612
42	9.840	.999969	.914386	16.760749	.818565	3.686499	8.437236
43	10.080	.999984	.805313	17.169548	.818578	3.699335	8.771867
44	10.320	.999992	.696206	17.578346	.818585	3.712129	9.106502
45	10.560	.999996	.587080	17.987145	.818588	3.724900	9.441139
46	10.800	.999998	.477946	18.395944	.818590	3.737659	9.775777
47	11.040	.999999	.368806	18.804743	.818590	3.750411	10.110416
48	11.280	1.000000	.259664	19.213542	.818591	3.763161	10.445055
49	11.520	1.000000	.150520	19.622340	.818591	3.775909	10.779694
50	11.760	1.000000	.041377	20.031139	.818591	3.788656	11.114333
51	12.000	1.000000	-.067767	20.439938	.818591	3.801403	11.448971
52	12.240	1.000000	-.176912	20.848737	.818591	3.814150	11.783610

INTERPOLATED

PSI	Y	Y
0.0000	1.75770	
.0050	2.06014	
.0100	2.23675	
.0150	2.39389	
.0200	2.51790	
.0250	2.62337	
.0300	2.72251	
.0350	2.81531	
.0400	2.89675	
.0450	2.96905	
.0500	3.03879	
.1000	3.58621	
.1500	3.97663	
.2000	4.29034	
.2500	4.55905	
.3000	4.79407	
.3500	5.00548	
.4000	5.19896	
.4500	5.37789	
.5000	5.54409	
1.0000	6.83429	
1.5000	7.79235	
2.0000	8.60353	
2.5000	9.33476	
3.0000	10.01851	
3.5000	10.67320	
4.0000	11.30964	
4.5000	11.93503	
5.0000	12.55380	
6.0000	13.78166	
7.0000	15.00471	
8.0000	16.22659	
9.0000	17.44824	
10.0000	18.66986	

X(J) = 2.50000 DELSTR = 6.982925

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.007186	.004757	.420358	-.005856	.002182	-.001231
3	.480	-.009543	.019669	.840715	-.007777	.009813	-.004096
4	.720	-.007037	.046016	1.261073	-.005735	.024705	-.006936
5	.960	.000392	.085055	1.681431	.000320	.048678	-.008074
6	1.200	.012832	.138006	2.101789	.010457	.083557	-.005809
7	1.440	.030413	.206024	2.522146	.024785	.131176	.001598
8	1.680	.053257	.290046	2.942504	.043401	.193278	.015929
9	1.920	.081451	.390665	3.362862	.066377	.271427	.039002
10	2.160	.115027	.508062	3.783219	.093740	.366937	.072655
11	2.400	.153924	.641890	4.203577	.125438	.480765	.118722
12	2.640	.197954	.791158	4.623935	.161321	.613377	.178993
13	2.880	.246772	.954148	5.044292	.201104	.764627	.255167
14	3.120	.299847	1.128364	5.464650	.244356	.933643	.348793
15	3.360	.356453	1.310542	5.885008	.290487	1.118758	.461206
16	3.600	.415673	1.496727	6.305366	.338748	1.317478	.593457
17	3.840	.476425	1.682418	6.725723	.388257	1.526529	.746258
18	4.080	.537501	1.862782	7.146081	.438030	1.741969	.919926
19	4.320	.597636	2.032925	7.566439	.487036	1.959384	1.114356
20	4.560	.655581	2.188192	7.986796	.534258	2.174146	1.329010
21	4.800	.710187	2.324471	8.407154	.578758	2.381714	1.562942
22	5.040	.760481	2.438461	8.827512	.619745	2.577942	1.814842
23	5.280	.805728	2.527870	9.247869	.656618	2.759360	2.083107
24	5.520	.845469	2.591520	9.668227	.689005	2.923388	2.365928
25	5.760	.879532	2.629351	10.088585	.716764	3.068456	2.661391
26	6.000	.908011	2.642320	10.508943	.739973	3.194025	2.967566
27	6.240	.931233	2.632225	10.929300	.758897	3.300506	3.282597
28	6.480	.949695	2.601473	11.349658	.773943	3.389099	3.604768
29	6.720	.964004	2.552833	11.770016	.785603	3.461586	3.932551
30	6.960	.974812	2.489199	12.190373	.794411	3.520101	4.264637
31	7.200	.982770	2.413386	12.610731	.800897	3.566918	4.599937
32	7.440	.988481	2.327980	13.031089	.805551	3.604267	4.937578
33	7.680	.992475	2.235243	13.451446	.808805	3.634199	5.276881
34	7.920	.995197	2.137067	13.871804	.811024	3.658503	5.617335
35	8.160	.997005	2.034971	14.292162	.812497	3.678667	5.958565
36	8.400	.998176	1.930131	14.712520	.813451	3.695876	6.300305
37	8.640	.998915	1.823422	15.132877	.814054	3.711038	6.642372
38	8.880	.999370	1.715476	15.553235	.814424	3.724822	6.984644
39	9.120	.999642	1.606733	15.973593	.814646	3.737705	7.327040
40	9.360	.999802	1.497491	16.393950	.814776	3.750015	7.669510
41	9.600	.999893	1.387944	16.814308	.814851	3.761972	8.012023
42	9.840	.999943	1.278216	17.234666	.814892	3.773716	8.354561
43	10.080	.999971	1.168384	17.655023	.814914	3.785336	8.697111
44	10.320	.999985	1.058493	18.075381	.814926	3.796885	9.039669
45	10.560	.999993	.948569	18.495739	.814932	3.808394	9.382231
46	10.800	.999997	.838628	18.916097	.814935	3.819883	9.724794
47	11.040	.999998	.728678	19.336454	.814937	3.831360	10.067359
48	11.280	.999999	.618723	19.756812	.814937	3.842831	10.409924
49	11.520	1.000000	.508766	20.177170	.814938	3.854300	10.752489
50	11.760	1.000000	.398808	20.597527	.814938	3.865767	11.095054
51	12.000	1.000000	.288850	21.017885	.814938	3.877234	11.437620
52	12.240	1.000000	.178891	21.438243	.814938	3.888701	11.780185

INTERPOLATED PSI	Y	Y
-.0050	2.15445	.87715
0.0000	2.44317	
.0050	2.63298	
.0100	2.78340	
.0150	2.91895	
.0200	3.02448	
.0250	3.12059	
.0300	3.21165	
.0350	3.29766	
.0400	3.37670	
.0450	3.44478	
.0500	3.51075	
.1000	4.04309	
.1500	4.43140	
.2000	4.74688	
.2500	5.01800	
.3000	5.25355	
.3500	5.46947	
.4000	5.66332	
.4500	5.84571	
.5000	6.01375	
1.0000	7.32376	
1.5000	8.29689	
2.0000	9.11990	
2.5000	9.86076	
3.0000	10.55265	
3.5000	11.21374	
4.0000	11.85572	
4.5000	12.48575	
5.0000	13.10853	
6.0000	14.34315	
7.0000	15.57209	
8.0000	16.79955	
9.0000	18.02670	
10.0000	19.25380	

X(J) = 2.62500 DELSTR = 7.525652

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.008836	.004234	.431586	-.007172	.001719	-.001548
3	.480	-.013209	.017484	.863173	-.010722	.007824	-.005409
4	.720	-.013086	.040855	1.294759	-.010623	.019897	-.010015
5	.960	-.008406	.075460	1.726346	-.006823	.039545	-.013780
6	1.200	.000927	.122417	2.157932	.000752	.068408	-.015090
7	1.440	.015029	.182862	2.589518	.012200	.108170	-.012295
8	1.680	.034096	.257925	3.021105	.027677	.160587	-.003690
9	1.920	.058273	.348501	3.452691	.047302	.227312	.012490
10	2.160	.087675	.455098	3.884278	.071169	.309802	.038055
11	2.400	.122354	.577808	4.315864	.099319	.409273	.074846
12	2.640	.162262	.716180	4.747450	.131714	.526576	.124701
13	2.880	.207215	.869098	5.179037	.168204	.662058	.189422
14	3.120	.256858	1.034691	5.610623	.208502	.815435	.270712
15	3.360	.310644	1.210289	6.042210	.252162	.985682	.370120
16	3.600	.367819	1.392449	6.473796	.298573	1.170967	.488965
17	3.840	.427436	1.577052	6.905383	.346966	1.368640	.628268
18	4.080	.488378	1.759478	7.336969	.396435	1.575294	.788689
19	4.320	.549413	1.934851	7.768555	.445980	1.786908	.970477
20	4.560	.609261	2.098332	8.200142	.494561	1.999064	1.173439
21	4.800	.666678	2.245429	8.631728	.541169	2.207219	1.396942
22	5.040	.720535	2.372300	9.063315	.584887	2.407007	1.639937
23	5.280	.769899	2.476001	9.494901	.624957	2.594547	1.901013
24	5.520	.814086	2.554648	9.926487	.660825	2.766693	2.178476
25	5.760	.852697	2.607488	10.358074	.692167	2.921221	2.470443
26	6.000	.885619	2.634855	10.789660	.718891	3.056911	2.774940
27	6.240	.913004	2.638042	11.221247	.741120	3.173538	3.090000
28	6.480	.935219	2.619091	11.652833	.759153	3.271757	3.413749
29	6.720	.952792	2.580561	12.084419	.773418	3.352938	3.744468
30	6.960	.966345	2.525273	12.516006	.784420	3.418947	4.080639
31	7.200	.976536	2.456096	12.947592	.792692	3.471928	4.420969
32	7.440	.984005	2.375756	13.379179	.798755	3.514102	4.764392
33	7.680	.989341	2.286714	13.810765	.803087	3.547604	5.110058
34	7.920	.993059	2.191084	14.242351	.806104	3.574369	5.457311
35	8.160	.995582	2.090612	14.673938	.808153	3.596059	5.805657
36	8.400	.997253	1.986682	15.105524	.809509	3.614041	6.154737
37	8.640	.998331	1.880350	15.537111	.810384	3.629395	6.504299
38	8.880	.999010	1.772396	15.968697	.810935	3.642939	6.854169
39	9.120	.999426	1.663378	16.400283	.811273	3.655272	7.204230
40	9.360	.999675	1.553678	16.831870	.811475	3.666818	7.554408
41	9.600	.999820	1.443556	17.263456	.811593	3.677865	7.904655
42	9.840	.999903	1.333176	17.695043	.811660	3.688606	8.254942
43	10.080	.999949	1.222646	18.126629	.811697	3.699164	8.605251
44	10.320	.999974	1.112028	18.558216	.811717	3.709615	8.955573
45	10.560	.999987	1.001362	18.989802	.811728	3.720005	9.305901
46	10.800	.999993	.890669	19.421388	.811733	3.730362	9.656233
47	11.040	.999997	.779962	19.852975	.811736	3.740701	10.006567
48	11.280	.999999	.669248	20.284561	.811738	3.751031	10.356902
49	11.520	.999999	.558531	20.716148	.811738	3.761356	10.707237
50	11.760	1.000000	.447811	21.147734	.811739	3.771678	11.057572
51	12.000	1.000000	.337091	21.579320	.811739	3.781999	11.407907
52	12.240	1.000000	.226370	22.010907	.811739	3.792320	11.758243

INTERPOLATED

PSI	Y	Y
-.0150	2.42487	2.12359
-.0100	2.71835	1.29314
-.0050	2.96445	.82044
0.0000	3.13034	
.0050	3.26817	
.0100	3.39427	
.0150	3.49984	
.0200	3.59067	
.0250	3.67737	
.0300	3.75994	
.0350	3.83838	
.0400	3.90949	
.0450	3.97310	
.0500	4.03493	
.1000	4.54440	
.1500	4.92544	
.2000	5.23920	
.2500	5.50738	
.3000	5.74446	
.3500	5.96005	
.4000	6.15621	
.4500	6.33872	
.5000	6.50991	
1.0000	7.83368	
1.5000	8.81829	
2.0000	9.65127	
2.5000	10.40059	
3.0000	11.09913	
3.5000	11.76606	
4.0000	12.41296	
4.5000	13.04716	
5.0000	13.67356	
6.0000	14.91429	
7.0000	16.14851	
8.0000	17.38093	
9.0000	18.61295	
10.0000	19.84488	

X(J) = 2,75000 DELSTR = 8,043320

K	ETA	U	V	Y	UST	VST	PSI
1	0,000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000
2	,240	-,010158	,003636	,442515	-,008217	,001263	-,001818
3	,480	-,016119	,014802	,885031	-,013039	,005777	-,006521
4	,720	-,017855	,034022	1,327546	-,014443	,014712	-,012601
5	,960	-,015311	,061867	1,770061	-,012385	,029278	-,018537
6	1,200	-,008404	,098968	2,212576	-,006798	,050742	-,022782
7	1,440	,002976	,146035	2,655092	,002407	,080449	-,023753
8	1,680	,018961	,203930	3,097607	,015337	,119869	-,019827
9	1,920	,039801	,273598	3,540122	,032196	,170617	-,009310
10	2,160	,065662	,355787	3,982637	,053115	,234221	,009565
11	2,400	,096670	,450938	4,425153	,078197	,312060	,038619
12	2,640	,132882	,559118	4,867668	,107489	,405291	,079704
13	2,880	,174245	,679884	5,310183	,140948	,514720	,134672
14	3,120	,220558	,812155	5,752698	,178411	,640658	,205333
15	3,360	,271440	,954131	6,195214	,219570	,782791	,293389
16	3,600	,326302	1,103262	6,637729	,263948	,940078	,400371
17	3,840	,384342	1,256292	7,080244	,310897	1,110690	,527560
18	4,080	,444560	1,409381	7,522759	,359608	1,292023	,675915
19	4,320	,505791	1,558297	7,965275	,409138	1,480775	,846005
20	4,560	,566767	1,698670	8,407790	,458462	1,673106	1,037969
21	4,800	,626193	1,826282	8,850305	,506532	1,864864	1,251481
22	5,040	,682831	1,937355	9,292820	,552347	2,051863	1,485766
23	5,280	,735589	2,028813	9,735336	,595023	2,230173	1,739630
24	5,520	,783592	2,098475	10,177851	,633854	2,396394	2,011528
25	5,760	,826236	2,145164	10,620366	,668349	2,547877	2,299650
26	6,000	,863208	2,168717	11,062881	,698255	2,682867	2,602022
27	6,240	,894480	2,169901	11,505397	,723552	2,800542	2,916607
28	6,480	,920282	2,150257	11,947912	,744423	2,900975	3,241408
29	6,720	,941042	2,111893	12,390427	,761216	2,985003	3,574542
30	6,960	,957330	2,057260	12,832942	,774391	3,054050	3,914307
31	7,200	,969790	1,988937	13,275458	,784470	3,109929	4,259217
32	7,440	,979082	1,909451	13,717973	,791987	3,154639	4,608020
33	7,680	,985839	1,821134	14,160488	,797452	3,190191	4,959695
34	7,920	,990628	1,726038	14,603003	,801326	3,218477	5,313437
35	8,160	,993938	1,625887	15,045519	,804004	3,241179	5,668629
36	8,400	,996168	1,522075	15,488034	,805808	3,259719	6,024812
37	8,640	,997633	1,415684	15,930549	,806993	3,275249	6,381656
38	8,880	,998572	1,307528	16,373064	,807752	3,288666	6,738931
39	9,120	,999158	1,198197	16,815580	,808226	3,300641	7,096478
40	9,360	,999515	1,088104	17,258095	,808515	3,311662	7,454194
41	9,600	,999727	,977531	17,700610	,808686	3,322067	7,812012
42	9,840	,999850	,866663	18,143126	,808786	3,332087	8,169890
43	10,080	,999920	,755618	18,585641	,808842	3,341871	8,527803
44	10,320	,999958	,644472	19,028156	,808873	3,351516	8,885735
45	10,560	,999978	,533267	19,470671	,808890	3,361080	9,243677
46	10,800	,999989	,422030	19,913187	,808898	3,370599	9,601625
47	11,040	,999995	,310775	20,355702	,808903	3,380094	9,959576
48	11,280	,999997	,199512	20,798217	,808905	3,389575	10,317528
49	11,520	,999999	,088244	21,240732	,808906	3,399049	10,675481
50	11,760	,999999	-,023026	21,683248	,808907	3,408520	11,033435
51	12,000	1,000000	-,134298	22,125763	,808907	3,417989	11,391389
52	12,240	1,000000	-,245570	22,568278	,808907	3,427457	11,749342

INTERPOLATED

PSI	Y	Y
-,0200	3,08916	1,64859
-,0150	3,31812	1,48161
-,0100	3,51539	1,13689
-,0050	3,65192	,75149
0,0000	3,77365	
,0050	3,88680	
,0100	3,99005	
,0150	4,07357	
,0200	4,15392	
,0250	4,23109	
,0300	4,30507	
,0350	4,37588	
,0400	4,44158	
,0450	4,50015	
,0500	4,55731	
,1000	5,04107	
,1500	5,41279	
,2000	5,72202	
,2500	5,98600	
,3000	6,22442	
,3500	6,43738	
,4000	6,63630	
,4500	6,81733	
,5000	6,98930	
1,0000	8,32362	
1,5000	9,31838	
2,0000	10,15958	
2,5000	10,91546	
3,0000	11,62006	
3,5000	12,29215	
4,0000	12,94334	
4,5000	13,58132	
5,0000	14,21100	
6,0000	15,45723	
7,0000	16,69620	
8,0000	17,93306	
9,0000	19,16942	
10,0000	20,40568	

X(J) = 2.87500 DELSTR = 8.487083

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.011163	.003016	.453184	-.009001	.000838	-.002039
3	.480	-.018233	.011919	.906368	-.014702	.003830	-.007410
4	.720	-.021191	.026435	1.359552	-.017087	.009673	-.014613
5	.960	-.019997	.046352	1.812737	-.016124	.019103	-.022139
6	1.200	-.014589	.071549	2.265921	-.011764	.032927	-.028458
7	1.440	-.004883	.102043	2.719105	-.003938	.052046	-.032016
8	1.680	.009223	.138003	3.172289	.007437	.077478	-.031223
9	1.920	.027889	.179918	3.625473	.022488	.110467	-.024442
10	2.160	.051347	.228465	4.078657	.041402	.152443	-.009965
11	2.400	.079754	.284248	4.531841	.064308	.204814	.013988
12	2.640	.113230	.347741	4.985026	.091300	.268928	.049247
13	2.880	.151811	.419127	5.438210	.122409	.345949	.097672
14	3.120	.195414	.498161	5.891394	.157567	.436714	.161112
15	3.360	.243791	.584045	6.344578	.196575	.541592	.241358
16	3.600	.296497	.675359	6.797762	.239073	.660350	.340073
17	3.840	.352870	.770051	7.250946	.284528	.792064	.458717
18	4.080	.412027	.865500	7.704130	.332228	.935072	.598469
19	4.320	.472889	.958645	8.157315	.381303	1.087003	.760149
20	4.560	.534231	1.046182	8.610499	.430764	1.244868	.944157
21	4.800	.594748	1.124794	9.063683	.479561	1.405233	1.150430
22	5.040	.653142	1.191398	9.516867	.526646	1.564443	1.378428
23	5.280	.708218	1.243375	9.970051	.571055	1.718886	1.627158
24	5.520	.758958	1.278761	10.423235	.611968	1.865253	1.895222
25	5.760	.804599	1.296360	10.876420	.648769	2.000777	2.180895
26	6.000	.844663	1.295784	11.329604	.681075	2.123402	2.482227
27	6.240	.878976	1.277415	11.782788	.708741	2.231877	2.797148
28	6.480	.907637	1.242292	12.235972	.731852	2.325766	3.123575
29	6.720	.930984	1.191956	12.689156	.750677	2.405373	3.459505
30	6.960	.949527	1.128276	13.142340	.765629	2.471610	3.803087
31	7.200	.963887	1.053270	13.595524	.777207	2.525831	4.152682
32	7.440	.974727	.968951	14.048709	.785949	2.569650	4.506881
33	7.680	.982706	.877208	14.501893	.792382	2.604779	4.864518
34	7.920	.988431	.779720	14.955077	.796998	2.632890	5.224659
35	8.160	.992435	.677918	15.408261	.800227	2.655514	5.586577
36	8.400	.995166	.572967	15.861445	.802429	2.673983	5.949726
37	8.640	.996981	.465784	16.314629	.803893	2.689398	6.313706
38	8.880	.998158	.357061	16.767813	.804842	2.702638	6.678232
39	9.120	.998902	.247305	17.220998	.805441	2.714370	7.043110
40	9.360	.999361	.136876	17.674182	.805811	2.725090	7.408207
41	9.600	.999637	.026020	18.127366	.806033	2.735148	7.773438
42	9.840	.999798	-.085101	18.580550	.806164	2.744785	8.138749
43	10.080	.999890	-.196380	19.033734	.806238	2.754162	8.504106
44	10.320	.999942	-.307752	19.486918	.806280	2.763383	8.869490
45	10.560	.999970	-.419177	19.940102	.806302	2.772513	9.234888
46	10.800	.999985	-.530631	20.393287	.806314	2.781591	9.600294
47	11.040	.999993	-.642102	20.846471	.806320	2.790640	9.965705
48	11.280	.999996	-.753580	21.299655	.806324	2.799673	10.331117
49	11.520	.999998	-.865064	21.752839	.806325	2.808698	10.696530
50	11.760	.999999	-.976549	22.206023	.806326	2.817719	11.061944
51	12.000	1.000000	-1.088035	22.659207	.806326	2.826738	11.427359
52	12.240	1.000000	-1.199522	23.112391	.806326	2.835756	11.792773

INTERPOLATED

PSI	Y	Y
-.0300	3.26539	2.44480
-.0250	3.59400	1.96216
-.0200	3.77890	1.67436
-.0150	3.93637	1.38054
-.0100	4.07773	1.07148
-.0050	4.18226	.71517
0.0000	4.28148	
.0050	4.37558	
.0100	4.46455	
.0150	4.54630	
.0200	4.61646	
.0250	4.68453	
.0300	4.75051	
.0350	4.81441	
.0400	4.87622	
.0450	4.93594	
.0500	4.99278	
.1000	5.45632	
.1500	5.81807	
.2000	6.12051	
.2500	6.38701	
.3000	6.62213	
.3500	6.83809	
.4000	7.03452	
.4500	7.21979	
.5000	7.39075	
1.0000	8.73724	
1.5000	9.74230	
2.0000	10.59211	
2.5000	11.35560	
3.0000	12.06590	
3.5000	12.74297	
4.0000	13.39832	
4.5000	14.03995	
5.0000	14.67264	
6.0000	15.92408	
7.0000	17.16747	
8.0000	18.40843	
9.0000	19.64878	
10.0000	20.88900	

X(J) = 3.00000 DELSTR = 8.830110

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.011893	.002469	.463635	-.009560	.000487	-.002216
3	.480	-.019648	.009406	.927269	-.015794	.002253	-.008094
4	.720	-.023252	.019883	1.390904	-.018692	.005649	-.016088
5	.960	-.022682	.033028	1.854539	-.018233	.011057	-.024648
6	1.200	-.017896	.048056	2.318174	-.014386	.018919	-.032210
7	1.440	-.008843	.064306	2.781808	-.007109	.029755	-.037193
8	1.680	.004545	.081277	3.245443	.003654	.044191	-.037994
9	1.920	.022344	.098717	3.709078	.017962	.063001	-.032983
10	2.160	.044739	.116717	4.172713	.035965	.087225	-.020482
11	2.400	.071873	.135646	4.636347	.057777	.118067	.001249
12	2.640	.103873	.155995	5.099982	.083501	.156820	.033999
13	2.880	.140816	.178247	5.563617	.113199	.204768	.079598
14	3.120	.182687	.202732	6.027252	.146859	.263057	.139884
15	3.360	.229332	.229485	6.490886	.184356	.332544	.216665
16	3.600	.280413	.258135	6.954521	.225419	.413654	.311658
17	3.840	.335380	.287846	7.418156	.269605	.506253	.426413
18	4.080	.393456	.317320	7.881791	.316292	.609568	.562234
19	4.320	.453649	.344859	8.345425	.364680	.722152	.720095
20	4.560	.514790	.368493	8.809060	.413830	.841928	.900568
21	4.800	.575596	.386140	9.272695	.462711	.966299	1.103765
22	5.040	.634752	.395788	9.736329	.510265	1.092319	1.329318
23	5.280	.691007	.395672	10.199964	.555488	1.216913	1.576378
24	5.520	.743263	.384428	10.663599	.597495	1.337113	1.843659
25	5.760	.790651	.361189	11.127234	.635590	1.450285	2.129510
26	6.000	.832586	.325636	11.590868	.669300	1.554315	2.432006
27	6.240	.868785	.277976	12.054503	.698400	1.647733	2.749063
28	6.480	.899258	.218880	12.518138	.722897	1.729758	3.078544
29	6.720	.924270	.149377	12.981773	.743003	1.800274	3.418365
30	6.960	.944285	.070730	13.445407	.759092	1.859738	3.766577
31	7.200	.959897	-.015683	13.909042	.771643	1.909054	4.121428
32	7.440	.971767	-.108484	14.372677	.781185	1.949421	4.481401
33	7.680	.980566	-.206377	14.836312	.788258	1.982187	4.845225
34	7.920	.986922	-.308206	15.299946	.793368	2.008722	5.211873
35	8.160	.991399	-.412990	15.763581	.796967	2.030319	5.580541
36	8.400	.994472	-.519928	16.227216	.799437	2.048126	5.950615
37	8.640	.996528	-.628391	16.690851	.801090	2.063117	6.321645
38	8.880	.997870	-.737904	17.154485	.802169	2.076077	6.693308
39	9.120	.998724	-.848120	17.618120	.802855	2.087617	7.065380
40	9.360	.999253	-.958794	18.081755	.803280	2.098192	7.437710
41	9.600	.999573	-1.069758	18.545390	.803538	2.108130	7.810199
42	9.840	.999761	-1.180900	19.009024	.803689	2.117660	8.182782
43	10.080	.999870	-1.292149	19.472659	.803777	2.126935	8.555420
44	10.320	.999931	-1.403461	19.936294	.803825	2.136055	8.928090
45	10.560	.999964	-1.514808	20.399928	.803852	2.145085	9.300778
46	10.800	.999982	-1.626175	20.863563	.803866	2.154062	9.673475
47	11.040	.999991	-1.737553	21.327198	.803874	2.163011	10.046177
48	11.280	.999996	-1.848936	21.790833	.803878	2.171943	10.418882
49	11.520	.999998	-1.960322	22.254467	.803879	2.180867	10.791588
50	11.760	.999999	-2.071709	22.718102	.803880	2.189787	11.164295
51	12.000	1.000000	-2.183097	23.181737	.803881	2.198704	11.537001
52	12.240	1.000000	-2.294485	23.645372	.803881	2.207621	11.909709

INTERPOLATED PSI	Y	Y
-.0350	3.62082	2.06384
-.0300	3.83279	2.15273
-.0250	4.02176	1.86968
-.0200	4.18435	1.59470
-.0150	4.30142	1.32952
-.0100	4.41189	1.04050
-.0050	4.51578	.69619
0.0000	4.61308	
.0050	4.69499	
.0100	4.77093	
.0150	4.84432	
.0200	4.91516	
.0250	4.98346	
.0300	5.04922	
.0350	5.11120	
.0400	5.16655	
.0450	5.22074	
.0500	5.27375	
.1000	5.73033	
.1500	6.09288	
.2000	6.39701	
.2500	6.66182	
.3000	6.90151	
.3500	7.11676	
.4000	7.31728	
.4500	7.50297	
.5000	7.67678	
1.0000	9.04138	
1.5000	10.06023	
2.0000	10.92025	
2.5000	11.69174	
3.0000	12.40887	
3.5000	13.09124	
4.0000	13.75113	
4.5000	14.39646	
5.0000	15.03234	
6.0000	16.28897	
7.0000	17.53667	
8.0000	18.78158	
9.0000	20.02575	
10.0000	21.26975	

X(J) = 3.12500 DELSTR = 9.083181

K	ETA	U	V	Y	UST	VST	PSI	INTERPOLATED PSI	INTERPOLATED Y	Y
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-.0400	3.65770	2.76080
2	.240	-.012418	.002046	.473899	-.009953	.000226	-.002358	-.0350	3.88463	2.33054
3	.480	-.020575	.007553	.947798	-.016491	.001139	-.008624	-.0300	4.08649	2.07055
4	.720	-.024466	.015273	1.421698	-.019609	.002945	-.017178	-.0250	4.26329	1.82003
5	.960	-.024075	.023998	1.895597	-.019296	.005868	-.026397	-.0200	4.38521	1.56054
6	1.200	-.019378	.032577	2.369496	-.015532	.010175	-.034649	-.0150	4.49979	1.30415
7	1.440	-.010345	.039950	2.843395	-.008292	.016181	-.040294	-.0100	4.60746	1.02624
8	1.680	.003064	.045163	3.317295	.002456	.024272	-.041677	-.0050	4.70822	.68677
9	1.920	.020896	.047398	3.791194	.016748	.034914	-.037126	0.0000	4.79354	
10	2.160	.043244	.046116	4.265093	.034660	.048755	-.024945	.0050	4.87154	
11	2.400	.070200	.041130	4.738992	.056265	.066645	-.003401	.0100	4.94691	
12	2.640	.101854	.032522	5.212892	.081635	.089592	.029275	.0150	5.01966	
13	2.880	.138268	.020594	5.686791	.110821	.118717	.074877	.0200	5.08978	
14	3.120	.179438	.005763	6.160690	.143819	.155160	.135214	.0250	5.15727	
15	3.360	.225249	-.011557	6.634589	.180536	.199957	.212069	.0300	5.22121	
16	3.600	.275424	-.031085	7.108488	.220751	.253888	.307154	.0350	5.27786	
17	3.840	.329489	-.052770	7.582388	.264084	.317338	.422036	.0400	5.33331	
18	4.080	.386747	-.076849	8.056287	.309975	.390174	.558059	.0450	5.38756	
19	4.320	.446277	-.103840	8.530186	.357689	.471679	.716262	.0500	5.44062	
20	4.560	.506970	-.134494	9.004085	.406333	.560541	.897296	.1000	5.89500	
21	4.800	.567577	-.169704	9.477985	.454910	.654906	1.101368	.1500	6.25817	
22	5.040	.626797	-.210385	9.951884	.502374	.752510	1.328196	.2000	6.56554	
23	5.280	.683364	-.257363	10.425783	.547712	.850845	1.577013	.2500	6.83250	
24	5.520	.736144	-.311271	10.899682	.590016	.947372	1.846598	.3000	7.07541	
25	5.760	.784221	-.372475	11.373582	.628548	1.039723	2.135336	.3500	7.29312	
26	6.000	.826947	-.441044	11.847481	.662794	1.125893	2.441319	.4000	7.49672	
27	6.240	.863983	-.516751	12.321380	.692478	1.204367	2.762450	.4500	7.68483	
28	6.480	.895284	-.599113	12.795279	.717565	1.274199	3.096559	.5000	7.86153	
29	6.720	.921073	-.687457	13.269178	.738235	1.335016	3.441510	1.0000	9.24822	
30	6.960	.941783	-.780986	13.743078	.754834	1.386959	3.795292	1.5000	10.28285	
31	7.200	.957992	-.878862	14.216977	.767825	1.430592	4.156086	2.0000	11.15469	
32	7.440	.970356	-.980263	14.690876	.777735	1.466777	4.522306	2.5000	11.93542	
33	7.680	.979548	-1.084430	15.164775	.785102	1.496549	4.892620	3.0000	12.65983	
34	7.920	.986208	-1.190703	15.638675	.790440	1.521001	5.265944	3.5000	13.34816	
35	8.160	.990910	-1.298532	16.112574	.794209	1.541191	5.641426	4.0000	14.01281	
36	8.400	.994146	-1.407475	16.586473	.796803	1.558082	6.018415	4.5000	14.66216	
37	8.640	.996317	-1.517192	17.060372	.798543	1.572500	6.396432	5.0000	15.30136	
38	8.880	.997737	-1.627434	17.534272	.799680	1.585121	6.775130	6.0000	16.56335	
39	9.120	.998642	-1.738020	18.008171	.800406	1.596477	7.154270	7.0000	17.81539	
40	9.360	.999204	-1.848825	18.482070	.800856	1.606967	7.533688	8.0000	19.06421	
41	9.600	.999544	-1.959767	18.955969	.801129	1.616884	7.913278	9.0000	20.31215	
42	9.840	.999745	-2.070790	19.429868	.801290	1.626430	8.292970	10.0000	21.55986	
43	10.080	.999861	-2.181861	19.903768	.801383	1.635744	8.672723			
44	10.320	.999926	-2.292960	20.377667	.801435	1.644917	9.052510			
45	10.560	.999961	-2.404074	20.851566	.801464	1.654007	9.432317			
46	10.800	.999980	-2.515196	21.325465	.801479	1.663048	9.812133			
47	11.040	.999990	-2.626322	21.799365	.801487	1.672063	10.191955			
48	11.280	.999995	-2.737450	22.273264	.801491	1.681062	10.571780			
49	11.520	.999998	-2.848580	22.747163	.801493	1.690054	10.951606			
50	11.760	.999999	-2.959709	23.221062	.801494	1.699042	11.331433			
51	12.000	1.000000	-3.070840	23.694962	.801494	1.708028	11.711261			
52	12.240	1.000000	-3.181970	24.168861	.801494	1.717012	12.091088			

X(J) = 3.25000 DELSTR = 9.275308

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.012796	.001722	.483997	-.010226	.000034	-.002475
3	.480	-.021193	.006219	.967994	-.016936	.000369	-.009048
4	.720	-.025186	.012160	1.451991	-.020127	.001191	-.018017
5	.960	-.024767	.018242	1.935988	-.019792	.002701	-.027677
6	1.200	-.019922	.023201	2.419985	-.015920	.005125	-.036320
7	1.440	-.010632	.025823	2.903981	-.008496	.008719	-.042228
8	1.680	.003127	.024964	3.387978	.002499	.013781	-.043680
9	1.920	.021383	.019563	3.871975	.017088	.020657	-.038940
10	2.160	.044177	.008719	4.355972	.035304	.029789	-.026261
11	2.400	.071555	-.008225	4.839969	.057182	.041752	-.003880
12	2.640	.103554	-.031662	5.323966	.082754	.057257	.029985
13	2.880	.140190	-.061696	5.807963	.112031	.077155	.077122
14	3.120	.181429	-.098166	6.291960	.144986	.102386	.139320
15	3.360	.227143	-.140708	6.775957	.181518	.133902	.218334
16	3.600	.277070	-.188852	7.259954	.221417	.172544	.315843
17	3.840	.330768	-.242122	7.743950	.264329	.218904	.433393
18	4.080	.387585	-.300125	8.227947	.309733	.273190	.572315
19	4.320	.446653	-.362601	8.711944	.356936	.335133	.733648
20	4.560	.506908	-.429426	9.195941	.405088	.403930	.918056
21	4.800	.567143	-.500586	9.679938	.453224	.478270	1.125767
22	5.040	.626079	-.576126	10.163935	.500322	.556408	1.356524
23	5.280	.682463	-.656085	10.647932	.545381	.636307	1.609582
24	5.520	.735159	-.740442	11.131929	.587492	.715816	1.883736
25	5.760	.783236	-.829079	11.615926	.625912	.792851	2.177378
26	6.000	.826029	-.921761	12.099923	.660109	.865579	2.488593
27	6.240	.863174	-1.018144	12.583919	.689793	.932549	2.815267
28	6.480	.894607	-1.117795	13.067916	.714912	.992777	3.155204
29	6.720	.920532	-1.220230	13.551913	.735630	1.045774	3.506233
30	6.960	.941369	-1.324949	14.035910	.752281	1.091508	3.866305
31	7.200	.957688	-1.431476	14.519907	.765323	1.130336	4.233563
32	7.440	.970143	-1.539377	15.003904	.775276	1.162898	4.606385
33	7.680	.979404	-1.648287	15.487901	.782677	1.190011	4.983407
34	7.920	.986114	-1.757906	15.971898	.788039	1.212567	5.363518
35	8.160	.990853	-1.868007	16.455895	.791826	1.231449	5.745843
36	8.400	.994113	-1.978420	16.939892	.794431	1.247470	6.129715
37	8.640	.996299	-2.089026	17.423889	.796178	1.261336	6.514640
38	8.880	.997727	-2.199747	17.907885	.797320	1.273630	6.900264
39	9.120	.998637	-2.310531	18.391882	.798047	1.284813	7.286341
40	9.360	.999202	-2.421349	18.875879	.798498	1.295234	7.672702
41	9.600	.999544	-2.532181	19.359876	.798771	1.305149	8.059239
42	9.840	.999745	-2.643020	19.843873	.798933	1.314736	8.445881
43	10.080	.999861	-2.753860	20.327870	.799025	1.324118	8.832584
44	10.320	.999926	-2.864699	20.811867	.799077	1.333374	9.219322
45	10.560	.999962	-2.975538	21.295864	.799105	1.342557	9.606080
46	10.800	.999981	-3.086375	21.779861	.799120	1.351697	9.992848
47	11.040	.999990	-3.197212	22.263858	.799128	1.360812	10.379622
48	11.280	.999995	-3.308048	22.747854	.799132	1.369915	10.766399
49	11.520	.999998	-3.418884	23.231851	.799134	1.379011	11.153177
50	11.760	.999999	-3.529720	23.715848	.799135	1.388103	11.539955
51	12.000	1.000000	-3.640556	24.199845	.799136	1.397194	11.926734
52	12.240	1.000000	-3.751391	24.683842	.799136	1.406283	12.313514

INTERPOLATED

PSI	Y	Y
-.0400	3.82462	2.44111
-.0350	4.03862	2.32887
-.0300	4.22902	2.03993
-.0250	4.38672	1.79582
-.0200	4.50453	1.54643
-.0150	4.61582	1.29290
-.0100	4.72059	1.02095
-.0050	4.81885	.68288
0.0000	4.90120	
.0050	4.97790	
.0100	5.05212	
.0150	5.12386	
.0200	5.19311	
.0250	5.25988	
.0300	5.32414	
.0350	5.38027	
.0400	5.43526	
.0450	5.48911	
.0500	5.54182	
.1000	5.99654	
.1500	6.36218	
.2000	6.67098	
.2500	6.94134	
.3000	7.18641	
.3500	7.40763	
.4000	7.61340	
.4500	7.80508	
.5000	7.98377	
1.0000	9.39235	
1.5000	10.44274	
2.0000	11.32674	
2.5000	12.11714	
3.0000	12.84881	
3.5000	13.54342	
4.0000	14.21293	
4.5000	14.86634	
5.0000	15.50909	
6.0000	16.77649	
7.0000	18.03295	
8.0000	19.28571	
9.0000	20.53739	
10.0000	21.78881	

X(J) = 3.37500 DELSTR = 9.432014

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.013067	.001462	.493939	-.010412	-.000111	-.002571
3	.480	-.021601	.005188	.987878	-.017212	-.000196	-.009394
4	.720	-.025601	.009862	1.481816	-.020399	-.000039	-.018682
5	.960	-.025064	.014191	1.975755	-.019971	.000590	-.028653
6	1.200	-.019980	.016908	2.469694	-.015920	.001932	-.037517
7	1.440	-.010339	.016784	2.963633	-.008238	.004253	-.043483
8	1.680	.003875	.012634	3.457572	.003087	.007845	-.044755
9	1.920	.022677	.003331	3.951511	.018069	.013029	-.039530
10	2.160	.046084	-.012153	4.445449	.036720	.020182	-.025999
11	2.400	.074109	-.034695	4.939388	.059050	.029753	-.002347
12	2.640	.106746	-.064971	5.433327	.085056	.042284	.033243
13	2.880	.143967	-.103400	5.927266	.114713	.058417	.082580
14	3.120	.185690	-.150121	6.421205	.147958	.078885	.147451
15	3.360	.231751	-.204987	6.915143	.184660	.104464	.229598
16	3.600	.281869	-.267609	7.409082	.224593	.135895	.330671
17	3.840	.335597	-.337429	7.903021	.267404	.173766	.452179
18	4.080	.392299	-.413797	8.396960	.312584	.218394	.595418
19	4.320	.451134	-.496049	8.890899	.359464	.269711	.761394
20	4.560	.511071	-.583548	9.384837	.407222	.327195	.950742
21	4.800	.570933	-.675708	9.878776	.454920	.389861	1.163665
22	5.040	.629472	-.771985	10.372715	.501564	.456308	1.399887
23	5.280	.685456	-.871868	10.866654	.546172	.524831	1.658646
24	5.520	.737765	-.974857	11.360593	.587852	.593571	1.938715
25	5.760	.785476	-1.080455	11.854532	.625869	.660684	2.238467
26	6.000	.827933	-1.188170	12.348470	.659698	.724507	2.555963
27	6.240	.864772	-1.297524	12.842409	.689051	.783688	2.889062
28	6.480	.895929	-1.408069	13.336348	.713877	.837275	3.235543
29	6.720	.921609	-1.519406	13.830287	.734339	.884752	3.593208
30	6.960	.942231	-1.631198	14.324226	.750771	.926013	3.959984
31	7.200	.958366	-1.743182	14.818164	.763627	.961307	4.333995
32	7.440	.970665	-1.855167	15.312103	.773427	.991150	4.713600
33	7.680	.979797	-1.967031	15.806042	.780703	1.016227	5.097422
34	7.920	.986404	-2.078708	16.299981	.785968	1.037302	5.484342
35	8.160	.991061	-2.190174	16.793920	.789678	1.055140	5.873479
36	8.400	.994259	-2.301436	17.287858	.792226	1.070452	6.264161
37	8.640	.996399	-2.412518	17.781797	.793932	1.083858	6.655893
38	8.880	.997794	-2.523452	18.275736	.795043	1.095872	7.048321
39	9.120	.998681	-2.634270	18.769675	.795750	1.106902	7.441199
40	9.360	.999230	-2.745001	19.263614	.796187	1.117258	7.834358
41	9.600	.999561	-2.855672	19.757553	.796451	1.127165	8.227691
42	9.840	.999756	-2.966300	20.251491	.796606	1.136782	8.621128
43	10.080	.999867	-3.076900	20.745430	.796695	1.146217	9.014625
44	10.320	.999930	-3.187482	21.239369	.796745	1.155542	9.408156
45	10.560	.999964	-3.298054	21.733308	.796772	1.164801	9.801706
46	10.800	.999982	-3.408618	22.227247	.796787	1.174023	10.195266
47	11.040	.999991	-3.519179	22.721185	.796794	1.183223	10.588832
48	11.280	.999996	-3.629738	23.215124	.796798	1.192413	10.982400
49	11.520	.999998	-3.740296	23.709063	.796800	1.201596	11.375970
50	11.760	.999999	-3.850853	24.203002	.796801	1.210776	11.769541
51	12.000	1.000000	-3.961409	24.696941	.796801	1.219955	12.163111
52	12.240	1.000000	-4.071965	25.190879	.796801	1.229132	12.556682

INTERPOLATED

PSI	Y	Y
-.0400	3.93160	2.31023
-.0350	4.13401	2.30031
-.0300	4.31542	2.03236
-.0250	4.46899	1.78723
-.0200	4.58325	1.54335
-.0150	4.69160	1.28990
-.0100	4.79404	1.02112
-.0050	4.89057	.68251
0.0000	4.97551	
.0050	5.05080	
.0100	5.12381	
.0150	5.19455	
.0200	5.26301	
.0250	5.32919	
.0300	5.39310	
.0350	5.45267	
.0400	5.50702	
.0450	5.56031	
.0500	5.61255	
.1000	6.06891	
.1500	6.43778	
.2000	6.74673	
.2500	7.02093	
.3000	7.26717	
.3500	7.49226	
.4000	7.69934	
.4500	7.89477	
.5000	8.07490	
1.0000	9.50321	
1.5000	10.56810	
2.0000	11.46376	
2.5000	12.26305	
3.0000	13.00222	
3.5000	13.70273	
4.0000	14.37742	
4.5000	15.03483	
5.0000	15.68104	
6.0000	16.95403	
7.0000	18.21495	
8.0000	19.47164	
9.0000	20.72707	
10.0000	21.98218	

X(J) = 3.50000 DELSTR = 9.568845

K	ETA	U	V	Y	UST	VST	PSI	INTERPOLATED PSI	Y	Y
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-.0450	3.79180	3.40711
2	.240	-.013253	.001243	.503733	-.010530	-.000227	-.002652	-.0400	4.00304	2.20316
3	.480	-.021853	.004328	1.007465	-.017362	-.000639	-.009677	-.0350	4.19597	2.29229
4	.720	-.025801	.007975	1.511198	-.020498	-.000983	-.019213	-.0300	4.37058	2.03881
5	.960	-.025095	.010921	2.014930	-.019938	-.001000	-.029397	-.0250	4.52686	1.78854
6	1.200	-.019734	.011927	2.518663	-.015678	-.000414	-.038368	-.0200	4.63953	1.54755
7	1.440	-.009709	.009788	3.022396	-.007714	.001064	-.044260	-.0150	4.74538	1.29248
8	1.680	.004986	.003334	3.526128	.003962	.003745	-.045205	-.0100	4.84595	1.02503
9	1.920	.024359	-.008553	4.029861	.019353	.007967	-.039332	-.0050	4.94122	.68461
10	2.160	.048412	-.026918	4.533594	.038463	.014099	-.024771	0.0000	5.03119	
11	2.400	.077133	-.052695	5.037326	.061282	.022557	.000352	.0050	5.10601	
12	2.640	.110491	-.086665	5.541059	.087785	.033813	.037897	.0100	5.17790	
13	2.880	.148418	-.129404	6.044791	.117917	.048401	.089706	.0150	5.24772	
14	3.120	.190790	-.181238	6.548524	.151582	.066914	.157584	.0200	5.31548	
15	3.360	.237403	-.242207	7.052257	.188615	.089980	.243268	.0250	5.38117	
16	3.600	.287938	-.312066	7.555989	.228765	.118207	.348392	.0300	5.44479	
17	3.840	.341927	-.390314	8.059722	.271659	.152097	.474432	.0350	5.50634	
18	4.080	.398726	-.476250	8.563455	.316786	.191949	.622641	.0400	5.56352	
19	4.320	.457501	-.569043	9.067187	.363481	.237750	.793977	.0450	5.61623	
20	4.560	.517236	-.667799	9.570920	.410941	.289102	.989028	.0500	5.66798	
21	4.800	.576780	-.771602	10.074652	.458248	.345195	1.207948	.1000	6.12714	
22	5.040	.634909	-.879557	10.578385	.504431	.404834	1.450414	.1500	6.49684	
23	5.280	.690418	-.990799	11.082118	.548533	.466528	1.715620	.2000	6.80834	
24	5.520	.742211	-1.104512	11.585850	.589682	.528624	2.002298	.2500	7.08679	
25	5.760	.789389	-1.219941	12.089583	.627164	.589458	2.308781	.3000	7.33355	
26	6.000	.831311	-1.336408	12.593315	.660471	.647510	2.633093	.3500	7.56285	
27	6.240	.867633	-1.453329	13.097048	.689329	.701528	2.973062	.4000	7.77062	
28	6.480	.898304	-1.570227	13.600781	.713697	.750619	3.326437	.4500	7.96749	
29	6.720	.923540	-1.686739	14.104513	.733747	.794280	3.690999	.5000	8.15113	
30	6.960	.943768	-1.802619	14.608246	.749817	.832385	4.064659	1.0000	9.59727	
31	7.200	.959561	-1.917729	15.111979	.762365	.865138	4.445527	1.5000	10.67532	
32	7.440	.971573	-2.032021	15.615711	.771908	.892988	4.831959	2.0000	11.58194	
33	7.680	.980471	-2.145520	16.119444	.778978	.916544	5.222575	2.5000	12.38933	
34	7.920	.986892	-2.258299	16.623176	.784079	.936491	5.616256	3.0000	13.13598	
35	8.160	.991406	-2.370460	17.126909	.787665	.953519	6.012125	3.5000	13.84211	
36	8.400	.994496	-2.482114	17.630642	.790121	.968268	6.409517	4.0000	14.52175	
37	8.640	.996559	-2.593371	18.134374	.791759	.981301	6.807939	4.5000	15.18331	
38	8.880	.997899	-2.704327	18.638107	.792824	.993081	7.207042	5.0000	15.83289	
39	9.120	.998748	-2.815066	19.141840	.793499	1.003977	7.606583	6.0000	17.11151	
40	9.360	.999271	-2.925650	19.645572	.793915	1.014268	8.006399	7.0000	18.37686	
41	9.600	.999586	-3.036131	20.149305	.794165	1.024157	8.406383	8.0000	19.63751	
42	9.840	.999771	-3.146542	20.653037	.794311	1.033787	8.806467	9.0000	20.89668	
43	10.080	.999876	-3.256910	21.156770	.794395	1.043255	9.206608	10.0000	22.15546	
44	10.320	.999935	-3.367251	21.660503	.794442	1.052625	9.606783			
45	10.560	.999966	-3.477575	22.164235	.794467	1.061937	10.006975			
46	10.800	.999983	-3.587890	22.667968	.794480	1.071216	10.407178			
47	11.040	.999992	-3.698199	23.171700	.794487	1.080476	10.807385			
48	11.280	.999996	-3.808506	23.675433	.794490	1.089727	11.207595			
49	11.520	.999998	-3.918811	24.179166	.794492	1.098972	11.607806			
50	11.760	.999999	-4.029115	24.682898	.794493	1.108214	12.008018			
51	12.000	1.000000	-4.139418	25.186631	.794493	1.117456	12.408230			
52	12.240	1.000000	-4.249721	25.690364	.794494	1.126696	12.808442			

X(J) = 3.62500 DELSTR = 9.693414

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.013372	.001052	.513385	-.010593	-.000321	-.002719
3	.480	-.021980	.003574	1.026770	-.017413	-.000999	-.009908
4	.720	-.025829	.006310	1.540155	-.020462	-.001757	-.019631
5	.960	-.024919	.008019	2.053540	-.019741	-.002306	-.029950
6	1.200	-.019253	.007485	2.566925	-.015252	-.002348	-.038933
7	1.440	-.008827	.003525	3.080310	-.006993	-.001569	-.044643
8	1.680	.006359	-.005008	3.593694	.005038	.000362	-.045145
9	1.920	.026304	-.019209	4.107079	.020839	.003802	-.038503
10	2.160	.050999	-.040104	4.620464	.040402	.009131	-.022783
11	2.400	.080415	-.068619	5.133849	.063706	.016765	.003941
12	2.640	.114499	-.105552	5.647234	.090708	.027156	.043578
13	2.880	.153153	-.151526	6.160619	.121331	.040792	.098007
14	3.120	.196219	-.206945	6.674004	.155448	.058193	.169054
15	3.360	.243454	-.271948	7.187389	.192868	.079889	.258464
16	3.600	.294501	-.346391	7.700774	.233309	.106383	.367860
17	3.840	.348861	-.429840	8.214159	.276374	.138088	.498692
18	4.080	.405870	-.521608	8.727544	.321537	.175243	.652171
19	4.320	.464686	-.620807	9.240929	.368133	.217825	.829204
20	4.560	.524300	-.726412	9.754314	.415360	.265478	1.030321
21	4.800	.583575	-.837327	10.267699	.462318	.317478	1.255614
22	5.040	.641309	-.952437	10.781083	.508056	.372753	1.504702
23	5.280	.696323	-1.070657	11.294468	.551639	.429953	1.776718
24	5.520	.747550	-1.190963	11.807853	.592222	.487569	2.070339
25	5.760	.794117	-1.312430	12.321238	.629113	.544073	2.383846
26	6.000	.835412	-1.434257	12.834623	.661827	.598059	2.715221
27	6.240	.871114	-1.555788	13.348008	.690111	.648369	3.062253
28	6.480	.901195	-1.676526	13.861393	.713942	.694168	3.422663
29	6.720	.925886	-1.796133	14.374778	.733503	.734984	3.794211
30	6.960	.945629	-1.914421	14.888163	.749143	.770698	4.174795
31	7.200	.961003	-2.031336	15.401548	.761323	.801493	4.562521
32	7.440	.972663	-2.146924	15.914933	.770560	.827783	4.955744
33	7.680	.981275	-2.261304	16.428318	.777383	.850130	5.353089
34	7.920	.987471	-2.374640	16.941703	.782291	.869167	5.753445
35	8.160	.991812	-2.487113	17.455088	.785730	.885530	6.155945
36	8.400	.994774	-2.598900	17.968472	.788077	.899812	6.559929
37	8.640	.996744	-2.710162	18.481857	.789638	.912526	6.964917
38	8.880	.998020	-2.821038	18.995242	.790648	.924102	7.370565
39	9.120	.998824	-2.931638	19.508627	.791286	.934874	7.776635
40	9.360	.999319	-3.042047	20.022012	.791677	.945098	8.182970
41	9.600	.999615	-3.152328	20.535397	.791912	.954960	8.589465
42	9.840	.999788	-3.262527	21.048782	.792049	.964590	8.996056
43	10.080	.999886	-3.372674	21.562167	.792127	.974074	9.402702
44	10.320	.999940	-3.482790	22.075552	.792170	.983471	9.809379
45	10.560	.999969	-3.592886	22.588937	.792193	.992816	10.216073
46	10.800	.999985	-3.702971	23.102322	.792205	1.002132	10.622776
47	11.040	.999993	-3.813051	23.615707	.792211	1.011432	11.029484
48	11.280	.999997	-3.923127	24.129092	.792214	1.020723	11.436194
49	11.520	.999998	-4.033202	24.642476	.792216	1.030009	11.842905
50	11.760	.999999	-4.143275	25.155861	.792217	1.039293	12.249617
51	12.000	1.000000	-4.253348	25.669246	.792217	1.048576	12.656329
52	12.240	1.000000	-4.363420	26.182631	.792217	1.057858	13.063042

INTERPOLATED

PSI	Y	Y
-.0450	3.84917	3.43727
-.0400	4.05003	1.91898
-.0350	4.23504	2.29786
-.0300	4.40421	2.05538
-.0250	4.55755	1.79707
-.0200	4.68021	1.55712
-.0150	4.78388	1.29923
-.0100	4.88284	1.03174
-.0050	4.97708	.68857
0.0000	5.06661	
.0050	5.14910	
.0100	5.21994	
.0150	5.28892	
.0200	5.35602	
.0250	5.42125	
.0300	5.48461	
.0350	5.54610	
.0400	5.60572	
.0450	5.66197	
.0500	5.71323	
.1000	6.17630	
.1500	6.54548	
.2000	6.86124	
.2500	7.14240	
.3000	7.39133	
.3500	7.62219	
.4000	7.83335	
.4500	8.03124	
.5000	8.21880	
1.0000	9.68024	
1.5000	10.77178	
2.0000	11.68774	
2.5000	12.50377	
3.0000	13.25729	
3.5000	13.96925	
4.0000	14.65354	
4.5000	15.31925	
5.0000	15.97230	
6.0000	17.25640	
7.0000	18.52628	
8.0000	19.79086	
9.0000	21.05376	
10.0000	22.31618	

X(J) = 3.75000 DELSTR = 9.808576

K	ETA	U	V	Y	UST	VST	PSI	INTERPOLATED PSI	INTERPOLATED Y	Y
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-.0400	4.00178	2.67848
2	.240	-.013435	.000878	.522902	-.010613	-.000400	-.002775	-.0350	4.25564	2.31368
3	.480	-.022003	.002879	1.045804	-.017382	-.001307	-.010094	-.0300	4.42006	2.07343
4	.720	-.025711	.004748	1.568706	-.020311	-.002428	-.019949	-.0250	4.57088	1.81143
5	.960	-.024562	.005247	2.091608	-.019404	-.003460	-.030332	-.0200	4.70768	1.57105
6	1.200	-.018563	.003165	2.614510	-.014664	-.004091	-.039239	-.0150	4.80931	1.30936
7	1.440	-.007716	-.002676	3.137412	-.006095	-.003994	-.044667	-.0100	4.90676	1.03981
8	1.680	.007975	-.013409	3.660315	.006300	-.002820	-.044614	-.0050	5.00002	.69401
9	1.920	.028499	-.030112	4.183217	.022513	-.000203	-.037080	0.0000	5.08910	
10	2.160	.053835	-.053789	4.706119	.042528	.004253	-.020075	.0050	5.17399	
11	2.400	.083941	-.085343	5.229021	.066311	.010969	.008381	.0100	5.25145	
12	2.640	.118743	-.125556	5.751923	.093804	.020394	.050243	.0150	5.31958	
13	2.880	.158121	-.175043	6.274825	.124911	.032999	.107427	.0200	5.38603	
14	3.120	.201885	-.234217	6.797727	.159484	.049268	.181782	.0250	5.45079	
15	3.360	.249758	-.303245	7.320629	.197303	.069679	.275064	.0300	5.51385	
16	3.600	.301348	-.382018	7.843531	.238057	.094667	.388890	.0350	5.57523	
17	3.840	.356124	-.470132	8.366433	.281329	.124575	.524684	.0400	5.63492	
18	4.080	.413395	-.566905	8.889335	.326572	.159587	.683620	.0450	5.69292	
19	4.320	.472305	-.671413	9.412237	.373109	.199652	.866552	.0500	5.74923	
20	4.560	.531841	-.782548	9.935139	.420140	.244424	1.073948	.1000	6.21285	
21	4.800	.590875	-.899092	10.458042	.466776	.293227	1.305833	.1500	6.58574	
22	5.040	.646224	-1.019780	10.980944	.512080	.345066	1.561756	.2000	6.90653	
23	5.280	.702734	-1.143369	11.503846	.555141	.398694	1.840782	.2500	7.18848	
24	5.520	.753365	-1.268690	12.026748	.595139	.452710	2.141524	.3000	7.44178	
25	5.760	.799279	-1.394699	12.549650	.631410	.505696	2.462207	.3500	7.67355	
26	6.000	.839893	-1.520510	13.072552	.663494	.556345	2.800761	.4000	7.88895	
27	6.240	.874918	-1.645424	13.595454	.691163	.603576	3.154937	.4500	8.08753	
28	6.480	.904350	-1.768938	14.118356	.714413	.646615	3.522426	.5000	8.27660	
29	6.720	.928443	-1.890743	14.641258	.733446	.685023	3.900971	1.0000	9.75468	
30	6.960	.947651	-2.010708	15.164160	.748620	.718693	4.288458	1.5000	10.85856	
31	7.200	.962563	-2.128844	15.687062	.760400	.747800	4.682993	2.0000	11.78460	
32	7.440	.973838	-2.245276	16.209964	.769307	.772734	5.082937	2.5000	12.60914	
33	7.680	.982138	-2.360200	16.732866	.775864	.794022	5.486923	3.0000	13.36899	
34	7.920	.988089	-2.473848	17.255768	.780565	.812256	5.893853	3.5000	14.08688	
35	8.160	.992243	-2.586460	17.778671	.783847	.828028	6.302870	4.0000	14.77578	
36	8.400	.995068	-2.698263	18.301573	.786078	.841888	6.713329	4.5000	15.44540	
37	8.640	.996939	-2.809457	18.824475	.787556	.854313	7.124757	5.0000	16.10196	
38	8.880	.998146	-2.920207	19.347377	.788509	.865698	7.536821	6.0000	17.39165	
39	9.120	.998904	-3.030645	19.870279	.789108	.876352	7.949291	7.0000	18.66600	
40	9.360	.999368	-3.140869	20.393181	.789475	.886510	8.362013	8.0000	19.93454	
41	9.600	.999644	-3.250952	20.916083	.789693	.896340	8.774888	9.0000	21.20113	
42	9.840	.999805	-3.360944	21.438985	.789820	.905960	9.187853	10.0000	22.46717	
43	10.080	.999895	-3.470880	21.961887	.789892	.915451	9.600871			
44	10.320	.999945	-3.580782	22.484789	.789931	.924863	10.013917			
45	10.560	.999972	-3.690664	23.007691	.789952	.934229	10.426979			
46	10.800	.999986	-3.800535	23.530593	.789964	.943570	10.840050			
47	11.040	.999993	-3.910399	24.053495	.789969	.952896	11.253125			
48	11.280	.999997	-4.020260	24.576398	.789972	.962215	11.666202			
49	11.520	.999999	-4.130118	25.099300	.789973	.971530	12.079281			
50	11.760	.999999	-4.239976	25.622202	.789974	.980842	12.492360			
51	12.000	1.000000	-4.349834	26.145104	.789974	.990154	12.905439			
52	12.240	1.000000	-4.459691	26.668006	.789974	.999465	13.318518			

X(J) = 3,87500 DELSTR = 9,914699

K	ETA	U	V	Y	UST	VST	PSI
1	0,000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000
2	,240	-,013449	,000711	,532290	-,010595	-,000470	-,002820
3	,480	-,021933	,002199	1,064581	-,017278	-,001587	-,010238
4	,720	-,025458	,003187	1,596871	-,020055	-,003052	-,020174
5	,960	-,024033	,002416	2,129161	-,018932	-,004561	-,030551
6	1,200	-,017666	-,001343	2,661452	-,013917	-,005797	-,039293
7	1,440	-,006367	-,009278	3,193742	-,005016	-,006429	-,044332
8	1,680	,009853	-,022529	3,726033	,007762	-,006104	-,043601
9	1,920	,030976	-,042167	4,258323	,024402	-,004448	-,035041
10	2,160	,056967	-,069179	4,790613	,044877	-,001058	-,016603
11	2,400	,087772	-,104449	5,322904	,069144	,004492	,013743
12	2,640	,123297	-,148727	5,855194	,097129	,012654	,057996
13	2,880	,163398	-,202600	6,387484	,128720	,023893	,118104
14	3,120	,207861	-,266454	6,919775	,163746	,038677	,195943
15	3,360	,256377	-,340434	7,452065	,201965	,057458	,293275
16	3,600	,308521	-,424413	7,984356	,243042	,080631	,411712
17	3,840	,363728	-,517966	8,516646	,286532	,108497	,552655
18	4,080	,421281	-,620381	9,048936	,331871	,141202	,717240
19	4,320	,480305	-,730678	9,581227	,378368	,178673	,906267
20	4,560	,539779	-,847666	10,113517	,425219	,220568	1,120138
21	4,800	,598580	-,970015	10,645807	,471540	,266246	1,358806
22	5,040	,655539	-1,096330	11,178098	,516411	,314774	1,621744
23	5,280	,709526	-1,225235	11,710388	,558940	,364988	1,907944
24	5,520	,759534	-1,355441	12,242679	,598335	,415580	2,215947
25	5,760	,804756	-1,485808	12,774969	,633959	,465228	2,543916
26	6,000	,844645	-1,615388	13,307259	,665383	,512712	2,889730
27	6,240	,878946	-1,743459	13,839550	,692403	,557024	3,251098
28	6,480	,907684	-1,869528	14,371840	,715042	,597444	3,625683
29	6,720	,931136	-1,993328	14,904130	,733517	,633567	4,011210
30	6,960	,949774	-2,114786	15,436421	,748199	,665296	4,405562
31	7,200	,964196	-2,233991	15,968711	,759561	,692799	4,806845
32	7,440	,975062	-2,351142	16,501001	,768120	,716444	5,213430
33	7,680	,983033	-2,466511	17,033292	,774400	,736725	5,623964
34	7,920	,988727	-2,580397	17,565582	,778885	,754194	6,037363
35	8,160	,992686	-2,693095	18,097873	,782004	,769404	6,452786
36	8,400	,995368	-2,804878	18,630163	,784117	,782863	6,869602
37	8,640	,997137	-2,915980	19,162453	,785510	,795012	7,287350
38	8,880	,998273	-3,026591	19,694744	,786405	,806215	7,705708
39	9,120	,998983	-3,136859	20,227034	,786965	,816755	8,124453
40	9,360	,999416	-3,246897	20,759324	,787306	,826847	8,543437
41	9,600	,999673	-3,356782	21,291615	,787508	,836644	8,962566
42	9,840	,999821	-3,466572	21,823905	,787625	,846253	9,381780
43	10,080	,999905	-3,576302	22,356196	,787691	,855747	9,801043
44	10,320	,999951	-3,685996	22,888486	,787727	,865170	10,220333
45	10,560	,999975	-3,795670	23,420776	,787746	,874554	10,639637
46	10,800	,999988	-3,905332	23,953067	,787756	,883915	11,058949
47	11,040	,999994	-4,014987	24,485357	,787761	,893263	11,478265
48	11,280	,999997	-4,124639	25,017647	,787763	,902604	11,897584
49	11,520	,999999	-4,234289	25,549938	,787765	,911942	12,316903
50	11,760	1,000000	-4,343938	26,082228	,787765	,921279	12,736223
51	12,000	1,000000	-4,453587	26,614518	,787765	,930614	13,155542
52	12,240	1,000000	-4,563236	27,146809	,787766	,939949	13,574862

INTERPOLATED

PSI	Y	Y
-,0400	3,97200	2,72617
-,0350	4,25968	2,33803
-,0300	4,41953	2,09821
-,0250	4,56777	1,83100
-,0200	4,70440	1,58773
-,0150	4,82213	1,32244
-,0100	4,91801	1,04929
-,0050	5,01020	,70069
0,0000	5,09870	
,0050	5,18350	
,0100	5,26460	
,0150	5,33966	
,0200	5,40539	
,0250	5,46960	
,0300	5,53228	
,0350	5,59345	
,0400	5,65310	
,0450	5,71122	
,0500	5,76783	
,1000	6,23828	
,1500	6,61706	
,2000	6,94367	
,2500	7,22597	
,3000	7,48437	
,3500	7,71669	
,4000	7,93518	
,4500	8,13594	
,5000	8,32604	
1,0000	9,82095	
1,5000	10,93679	
2,0000	11,87277	
2,5000	12,70524	
3,0000	13,47164	
3,5000	14,19490	
4,0000	14,88882	
4,5000	15,56231	
5,0000	16,22222	
6,0000	17,51758	
7,0000	18,79640	
8,0000	20,06887	
9,0000	21,33915	
10,0000	22,60877	

X(J) = 4.00000 DELSTR = 10.010948

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.013420	.000539	.541556	-.010543	-.000538	-.002855
3	.480	-.021775	.001488	1.083112	-.017106	-.001860	-.010341
4	.720	-.025073	.001523	1.624668	-.019697	-.003677	-.020307
5	.960	-.023327	-.000659	2.166225	-.018325	-.005691	-.030603
6	1.200	-.016549	-.006325	2.707781	-.013001	-.007591	-.039085
7	1.440	-.004755	-.016694	3.249337	-.003736	-.009049	-.043617
8	1.680	.012035	-.032925	3.790893	.009455	-.009717	-.042068
9	1.920	.033792	-.056096	4.332449	.026547	-.009218	-.032320
10	2.160	.060471	-.087188	4.874005	.047505	-.007149	-.012268
11	2.400	.092000	-.127062	5.415561	.072274	-.003079	.020165
12	2.640	.128268	-.176439	5.957117	.100766	.003445	.067021
13	2.880	.169109	-.235864	6.498674	.132850	.012889	.130279
14	3.120	.214283	-.305673	7.040230	.168338	.025715	.211834
15	3.360	.263450	-.385956	7.581786	.206963	.042363	.313457
16	3.600	.316154	-.476525	8.123342	.248367	.063211	.436751
17	3.840	.371800	-.576893	8.664898	.292082	.088539	.583092
18	4.080	.429641	-.686270	9.206454	.337521	.118473	.753575
19	4.320	.488782	-.803587	9.748010	.383981	.152935	.948942
20	4.560	.548191	-.927543	10.289566	.430653	.191595	1.169528
21	4.800	.606747	-1.056680	10.831123	.476654	.233845	1.415206
22	5.040	.663295	-1.189471	11.372679	.521077	.278812	1.685370
23	5.280	.716728	-1.324407	11.914235	.563054	.325408	1.978929
24	5.520	.766071	-1.460083	12.455791	.601817	.372415	2.294351
25	5.760	.810553	-1.595274	12.997347	.636762	.418598	2.629731
26	6.000	.849668	-1.728984	13.538903	.667490	.462821	2.982893
27	6.240	.883194	-1.860479	14.080459	.693827	.504144	3.351508
28	6.480	.911190	-1.989296	14.622015	.715821	.541896	3.733210
29	6.720	.933960	-2.115220	15.163572	.733709	.575701	4.125711
30	6.960	.951992	-2.238257	15.705128	.747875	.605470	4.526891
31	7.200	.965895	-2.358581	16.246684	.758796	.631362	4.934865
32	7.440	.976330	-2.476480	16.788240	.766995	.653718	5.348016
33	7.680	.983956	-2.592307	17.329796	.772985	.672997	5.765008
34	7.920	.989381	-2.706434	17.871352	.777247	.689710	6.184777
35	8.160	.993139	-2.819218	18.412908	.780199	.704366	6.606499
36	8.400	.995673	-2.930978	18.954464	.782190	.717433	7.029560
37	8.640	.997337	-3.041983	19.496021	.783497	.729315	7.453514
38	8.880	.998401	-3.152451	20.037577	.784333	.740343	7.878048
39	9.120	.999063	-3.262548	20.579133	.784853	.750775	8.302949
40	9.360	.999465	-3.372396	21.120689	.785169	.760807	8.728076
41	9.600	.999702	-3.482083	21.662245	.785355	.770575	9.153339
42	9.840	.999838	-3.591668	22.203801	.785462	.780177	9.578682
43	10.080	.999914	-3.701191	22.745357	.785522	.789676	10.004070
44	10.320	.999956	-3.810677	23.286913	.785554	.799114	10.429483
45	10.560	.999978	-3.920141	23.828470	.785572	.808517	10.854909
46	10.800	.999989	-4.029594	24.370026	.785581	.817900	11.280343
47	11.040	.999995	-4.139040	24.911582	.785585	.827272	11.705780
48	11.280	.999998	-4.248483	25.453138	.785587	.836638	12.131219
49	11.520	.999999	-4.357923	25.994694	.785588	.846001	12.556659
50	11.760	1.000000	-4.467363	26.536250	.785589	.855363	12.982100
51	12.000	1.000000	-4.576803	27.077806	.785589	.864724	13.407540
52	12.240	1.000000	-4.686242	27.619363	.785589	.874085	13.832981

INTERPOLATED

PSI	Y	Y
-.0400	3.92101	2.80297
-.0350	4.20171	2.37015
-.0300	4.40319	2.13103
-.0250	4.54845	1.85578
-.0200	4.68390	1.60824
-.0150	4.80952	1.33839
-.0100	4.91631	1.06093
-.0050	5.00722	.70855
0.0000	5.09489	
.0050	5.17931	
.0100	5.26050	
.0150	5.33844	
.0200	5.41315	
.0250	5.47697	
.0300	5.53914	
.0350	5.59995	
.0400	5.65940	
.0450	5.71749	
.0500	5.77421	
.1000	6.25270	
.1500	6.63836	
.2000	6.96755	
.2500	7.25370	
.3000	7.51501	
.3500	7.75043	
.4000	7.97008	
.4500	8.17529	
.5000	8.36610	
1.0000	9.87802	
1.5000	11.00555	
2.0000	11.95139	
2.5000	12.79101	
3.0000	13.56444	
3.5000	14.29288	
4.0000	14.99138	
4.5000	15.66911	
5.0000	16.33239	
6.0000	17.63327	
7.0000	18.91666	
8.0000	20.19304	
9.0000	21.46699	
10.0000	22.74018	

X(J) = 4.12500 DELSTR = 10.095966

K	ETA	U	V	Y	UST	VST	PSI	INTERPOLATED PSI	INTERPOLATED Y	Y
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	-.0400	3.85189	2.93183
2	.240	-.013348	.000349	.550706	-.010457	-.000609	-.002879	-.0350	4.12226	2.41013
3	.480	-.021526	.000693	1.101411	-.016865	-.002152	-.010403	-.0300	4.35581	2.17358
4	.720	-.024548	-.000359	1.652117	-.019232	-.004354	-.020342	-.0250	4.51307	1.88635
5	.960	-.022428	-.004175	2.202823	-.017571	-.006932	-.030476	-.0200	4.64649	1.63335
6	1.200	-.015185	-.012077	2.753528	-.011896	-.009590	-.038589	-.0150	4.77169	1.35744
7	1.440	-.002841	-.025331	3.304234	-.002226	-.012011	-.042478	-.0100	4.88867	1.07487
8	1.680	.014573	-.045130	3.854940	.011417	-.013854	-.039947	-.0050	4.99054	.71761
9	1.920	.037018	-.072570	4.405645	.029001	-.014748	-.028818	0.0000	5.07705	
10	2.160	.064432	-.108628	4.956351	.050479	-.014291	-.006933	.0050	5.16074	
11	2.400	.096729	-.154152	5.507057	.075782	-.012051	.027833	.0100	5.24160	
12	2.640	.133778	-.209823	6.057762	.104808	-.007573	.077559	.0150	5.31965	
13	2.880	.175391	-.276135	6.608468	.137409	-.000388	.144254	.0200	5.39487	
14	3.120	.221300	-.353356	7.159173	.173376	.009969	.229830	.0250	5.46728	
15	3.360	.271136	-.441496	7.709879	.212420	.023935	.336059	.0300	5.53355	
16	3.600	.324413	-.540271	8.260585	.254159	.041888	.464533	.0350	5.59381	
17	3.840	.380503	-.649088	8.811290	.298102	.064101	.616600	.0400	5.65286	
18	4.080	.438631	-.767039	9.361996	.343643	.090704	.793306	.0450	5.71070	
19	4.320	.497880	-.892924	9.912702	.390061	.121624	.995333	.0500	5.76733	
20	4.560	.557208	-1.025296	10.463407	.436541	.156556	1.222941	.1000	6.25494	
21	4.800	.615492	-1.162547	11.014113	.482203	.194934	1.475919	.1500	6.64844	
22	5.040	.671591	-1.302994	11.564819	.526153	.235947	1.753573	.2000	6.97806	
23	5.280	.724421	-1.444987	12.115524	.567543	.278584	2.054725	.2500	7.27038	
24	5.520	.773042	-1.587005	12.666230	.605635	.321714	2.377763	.3000	7.53262	
25	5.760	.816724	-1.727739	13.216936	.639857	.364188	2.720712	.3500	7.77342	
26	6.000	.855000	-1.866157	13.767641	.669844	.404950	3.081342	.4000	7.99374	
27	6.240	.887691	-2.001528	14.318347	.695455	.443126	3.457281	.4500	8.20221	
28	6.480	.914890	-2.133431	14.869053	.716764	.478089	3.846140	.5000	8.39538	
29	6.720	.936929	-2.261728	15.419758	.734030	.509488	4.245620	1.0000	9.92452	
30	6.960	.954314	-2.386518	15.970464	.747651	.537237	4.653605	1.5000	11.06351	
31	7.200	.967665	-2.508077	16.521170	.758110	.561478	5.068221	2.0000	12.01813	
32	7.440	.977646	-2.626798	17.071875	.765930	.582523	5.487870	2.5000	12.86554	
33	7.680	.984908	-2.743127	17.622581	.771620	.600791	5.911238	3.0000	13.64534	
34	7.920	.990053	-2.857519	18.173286	.775650	.616747	6.337283	3.5000	14.37955	
35	8.160	.993600	-2.970399	18.723992	.778429	.630854	6.765203	4.0000	15.08250	
36	8.400	.995982	-3.082139	19.274698	.780295	.643537	7.194402	4.5000	15.76415	
37	8.640	.997538	-3.193046	19.825403	.781514	.655160	7.624451	5.0000	16.43101	
38	8.880	.998529	-3.303366	20.376109	.782290	.666024	8.055049	6.0000	17.73751	
39	9.120	.999142	-3.413285	20.926815	.782771	.676359	8.485993	7.0000	19.02539	
40	9.360	.999512	-3.522937	21.477520	.783061	.686339	8.917149	8.0000	20.30573	
41	9.600	.999730	-3.632418	22.028226	.783231	.696087	9.348432	9.0000	21.58332	
42	9.840	.999854	-3.741791	22.578932	.783328	.705690	9.779789	10.0000	22.86005	
43	10.080	.999923	-3.851100	23.129637	.783383	.715203	10.211187			
44	10.320	.999961	-3.960371	23.680343	.783412	.724663	10.642609			
45	10.560	.999980	-4.069619	24.231049	.783428	.734093	11.074042			
46	10.800	.999990	-4.178856	24.781754	.783435	.743505	11.505482			
47	11.040	.999996	-4.288085	25.332460	.783439	.752908	11.936926			
48	11.280	.999998	-4.397312	25.883166	.783441	.762306	12.368371			
49	11.520	.999999	-4.506536	26.433871	.783442	.771702	12.799817			
50	11.760	1.000000	-4.615760	26.984577	.783443	.781097	13.231263			
51	12.000	1.000000	-4.724983	27.535283	.783443	.790490	13.662709			
52	12.240	1.000000	-4.834206	28.085988	.783443	.799884	14.094156			

X(J) = 4.25000 DELSTR = 10.168214

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.013228	.000125	.559745	-.010336	-.000689	-.002893
3	.480	-.021179	-.000243	1.119490	-.016548	-.002484	-.010417
4	.720	-.023867	-.002584	1.679235	-.018648	-.005130	-.020267
5	.960	-.021311	-.008343	2.238981	-.016651	-.008365	-.030146
6	1.200	-.013537	-.018914	2.798726	-.010577	-.011912	-.037766
7	1.440	-.000576	-.035622	3.358471	-.000450	-.015468	-.040852
8	1.680	.017532	-.059701	3.918216	.013698	-.018704	-.037144
9	1.920	.040731	-.092271	4.477961	.031824	-.021260	-.024404
10	2.160	.068946	-.134315	5.037706	.053869	-.022735	-.000421
11	2.400	.102071	-.186656	5.597452	.079750	-.022698	.036975
12	2.640	.139955	-.249936	6.157197	.109350	-.020690	.089899
13	2.880	.182385	-.324582	6.716942	.142501	-.016234	.160385
14	3.120	.229065	-.410777	7.276687	.178974	-.008860	.250357
15	3.360	.279598	-.508421	7.836432	.218457	.001878	.361587
16	3.600	.333464	-.617107	8.396177	.260543	.016368	.495646
17	3.840	.390003	-.736097	8.955923	.304719	.034893	.653847
18	4.080	.448414	-.864322	9.515668	.350356	.057597	.837185
19	4.320	.507754	-1.000408	10.075413	.396720	.084433	1.046271
20	4.560	.566970	-1.142729	10.635158	.442987	.115129	1.281282
21	4.800	.624940	-1.289491	11.194903	.488280	.149173	1.541918
22	5.040	.680534	-1.438838	11.754648	.531717	.185819	1.827387
23	5.280	.732697	-1.588965	12.314394	.572473	.224136	2.136420
24	5.520	.780524	-1.738231	12.874139	.609841	.263080	2.467317
25	5.760	.823328	-1.885251	13.433884	.643285	.301590	2.818033
26	6.000	.860690	-2.028963	13.993629	.672477	.338683	3.186279
27	6.240	.892473	-2.168659	14.553374	.697310	.373549	3.569645
28	6.480	.918810	-2.303980	15.113119	.717887	.405601	3.965720
29	6.720	.940060	-2.434883	15.672865	.734491	.434506	4.372201
30	6.960	.956753	-2.561583	16.232610	.747533	.460176	4.786979
31	7.200	.969516	-2.684478	16.792355	.757505	.482731	5.208198
32	7.440	.979014	-2.804078	17.352100	.764926	.502448	5.634285
33	7.680	.985894	-2.920939	17.911845	.770302	.519699	6.063953
34	7.920	.990744	-3.035608	18.471590	.774091	.534902	6.496186
35	8.160	.994073	-3.148584	19.031336	.776692	.548470	6.930208
36	8.400	.996296	-3.260296	19.591081	.778430	.560780	7.365444
37	8.640	.997742	-3.371095	20.150826	.779559	.572160	7.801482
38	8.880	.998658	-3.481256	20.710571	.780274	.582872	8.238037
39	9.120	.999222	-3.590984	21.270316	.780715	.593124	8.674915
40	9.360	.999560	-3.700427	21.830061	.780979	.603066	9.111990
41	9.600	.999757	-3.809690	22.389807	.781134	.612807	9.549183
42	9.840	.999870	-3.918840	22.949552	.781221	.622423	9.986443
43	10.080	.999932	-4.027922	23.509297	.781270	.631961	10.423742
44	10.320	.999965	-4.136966	24.069042	.781296	.641455	10.861061
45	10.560	.999983	-4.245986	24.628787	.781310	.650922	11.298391
46	10.800	.999992	-4.354995	25.188532	.781317	.660375	11.735728
47	11.040	.999996	-4.463997	25.748278	.781320	.669820	12.173067
48	11.280	.999998	-4.572995	26.308023	.781322	.679262	12.610408
49	11.520	.999999	-4.681992	26.867768	.781323	.688701	13.047749
50	11.760	1.000000	-4.790987	27.427513	.781323	.698138	13.485091
51	12.000	1.000000	-4.899983	27.987258	.781323	.707576	13.922432
52	12.240	1.000000	-5.008978	28.547003	.781323	.717013	14.359774

INTERPOLATED

PSI	Y	Y
-.0400	3.76777	3.18476
-.0350	4.02517	2.46023
-.0300	4.25453	2.22937
-.0250	4.45584	1.92405
-.0200	4.59251	1.66410
-.0150	4.71615	1.38015
-.0100	4.83296	1.09150
-.0050	4.94296	.72807
0.0000	5.04477	
.0050	5.12728	
.0100	5.20736	
.0150	5.28501	
.0200	5.36022	
.0250	5.43301	
.0300	5.50337	
.0350	5.57129	
.0400	5.63267	
.0450	5.69002	
.0500	5.74631	
.1000	6.24395	
.1500	6.64116	
.2000	6.97519	
.2500	7.27465	
.3000	7.53719	
.3500	7.78216	
.4000	8.00483	
.4500	8.21439	
.5000	8.41253	
1.0000	9.95655	
1.5000	11.10802	
2.0000	12.07170	
2.5000	12.92740	
3.0000	13.71318	
3.5000	14.45300	
4.0000	15.16075	
4.5000	15.84624	
5.0000	16.51648	
6.0000	17.82874	
7.0000	19.12116	
8.0000	20.40541	
9.0000	21.68665	
10.0000	22.96691	

X(J) = 4.37500 DELSTR = 10.226161

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.013056	-.000148	.568681	-.010173	-.000785	-.002893
3	.480	-.020718	-.001386	1.137362	-.016144	-.002880	-.010376
4	.720	-.023005	-.005290	1.706042	-.017926	-.006055	-.020063
5	.960	-.019941	-.013395	2.274723	-.015538	-.010071	-.029579
6	1.200	-.011559	-.027176	2.843404	-.009007	-.014670	-.036558
7	1.440	.002099	-.048020	3.412085	.001636	-.019568	-.038654
8	1.680	.020983	-.077212	3.980765	.016350	-.024450	-.033540
9	1.920	.045017	-.115895	4.549446	.035079	-.028963	-.018916
10	2.160	.074111	-.165050	5.118127	.057749	-.032711	.007478
11	2.400	.108138	-.225475	5.686808	.084264	-.035259	.047859
12	2.640	.146922	-.297758	6.255488	.114486	-.036144	.104371
13	2.880	.190226	-.382247	6.824169	.148229	-.034879	.179072
14	3.120	.237724	-.479016	7.392850	.185241	-.030980	.273890
15	3.360	.288987	-.587832	7.961531	.225186	-.023983	.390591
16	3.600	.343461	-.708129	8.530211	.267634	-.013485	.530720
17	3.840	.400454	-.838988	9.098892	.312044	.000824	.695546
18	4.080	.459135	-.979139	9.667573	.357770	.019113	.886001
19	4.320	.518540	-1.126997	10.236254	.404060	.041372	1.102620
20	4.560	.577602	-1.280718	10.804934	.450082	.067377	1.345487
21	4.800	.635198	-1.438296	11.373615	.494963	.096674	1.614202
22	5.040	.690217	-1.597679	11.942296	.537835	.128591	1.907868
23	5.280	.741631	-1.756900	12.510977	.577898	.162280	2.225116
24	5.520	.788576	-1.914197	13.079657	.614479	.196781	2.564157
25	5.760	.830412	-2.068118	13.648338	.647079	.231117	2.922869
26	6.000	.866771	-2.217588	14.217019	.675410	.264381	3.298906
27	6.240	.897563	-2.361941	14.785700	.699405	.295817	3.689821
28	6.480	.922964	-2.500905	15.354380	.719198	.324874	4.093187
29	6.720	.943364	-2.634557	15.923061	.735094	.351232	4.506701
30	6.960	.959313	-2.763245	16.491742	.747522	.374794	4.928268
31	7.200	.971449	-2.887511	17.060423	.756978	.395653	5.356059
32	7.440	.980435	-3.007998	17.629103	.763981	.414044	5.788529
33	7.680	.986912	-3.125381	18.197784	.769028	.430291	6.224425
34	7.920	.991455	-3.240308	18.766465	.772567	.444757	6.662763
35	8.160	.994555	-3.353357	19.335146	.774984	.457804	7.102794
36	8.400	.996616	-3.465017	19.903826	.776589	.469763	7.543968
37	8.640	.997948	-3.575686	20.472507	.777627	.480917	7.985895
38	8.880	.998787	-3.685666	21.041188	.778281	.491498	8.428302
39	9.120	.999300	-3.795184	21.609869	.778681	.501682	8.871009
40	9.360	.999607	-3.904402	22.178549	.778920	.511603	9.313898
41	9.600	.999785	-4.013429	22.747230	.779058	.521353	9.756894
42	9.840	.999885	-4.122339	23.315911	.779136	.530996	10.199952
43	10.080	.999940	-4.231180	23.884592	.779179	.540574	10.643044
44	10.320	.999970	-4.339980	24.453272	.779203	.550115	11.086155
45	10.560	.999985	-4.448758	25.021953	.779214	.559633	11.529276
46	10.800	.999993	-4.557524	25.590634	.779221	.569140	11.972402
47	11.040	.999997	-4.666282	26.159315	.779224	.578641	12.415530
48	11.280	.999999	-4.775038	26.727995	.779225	.588138	12.858660
49	11.520	.999999	-4.883791	27.296676	.779226	.597633	13.301791
50	11.760	1.000000	-4.992544	27.865357	.779226	.607127	13.744921
51	12.000	1.000000	-5.101297	28.434038	.779226	.616621	14.188052
52	12.240	1.000000	-5.210049	29.002718	.779226	.626115	14.631183

INTERPOLATED

PSI	Y	Y
-.0350	3.91404	2.53977
-.0300	4.13500	2.25125
-.0250	4.33483	1.97131
-.0200	4.51351	1.70228
-.0150	4.64366	1.40751
-.0100	4.75896	1.11149
-.0050	4.86868	.74023
0.0000	4.97281	
.0050	5.07135	
.0100	5.15760	
.0150	5.23431	
.0200	5.30894	
.0250	5.38150	
.0300	5.45199	
.0350	5.52040	
.0400	5.58674	
.0450	5.65100	
.0500	5.71053	
.1000	6.21576	
.1500	6.61549	
.2000	6.95791	
.2500	7.25857	
.3000	7.52758	
.3500	7.77353	
.4000	8.00217	
.4500	8.21219	
.5000	8.41224	
1.0000	9.97407	
1.5000	11.13757	
2.0000	12.11109	
2.5000	12.97437	
3.0000	13.76671	
3.5000	14.51172	
4.0000	15.22423	
4.5000	15.91393	
5.0000	16.58752	
6.0000	17.90539	
7.0000	19.20243	
8.0000	20.49064	
9.0000	21.77551	
10.0000	23.05927	

X(J) = 4.50000 DELSTR = 10.268424

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.012820	-.000489	.577518	-.009963	-.000904	-.002877
3	.480	-.020123	-.002804	1.155037	-.015639	-.003365	-.010270
4	.720	-.021931	-.008622	1.732555	-.017044	-.007179	-.019707
5	.960	-.018274	-.019572	2.310073	-.014202	-.012128	-.028730
6	1.200	-.009195	-.037210	2.887591	-.007146	-.017976	-.034894
7	1.440	.005253	-.062991	3.465110	.004082	-.024455	-.035779
8	1.680	.025005	-.098238	4.042628	.019433	-.031259	-.028989
9	1.920	.049968	-.144110	4.620146	.038833	-.038042	-.012164
10	2.160	.080030	-.201581	5.197664	.062195	-.044408	.017009
11	2.400	.115040	-.271412	5.775183	.089403	-.049921	.060784
12	2.640	.154800	-.354125	6.352701	.120303	-.054105	.121339
13	2.880	.199041	-.449968	6.930219	.154684	-.056462	.200744
14	3.120	.247407	-.558886	7.507737	.192272	-.056485	.300930
15	3.360	.299434	-.680484	8.085256	.232705	-.053691	.423646
16	3.600	.354535	-.814003	8.662774	.275526	-.047644	.570402
17	3.840	.411982	-.958306	9.240292	.320171	-.038004	.742415
18	4.080	.470915	-1.111888	9.817810	.365970	-.024562	.940545
19	4.320	.530345	-1.272911	10.395329	.412156	-.007281	1.165236
20	4.560	.589196	-1.439285	10.972847	.457892	.013671	1.416470
21	4.800	.646346	-1.608767	11.550365	.502307	.037905	1.693736
22	5.040	.700703	-1.779096	12.127883	.544550	.064827	1.996026
23	5.280	.751271	-1.948138	12.705402	.583848	.093670	2.321861
24	5.520	.797230	-2.114018	13.282920	.619565	.123561	2.669358
25	5.760	.837995	-2.275233	13.860438	.651246	.153602	3.036316
26	6.000	.873252	-2.430718	14.437956	.678646	.182954	3.420335
27	6.240	.902965	-2.579876	15.015475	.701737	.210911	3.818933
28	6.480	.927351	-2.722546	15.592993	.720689	.236952	4.229671
29	6.720	.946836	-2.858949	16.170511	.735832	.260763	4.650255
30	6.960	.961990	-2.989593	16.748029	.747608	.282233	5.078612
31	7.200	.973458	-3.115175	17.325548	.756521	.301421	5.512943
32	7.440	.981905	-3.236486	17.903066	.763085	.318517	5.951743
33	7.680	.987958	-3.354330	18.480584	.767790	.333792	6.393797
34	7.920	.992180	-3.469458	19.058102	.771070	.347554	6.838157
35	8.160	.995045	-3.582531	19.635621	.773297	.360111	7.284107
36	8.400	.996938	-3.694099	20.213139	.774768	.371746	7.731125
37	8.640	.998154	-3.804602	20.790657	.775713	.382701	8.178840
38	8.880	.998915	-3.914372	21.368175	.776305	.393171	8.627000
39	9.120	.999378	-4.023656	21.945694	.776665	.403310	9.075434
40	9.360	.999653	-4.132625	22.523212	.776878	.413226	9.524033
41	9.600	.999811	-4.241397	23.100730	.777001	.423001	9.972730
42	9.840	.999900	-4.350050	23.678248	.777070	.432688	10.421482
43	10.080	.999948	-4.458631	24.255767	.777108	.442320	10.870265
44	10.320	.999974	-4.567172	24.833285	.777128	.451922	11.319065
45	10.560	.999987	-4.675690	25.410803	.777138	.461506	11.767873
46	10.800	.999994	-4.784196	25.988321	.777143	.471080	12.216686
47	11.040	.999997	-4.892696	26.565840	.777146	.480649	12.665501
48	11.280	.999999	-5.001192	27.143358	.777147	.490216	13.114317
49	11.520	1.000000	-5.109686	27.720876	.777147	.499781	13.563133
50	11.760	1.000000	-5.218180	28.298394	.777148	.509345	14.011950
51	12.000	1.000000	-5.326673	28.875913	.777148	.518909	14.460767
52	12.240	1.000000	-5.435166	29.453431	.777148	.528473	14.909584

INTERPOLATED PSI	Y	Y
-.0350	3.79292	2.95021
-.0300	4.00221	1.93596
-.0250	4.19571	2.03277
-.0200	4.37342	1.74631
-.0150	4.53533	1.44111
-.0100	4.66828	1.13590
-.0050	4.77624	.75463
0.0000	4.87968	
.0050	4.97859	
.0100	5.07298	
.0150	5.16284	
.0200	5.24140	
.0250	5.31311	
.0300	5.38307	
.0350	5.45127	
.0400	5.51773	
.0450	5.58243	
.0500	5.64538	
.1000	6.16273	
.1500	6.57337	
.2000	6.92530	
.2500	7.22606	
.3000	7.50281	
.3500	7.74901	
.4000	7.98068	
.4500	8.19472	
.5000	8.39547	
1.0000	9.97623	
1.5000	11.15165	
2.0000	12.13514	
2.5000	13.00518	
3.0000	13.80440	
3.5000	14.55473	
4.0000	15.27171	
4.5000	15.96538	
5.0000	16.64263	
6.0000	17.96626	
7.0000	19.26785	
8.0000	20.56004	
9.0000	21.84856	
10.0000	23.13583	

X(J) = 4.62500 DELSTR = 10.293850

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.012507	-.000918	.586263	-.009694	-.001051	-.002842
3	.480	-.019368	-.004571	1.172526	-.015012	-.003961	-.010084
4	.720	-.020606	-.012731	1.758790	-.015971	-.008547	-.019166
5	.960	-.016260	-.027117	2.345053	-.012603	-.014610	-.027542
6	1.200	-.006384	-.049357	2.931316	-.004948	-.021927	-.032687
7	1.440	.008959	-.080966	3.517579	.006944	-.030245	-.032102
8	1.680	.029681	-.123293	4.103842	.023005	-.039264	-.023323
9	1.920	.055673	-.177498	4.690105	.043151	-.048636	-.003930
10	2.160	.086798	-.244535	5.276369	.067275	-.057963	.028439
11	2.400	.122881	-.325114	5.862632	.095243	-.066801	.076079
12	2.640	.163694	-.419674	6.448895	.126877	-.074663	.141189
13	2.880	.208939	-.528343	7.035158	.161945	-.081028	.225852
14	3.120	.258223	-.650908	7.621421	.200145	-.085367	.331992
15	3.360	.311048	-.786783	8.207685	.241089	-.087163	.461331
16	3.600	.366788	-.934983	8.793948	.284292	-.085946	.615337
17	3.840	.424682	-1.094118	9.380211	.329164	-.081332	.795160
18	4.080	.483835	-1.262410	9.966474	.375013	-.073065	1.001577
19	4.320	.543240	-1.437741	10.552737	.421057	-.061054	1.234931
20	4.560	.601808	-1.617745	11.139000	.466452	-.045403	1.495088
21	4.800	.658424	-1.799926	11.725264	.510334	-.026431	1.781414
22	5.040	.712016	-1.981810	12.311527	.551872	-.004654	2.092781
23	5.280	.761626	-2.161099	12.897790	.590325	.019241	2.427595
24	5.520	.806486	-2.335824	13.484053	.625095	.044464	2.783873
25	5.760	.846069	-2.504452	14.070316	.655775	.070189	3.159336
26	6.000	.880120	-2.665961	14.656580	.682167	.095640	3.551529
27	6.240	.908659	-2.819850	15.242843	.704288	.120153	3.957943
28	6.480	.931952	-2.966102	15.829106	.722341	.143229	4.376133
29	6.720	.950457	-3.105105	16.415369	.736684	.164554	4.803819
30	6.960	.964765	-3.237546	17.001632	.747774	.183996	5.238961
31	7.200	.975530	-3.364294	17.587896	.756118	.201578	5.679799
32	7.440	.983410	-3.486297	18.174159	.762226	.217440	6.124874
33	7.680	.989023	-3.604489	18.760422	.766576	.231798	6.573014
34	7.920	.992914	-3.719725	19.346685	.769592	.244905	7.023313
35	8.160	.995537	-3.832748	19.932948	.771625	.257014	7.475093
36	8.400	.997259	-3.944167	20.519211	.772960	.268360	7.927859
37	8.640	.998358	-4.054459	21.105475	.773812	.279145	8.381267
38	8.880	.999041	-4.163985	21.691738	.774341	.289530	8.835080
39	9.120	.999454	-4.273006	22.278001	.774662	.299643	9.289141
40	9.360	.999697	-4.381704	22.864264	.774850	.309574	9.743352
41	9.600	.999837	-4.490201	23.450527	.774958	.319390	10.197650
42	9.840	.999914	-4.598577	24.036791	.775018	.329134	10.651996
43	10.080	.999956	-4.706882	24.623054	.775050	.338835	11.106370
44	10.320	.999978	-4.815147	25.209317	.775067	.348511	11.560759
45	10.560	.999989	-4.923390	25.795580	.775076	.358173	12.015155
46	10.800	.999995	-5.031620	26.381843	.775081	.367827	12.469555
47	11.040	.999998	-5.139845	26.968106	.775083	.377477	12.923957
48	11.280	.999999	-5.248066	27.554370	.775084	.387125	13.378359
49	11.520	1.000000	-5.356286	28.140633	.775084	.396772	13.832762
50	11.760	1.000000	-5.464505	28.726896	.775084	.406419	14.287166
51	12.000	1.000000	-5.572723	29.313159	.775084	.416065	14.741569
52	12.240	1.000000	-5.680942	29.899422	.775084	.425711	15.195972

INTERPOLATED

PSI	Y	Y
-.0300	3.67614	2.60368
-.0250	4.00729	2.11891
-.0200	4.21679	1.79672
-.0150	4.37702	1.48349
-.0100	4.52554	1.16635
-.0050	4.66235	.77201
0.0000	4.76940	
.0050	4.86703	
.0100	4.96104	
.0150	5.05142	
.0200	5.13817	
.0250	5.22130	
.0300	5.29768	
.0350	5.36500	
.0400	5.43085	
.0450	5.49524	
.0500	5.55817	
.1000	6.09170	
.1500	6.51482	
.2000	6.86731	
.2500	7.17687	
.3000	7.45469	
.3500	7.70818	
.4000	7.94037	
.4500	8.15975	
.5000	8.36219	
1.0000	9.96224	
1.5000	11.14944	
2.0000	12.14097	
2.5000	13.01930	
3.0000	13.82451	
3.5000	14.58070	
4.0000	15.30239	
4.5000	15.99992	
5.0000	16.68061	
6.0000	18.01008	
7.0000	19.31638	
8.0000	20.61253	
9.0000	21.90470	
10.0000	23.19547	

X(J) = 4.75000 DELSTR = 10.301566

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.012101	-.001456	.594921	-.009355	-.001232	-.002783
3	.480	-.018420	-.006764	1.189841	-.014239	-.004691	-.009801
4	.720	-.018985	-.017774	1.784762	-.014676	-.010205	-.018402
5	.960	-.013843	-.036273	2.379682	-.010701	-.017583	-.025950
6	1.200	-.003057	-.063948	2.974603	-.002363	-.026612	-.029837
7	1.440	.013290	-.102353	3.569524	.010274	-.037042	-.027484
8	1.680	.035092	-.152852	4.164444	.027127	-.048575	-.016358
9	1.920	.062217	-.216591	4.759365	.048096	-.060858	.006018
10	2.160	.094505	-.294483	5.354285	.073055	-.073484	.042055
11	2.400	.131751	-.387168	5.949206	.101848	-.085995	.094082
12	2.640	.173698	-.494975	6.544126	.134274	-.097883	.164319
13	2.880	.220010	-.617886	7.139047	.170075	-.108604	.254851
14	3.120	.270260	-.755504	7.733968	.208920	-.117595	.367587
15	3.360	.323910	-.907016	8.328888	.250393	-.124301	.504214
16	3.600	.380294	-1.071180	8.923809	.293980	-.128209	.666144
17	3.840	.438614	-1.246317	9.518729	.339063	-.128886	.854448
18	4.080	.497945	-1.430346	10.113650	.384928	-.126019	1.069807
19	4.320	.557258	-1.620841	10.708571	.430779	-.119457	1.312447
20	4.560	.615455	-1.815142	11.303491	.475767	-.109238	1.582109
21	4.800	.671432	-2.010493	11.898412	.519039	-.095608	1.878024
22	5.040	.724143	-2.204209	12.493332	.559786	-.079009	2.198932
23	5.280	.772673	-2.393848	13.088253	.597302	-.060048	2.543120
24	5.520	.816311	-2.577369	13.683173	.631035	-.039442	2.908501
25	5.760	.854593	-2.753245	14.278094	.660629	-.017951	3.292720
26	6.000	.887332	-2.920530	14.873015	.685937	.003701	3.693270
27	6.240	.914605	-3.078857	15.467935	.707020	.024886	4.107620
28	6.480	.936727	-3.228382	16.062856	.724121	.045117	4.533327
29	6.720	.954193	-3.369686	16.657776	.737623	.064074	4.968138
30	6.960	.967610	-3.503652	17.252697	.747995	.081599	5.410050
31	7.200	.977640	-3.631332	17.847618	.755748	.097674	5.857354
32	7.440	.984933	-3.753832	18.442538	.761386	.112389	6.308641
33	7.680	.990094	-3.872215	19.037459	.765375	.125905	6.762792
34	7.920	.993646	-3.987441	19.632379	.768121	.138417	7.218946
35	8.160	.996025	-4.100324	20.227300	.769960	.150128	7.676465
36	8.400	.997575	-4.211526	20.822221	.771159	.161224	8.134886
37	8.640	.998558	-4.321560	21.417141	.771918	.171869	8.593890
38	8.880	.999164	-4.430806	22.012062	.772387	.182194	9.053260
39	9.120	.999528	-4.539537	22.606982	.772668	.192300	9.512852
40	9.360	.999740	-4.647942	23.201903	.772832	.202262	9.972577
41	9.600	.999861	-4.756146	23.796823	.772925	.212132	10.432379
42	9.840	.999927	-4.864231	24.391744	.772977	.221946	10.892223
43	10.080	.999963	-4.972246	24.986665	.773005	.231725	11.352091
44	10.320	.999982	-5.080222	25.581585	.773019	.241485	11.811972
45	10.560	.999991	-5.188177	26.176506	.773026	.251234	12.271859
46	10.800	.999996	-5.296120	26.771426	.773030	.260978	12.731749
47	11.040	.999998	-5.404057	27.366347	.773032	.270718	13.191641
48	11.280	.999999	-5.511991	27.961268	.773033	.280456	13.651534
49	11.520	1.000000	-5.619924	28.556188	.773033	.290194	14.111427
50	11.760	1.000000	-5.727857	29.151109	.773033	.299931	14.571320
51	12.000	1.000000	-5.835788	29.746029	.773033	.309668	15.031214
52	12.240	1.000000	-5.943720	30.340950	.773033	.319405	15.491107

INTERPOLATED

PSI	Y	Y
-.0250	3.71955	2.26403
-.0200	3.99157	1.84894
-.0150	4.20548	1.53889
-.0100	4.35107	1.20261
-.0050	4.48802	.79351
0.0000	4.61635	
.0050	4.73606	
.0100	4.83246	
.0150	4.92165	
.0200	5.00796	
.0250	5.09138	
.0300	5.17193	
.0350	5.24959	
.0400	5.32438	
.0450	5.39146	
.0500	5.45362	
.1000	6.00383	
.1500	6.43230	
.2000	6.79106	
.2500	7.10982	
.3000	7.38860	
.3500	7.64735	
.4000	7.88280	
.4500	8.10300	
.5000	8.31181	
1.0000	9.92770	
1.5000	11.12767	
2.0000	12.12911	
2.5000	13.01556	
3.0000	13.82700	
3.5000	14.58839	
4.0000	15.31492	
4.5000	16.01673	
5.0000	16.70091	
6.0000	18.03607	
7.0000	19.34705	
8.0000	20.64725	
9.0000	21.94310	
10.0000	23.23739	

X(J) = 4.87500 DELSTR = 10.290948

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.011582	-.002126	.603495	-.008930	-.001455	-.002695
3	.480	-.017243	-.009469	1.206990	-.013294	-.005581	-.009400
4	.720	-.017017	-.023927	1.810485	-.013120	-.012203	-.017371
5	.960	-.010959	-.047326	2.413980	-.008449	-.021128	-.023879
6	1.200	.000853	-.081380	3.017474	.000658	-.032139	-.026230
7	1.440	.018324	-.127657	3.620969	.014127	-.044980	-.021769
8	1.680	.041319	-.187514	4.224464	.031857	-.059346	-.007893
9	1.920	.069686	-.262063	4.827959	.053728	-.074873	.017932
10	2.160	.103237	-.352150	5.431454	.079595	-.091137	.058161
11	2.400	.141737	-.458315	6.034949	.109278	-.107657	.115153
12	2.640	.184892	-.580748	6.638444	.142550	-.123899	.191142
13	2.880	.232330	-.719256	7.241939	.179125	-.139285	.288206
14	3.120	.283585	-.873222	7.845434	.218642	-.153212	.408231
15	3.360	.338075	-1.041579	8.448928	.260653	-.165083	.552857
16	3.600	.395094	-1.222790	9.052423	.304614	-.174331	.723425
17	3.840	.453807	-1.414859	9.655918	.349881	-.180470	.920918
18	4.080	.513256	-1.615372	10.259413	.395716	-.183125	1.145900
19	4.320	.572393	-1.821577	10.862908	.441310	-.182082	1.398471
20	4.560	.630117	-2.030510	11.466403	.485815	-.177312	1.678228
21	4.800	.685335	-2.239158	12.069898	.528388	-.168989	1.984261
22	5.040	.737035	-2.444641	12.673393	.568248	-.157484	2.315168
23	5.280	.784353	-2.644399	13.276888	.604730	-.143333	2.669112
24	5.520	.826640	-2.836357	13.880383	.637333	-.127189	3.043901
25	5.760	.863504	-3.019036	14.483877	.665755	-.109755	3.437104
26	6.000	.894825	-3.191606	15.087372	.689903	-.091715	3.846170
27	6.240	.920745	-3.353873	15.690867	.709887	-.073671	4.268553
28	6.480	.941627	-3.506197	16.294362	.725987	-.056104	4.701825
29	6.720	.958000	-3.649376	16.897857	.738610	-.039347	5.143763
30	6.960	.970491	-3.784500	17.501352	.748241	-.023590	5.592417
31	7.200	.979761	-3.912808	18.104847	.755388	-.008893	6.046133
32	7.440	.986454	-4.035564	18.708342	.760548	.004783	6.503562
33	7.680	.991155	-4.153955	19.311837	.764172	.017543	6.963643
34	7.920	.994366	-4.269034	19.915331	.766648	.029529	7.425564
35	8.160	.996501	-4.381680	20.518826	.768294	.040892	7.888729
36	8.400	.997881	-4.492598	21.122321	.769358	.051779	8.352712
37	8.640	.998749	-4.602325	21.725816	.770028	.062313	8.817218
38	8.880	.999281	-4.711259	22.329311	.770437	.072598	9.282049
39	9.120	.999597	-4.819679	22.932806	.770681	.082714	9.747078
40	9.360	.999780	-4.927776	23.536301	.770822	.092717	10.212223
41	9.600	.999883	-5.035677	24.139796	.770902	.102650	10.677434
42	9.840	.999940	-5.143461	24.743291	.770945	.112539	11.142683
43	10.080	.999970	-5.251179	25.346785	.770969	.122402	11.607951
44	10.320	.999985	-5.358859	25.950280	.770981	.132251	12.073230
45	10.560	.999993	-5.466520	26.553775	.770987	.142091	12.538515
46	10.800	.999997	-5.574170	27.157270	.770990	.151927	13.003803
47	11.040	.999999	-5.681814	27.760765	.770991	.161760	13.469091
48	11.280	.999999	-5.789456	28.364260	.770992	.171592	13.934381
49	11.520	1.000000	-5.897096	28.967755	.770992	.181424	14.399670
50	11.760	1.000000	-6.004736	29.571250	.770992	.191255	14.864960
51	12.000	1.000000	-6.112376	30.174745	.770992	.201086	15.330250
52	12.240	1.000000	-6.220015	30.778240	.770992	.210917	15.795539

INTERPOLATED		
PSI	Y	Y
-.0250	3.45242	2.67615
-.0200	3.70876	1.86553
-.0150	3.93976	1.61538
-.0100	4.14540	1.24719
-.0050	4.30048	.82084
0.0000	4.42685	
.0050	4.54688	
.0100	4.66059	
.0150	4.76795	
.0200	4.86257	
.0250	4.94463	
.0300	5.02442	
.0350	5.10195	
.0400	5.17720	
.0450	5.25018	
.0500	5.32090	
.1000	5.88711	
.1500	6.32599	
.2000	6.69780	
.2500	7.01671	
.3000	7.30536	
.3500	7.56427	
.4000	7.80702	
.4500	8.02838	
.5000	8.23813	
1.0000	9.87513	
1.5000	11.08765	
2.0000	12.09946	
2.5000	12.99261	
3.0000	13.81112	
3.5000	14.57789	
4.0000	15.30890	
4.5000	16.01470	
5.0000	16.70252	
6.0000	18.04371	
7.0000	19.35940	
8.0000	20.66362	
9.0000	21.96315	
10.0000	23.26097	

X(J) = 5.00000 DELSTR = 10.261606

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.010926	-.002953	.611990	-.008402	-.001727	-.002571
3	.480	-.015794	-.012781	1.223980	-.012145	-.006655	-.008858
4	.720	-.014644	-.031386	1.835969	-.011261	-.014594	-.016020
5	.960	-.007541	-.060595	2.447959	-.005798	-.025332	-.021240
6	1.200	.005426	-.102112	3.059949	.004172	-.038633	-.021738
7	1.440	.024142	-.157466	3.671939	.018564	-.054217	-.014780
8	1.680	.048448	-.227960	4.283929	.037255	-.071755	.002300
9	1.920	.078166	-.314643	4.895918	.060107	-.090862	.032092
10	2.160	.113077	-.418270	5.507908	.086952	-.111089	.077091
11	2.400	.152914	-.539250	6.119898	.117585	-.131928	.139678
12	2.640	.197345	-.677608	6.731888	.151750	-.152808	.222093
13	2.880	.245958	-.832942	7.343878	.189132	-.173111	.326401
14	3.120	.298243	-1.004386	7.955867	.229337	-.192192	.454451
15	3.360	.353575	-1.190579	8.567857	.271885	-.209398	.607822
16	3.600	.411205	-1.389664	9.179847	.316200	-.224109	.787773
17	3.840	.470257	-1.599296	9.791837	.361609	-.235778	.995180
18	4.080	.529747	-1.816710	10.403827	.407355	-.243967	1.230479
19	4.320	.588607	-2.038815	11.015816	.452615	-.248397	1.493625
20	4.560	.645735	-2.262347	11.627806	.496545	-.248972	1.784063
21	4.800	.700061	-2.484048	12.239796	.538320	-.245803	2.100727
22	5.040	.750611	-2.700872	12.851786	.577190	-.239194	2.442067
23	5.280	.796579	-2.910180	13.463775	.612538	-.229622	2.806118
24	5.520	.837385	-3.109910	14.075765	.643916	-.217687	3.190586
25	5.760	.872713	-3.298676	14.687755	.671082	-.204046	3.592969
26	6.000	.902518	-3.475816	15.299745	.694001	-.189353	4.010677
27	6.240	.927005	-3.641342	15.911735	.712831	-.174197	4.441161
28	6.480	.946588	-3.795851	16.523724	.727889	-.159061	4.882014
29	6.720	.961828	-3.940372	17.135714	.739608	-.144298	5.331060
30	6.960	.973365	-4.076214	17.747704	.748480	-.130130	5.786407
31	7.200	.981862	-4.204800	18.359694	.755013	-.116662	6.246468
32	7.440	.987948	-4.327543	18.971684	.759693	-.103906	6.709961
33	7.680	.992189	-4.445745	19.583673	.762954	-.091807	7.175883
34	7.920	.995063	-4.560536	20.195663	.765164	-.080276	7.643480
35	8.160	.996958	-4.672849	20.807653	.766621	-.069207	8.112198
36	8.400	.998172	-4.783420	21.419643	.767555	-.058494	8.581648
37	8.640	.998930	-4.892802	22.031633	.768138	-.048046	9.051563
38	8.880	.999390	-5.001400	22.643622	.768491	-.037784	9.521763
39	9.120	.999661	-5.109496	23.255612	.768700	-.027651	9.992136
40	9.360	.999817	-5.217279	23.867602	.768820	-.017601	10.462609
41	9.600	.999903	-5.324874	24.479592	.768886	-.007604	10.933140
42	9.840	.999951	-5.432358	25.091582	.768923	.002360	11.403701
43	10.080	.999975	-5.539780	25.703571	.768942	.012305	11.874280
44	10.320	.999988	-5.647167	26.315561	.768952	.022240	12.344867
45	10.560	.999994	-5.754536	26.927551	.768956	.032168	12.815459
46	10.800	.999997	-5.861895	27.539541	.768959	.042093	13.286054
47	11.040	.999999	-5.969250	28.151531	.768960	.052016	13.756649
48	11.280	1.000000	-6.076602	28.763520	.768960	.061939	14.227245
49	11.520	1.000000	-6.183953	29.375510	.768961	.071861	14.697841
50	11.760	1.000000	-6.291303	29.987500	.768961	.081782	15.168437
51	12.000	1.000000	-6.398653	30.599490	.768961	.091704	15.639033
52	12.240	1.000000	-6.506003	31.211480	.768961	.101626	16.109629

INTERPOLATED PSI	Y	Y
-.0200	3.44695	1.34198
-.0150	3.66283	1.73271
-.0100	3.86240	1.30390
-.0050	4.04566	.85672
0.0000	4.21261	
.0050	4.34618	
.0100	4.45789	
.0150	4.56496	
.0200	4.66739	
.0250	4.76518	
.0300	4.85832	
.0350	4.93982	
.0400	5.01389	
.0450	5.08618	
.0500	5.15670	
.1000	5.74666	
.1500	6.20276	
.2000	6.57895	
.2500	6.90560	
.3000	7.19861	
.3500	7.46357	
.4000	7.70687	
.4500	7.93614	
.5000	8.14630	
1.0000	9.80499	
1.5000	11.02977	
2.0000	12.04975	
2.5000	12.95129	
3.0000	13.77572	
3.5000	14.54831	
4.0000	15.28432	
4.5000	15.99405	
5.0000	16.68534	
6.0000	18.03239	
7.0000	19.35291	
8.0000	20.66125	
9.0000	21.96450	
10.0000	23.26584	

X(J) = 5.12500 DELSTR = 10.213431

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.010107	-.003962	.620408	-.007752	-.002052	-.002405
3	.480	-.014025	-.016786	1.240816	-.010757	-.007936	-.008146
4	.720	-.011801	-.040317	1.861224	-.009051	-.017417	-.014290
5	.960	-.003509	-.076320	2.481633	-.002691	-.030246	-.017933
6	1.200	.010749	-.126442	3.102041	.008244	-.046149	-.016210
7	1.440	.030831	-.192116	3.722449	.023645	-.064806	-.006318
8	1.680	.056561	-.274542	4.342857	.043379	-.085845	.014473
9	1.920	.087731	-.374671	4.963265	.067285	-.108848	.048801
10	2.160	.124092	-.493130	5.583673	.095171	-.133334	.099196
11	2.400	.165340	-.630172	6.204081	.126806	-.158757	.168054
12	2.640	.211103	-.785624	6.824490	.161904	-.184505	.257613
13	2.880	.260926	-.958842	7.444898	.200115	-.209914	.369913
14	3.120	.314252	-1.148676	8.065306	.241012	-.234286	.506752
15	3.360	.370410	-1.353444	8.685714	.284082	-.256912	.669639
16	3.600	.428606	-1.570933	9.306122	.328715	-.277111	.859731
17	3.840	.487927	-1.798433	9.926530	.374211	-.294272	1.077781
18	4.080	.547359	-2.032810	10.546939	.419791	-.307896	1.324084
19	4.320	.605822	-2.270637	11.167347	.464629	-.317639	1.598435
20	4.560	.662220	-2.508358	11.787755	.507883	-.323346	1.900112
21	4.800	.715508	-2.742501	12.408163	.548752	-.325067	2.227884
22	5.040	.764760	-2.969892	13.028571	.586525	-.323054	2.580051
23	5.280	.809236	-3.187865	13.648979	.620636	-.317736	2.954518
24	5.520	.848434	-3.394422	14.269387	.650698	-.309671	3.348890
25	5.760	.882117	-3.588329	14.889796	.676531	-.299486	3.760602
26	6.000	.910317	-3.769133	15.510204	.698158	-.287817	4.187036
27	6.240	.933305	-3.937096	16.130612	.715789	-.275248	4.625648
28	6.480	.951543	-4.093072	16.751020	.729776	-.262273	5.074068
29	6.720	.965621	-4.238337	17.371428	.740573	-.249269	5.530177
30	6.960	.976191	-4.374415	17.991836	.748680	-.236494	5.992149
31	7.200	.983910	-4.502908	18.612244	.754600	-.224095	6.458472
32	7.440	.989393	-4.625365	19.232653	.758805	-.212132	6.927937
33	7.680	.993181	-4.743183	19.853061	.761710	-.200601	7.399607
34	7.920	.995725	-4.857556	20.473469	.763662	-.189456	7.872783
35	8.160	.997388	-4.969452	21.093877	.764937	-.178634	8.346961
36	8.400	.998445	-5.079626	21.714285	.765747	-.168065	8.821785
37	8.640	.999098	-5.188637	22.334693	.766248	-.157685	9.297016
38	8.880	.999490	-5.296889	22.955102	.766549	-.147440	9.772496
39	9.120	.999719	-5.404660	23.575510	.766725	-.137287	10.248124
40	9.360	.999850	-5.512135	24.195918	.766825	-.127195	10.723837
41	9.600	.999922	-5.619433	24.816326	.766880	-.117141	11.199598
42	9.840	.999960	-5.726629	25.436734	.766909	-.107110	11.675386
43	10.080	.999980	-5.833767	26.057142	.766925	-.097093	12.151188
44	10.320	.999991	-5.940874	26.677550	.766933	-.087083	12.626997
45	10.560	.999996	-6.047965	27.297959	.766937	-.077078	13.102809
46	10.800	.999998	-6.155047	27.918367	.766938	-.067075	13.578624
47	11.040	.999999	-6.262124	28.538775	.766939	-.057074	14.054439
48	11.280	1.000000	-6.369200	29.159183	.766940	-.047072	14.530254
49	11.520	1.000000	-6.476275	29.779591	.766940	-.037072	15.006070
50	11.760	1.000000	-6.583349	30.399999	.766940	-.027071	15.481886
51	12.000	1.000000	-6.690423	31.020407	.766940	-.017070	15.957702
52	12.240	1.000000	-6.797497	31.640816	.766940	-.007070	16.433517

INTERPOLATED PSI	Y	Y
-.0150	3.18919	1.96737
-.0100	3.51602	1.37165
-.0050	3.76726	.90574
0.0000	3.93050	
.0050	4.08307	
.0100	4.22496	
.0150	4.35359	
.0200	4.45357	
.0250	4.55015	
.0300	4.64332	
.0350	4.73310	
.0400	4.81948	
.0450	4.90246	
.0500	4.97965	
.1000	5.59164	
.1500	6.05347	
.2000	6.43817	
.2500	6.77609	
.3000	7.07044	
.3500	7.34220	
.4000	7.58908	
.4500	7.81899	
.5000	8.03682	
1.0000	9.71289	
1.5000	10.95091	
2.0000	11.98121	
2.5000	12.89069	
3.0000	13.72183	
3.5000	14.49954	
4.0000	15.24018	
4.5000	15.95426	
5.0000	16.64926	
6.0000	18.00232	
7.0000	19.32757	
8.0000	20.64000	
9.0000	21.94698	
10.0000	23.25187	

X(J) = 5.25000 DELSTR = 10.146579

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.009096	-.005178	.628752	-.006958	-.002439	-.002187
3	.480	-.011886	-.021575	1.257503	-.009092	-.009444	-.007233
4	.720	-.008424	-.050887	1.886255	-.006444	-.020709	-.012117
5	.960	.001208	-.094738	2.515007	.000924	-.035917	-.013852
6	1.200	.016894	-.154637	3.143759	.012923	-.054732	-.009499
7	1.440	.038466	-.231886	3.772510	.029424	-.076781	.003813
8	1.680	.065729	-.327553	4.401262	.050278	-.101642	.028870
9	1.920	.098448	-.442437	5.030014	.075306	-.128847	.068350
10	2.160	.136339	-.576996	5.658766	.104290	-.157870	.124811
11	2.400	.179060	-.731282	6.287517	.136969	-.188115	.200657
12	2.640	.226196	-.904889	6.916269	.173025	-.218924	.298112
13	2.880	.277246	-1.096897	7.545021	.212075	-.249577	.419178
14	3.120	.331604	-1.305838	8.173773	.253655	-.279317	.565592
15	3.360	.388552	-1.529680	8.802524	.297216	-.307376	.738773
16	3.600	.447249	-1.765830	9.431276	.342115	-.333009	.939763
17	3.840	.506745	-2.011194	10.060028	.387626	-.355542	1.169176
18	4.080	.566002	-2.262270	10.688780	.432954	-.374413	1.427147
19	4.320	.623931	-2.515299	11.317531	.477265	-.389221	1.713297
20	4.560	.679448	-2.766465	11.946283	.519732	-.399757	2.026729
21	4.800	.731544	-3.012117	12.575035	.559582	-.406023	2.366040
22	5.040	.779348	-3.249008	13.203787	.596149	-.408230	2.729374
23	5.280	.822193	-3.474503	13.832538	.628922	-.406772	3.114507
24	5.520	.859660	-3.686730	14.461290	.657582	-.402182	3.518953
25	5.760	.891599	-3.884662	15.090042	.682014	-.395070	3.940090
26	6.000	.918120	-4.068103	15.718794	.702300	-.386066	4.375284
27	6.240	.939558	-4.237597	16.347545	.718699	-.375759	4.822012
28	6.480	.956420	-4.394275	16.976297	.731597	-.364660	5.277950
29	6.720	.969323	-4.539663	17.605049	.741467	-.353174	5.741046
30	6.960	.978926	-4.675496	18.233801	.748813	-.341593	6.209554
31	7.200	.985876	-4.803540	18.862552	.754129	-.330108	6.682043
32	7.440	.990768	-4.925458	19.491304	.757871	-.318822	7.157379
33	7.680	.994116	-5.042723	20.120056	.760432	-.307774	7.634697
34	7.920	.996344	-5.156572	20.748808	.762137	-.296959	8.113356
35	8.160	.997786	-5.267994	21.377559	.763240	-.286350	8.592898
36	8.400	.998694	-5.377745	22.006311	.763934	-.275908	9.073004
37	8.640	.999250	-5.486382	22.635063	.764359	-.265593	9.553463
38	8.880	.999580	-5.594299	23.263815	.764612	-.255370	10.034134
39	9.120	.999771	-5.701764	23.892566	.764758	-.245209	10.514931
40	9.360	.999879	-5.808955	24.521318	.764840	-.235091	10.995800
41	9.600	.999937	-5.915984	25.150070	.764885	-.224999	11.476709
42	9.840	.999969	-6.022920	25.778822	.764909	-.214923	11.957639
43	10.080	.999985	-6.129805	26.407573	.764921	-.204856	12.438581
44	10.320	.999993	-6.236662	27.036325	.764927	-.194794	12.919528
45	10.560	.999997	-6.343504	27.665077	.764930	-.184736	13.400479
46	10.800	.999999	-6.450339	28.293829	.764932	-.174679	13.881430
47	11.040	.999999	-6.557170	28.922580	.764933	-.164623	14.362383
48	11.280	1.000000	-6.664000	29.551332	.764933	-.154567	14.843336
49	11.520	1.000000	-6.770829	30.180084	.764933	-.144511	15.324289
50	11.760	1.000000	-6.877657	30.808836	.764933	-.134456	15.805241
51	12.000	1.000000	-6.984485	31.437587	.764933	-.124400	16.286194
52	12.240	1.000000	-7.091314	32.066339	.764933	-.114345	16.767147

INTERPOLATED

PSI	Y	Y
-.0100	3.11612	1.40696
-.0050	3.37913	.97664
0.0000	3.61330	
.0050	3.80631	
.0100	3.94434	
.0150	4.07526	
.0200	4.19908	
.0250	4.31580	
.0300	4.42143	
.0350	4.50910	
.0400	4.59427	
.0450	4.67695	
.0500	4.75713	
.1000	5.39936	
.1500	5.88111	
.2000	6.28260	
.2500	6.61954	
.3000	6.92683	
.3500	7.19782	
.4000	7.45199	
.4500	7.68478	
.5000	7.90311	
1.0000	9.60271	
1.5000	10.85382	
2.0000	11.89446	
2.5000	12.81087	
3.0000	13.64866	
3.5000	14.43237	
4.0000	15.17755	
4.5000	15.89559	
5.0000	16.59414	
6.0000	17.95322	
7.0000	19.28342	
8.0000	20.60001	
9.0000	21.91073	
10.0000	23.21917	

X(J) = 5.37500 DELSTR = 10.061357

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.007859	-.006632	.637021	-.005996	-.002894	-.001910
3	.480	-.009322	-.027261	1.274042	-.007112	-.011208	-.006085
4	.720	-.004443	-.063332	1.911063	-.003389	-.024530	-.009430
5	.960	.006687	-.116239	2.548084	.005102	-.042449	-.008884
6	1.200	.023938	-.187240	3.185105	.018264	-.064529	-.001442
7	1.440	.047122	-.277423	3.822126	.035952	-.090314	.015826
8	1.680	.076023	-.387681	4.459148	.058002	-.119321	.045751
9	1.920	.110377	-.518618	5.096169	.084212	-.151023	.091048
10	2.160	.149866	-.670483	5.733190	.114339	-.184835	.154288
11	2.400	.194106	-.843092	6.370211	.148092	-.220106	.237875
12	2.640	.242639	-1.035767	7.007232	.185120	-.256119	.344007
13	2.880	.294913	-1.247279	7.644253	.225002	-.292096	.474635
14	3.120	.350273	-1.475812	8.281274	.267239	-.327217	.631419
15	3.360	.407950	-1.718952	8.918295	.311243	-.360648	.815672
16	3.600	.467060	-1.973713	9.555316	.356341	-.391581	1.028305
17	3.840	.526618	-2.236609	10.192337	.401780	-.419278	1.269774
18	4.080	.585562	-2.503776	10.829358	.446752	-.443123	1.540041
19	4.320	.642804	-2.771147	11.466379	.490424	-.462663	1.838541
20	4.560	.697279	-3.034683	12.103401	.531986	-.477645	2.164189
21	4.800	.748021	-3.290609	12.740422	.570699	-.488038	2.515406
22	5.040	.794225	-3.535668	13.377443	.605950	-.494025	2.890181
23	5.280	.835306	-3.767322	14.014464	.637292	-.495983	3.286167
24	5.520	.870932	-3.983891	14.651485	.664473	-.494433	3.700793
25	5.760	.901043	-4.184611	15.288506	.687446	-.489982	4.131394
26	6.000	.925826	-4.369586	15.925527	.706354	-.483266	4.575334
27	6.240	.945680	-4.539669	16.562548	.721502	-.474889	5.030121
28	6.480	.961154	-4.696277	17.199569	.733308	-.465381	5.493493
29	6.720	.972885	-4.841186	17.836590	.742258	-.455177	5.963477
30	6.960	.981533	-4.976324	18.473611	.748856	-.444604	6.438412
31	7.200	.987733	-5.103598	19.110632	.753586	-.433891	6.916956
32	7.440	.992054	-5.224764	19.747654	.756883	-.423180	7.398056
33	7.680	.994982	-5.341348	20.384675	.759117	-.412547	7.880918
34	7.920	.996912	-5.454606	21.021696	.760589	-.402023	8.364960
35	8.160	.998149	-5.565529	21.658717	.761533	-.391610	8.849772
36	8.400	.998919	-5.674862	22.295738	.762120	-.381294	9.335072
37	8.640	.999385	-5.783149	22.932759	.762476	-.371055	9.820671
38	8.880	.999659	-5.890766	23.569780	.762685	-.360874	10.306451
39	9.120	.999816	-5.997968	24.206801	.762805	-.350734	10.792336
40	9.360	.999904	-6.104922	24.843822	.762872	-.340620	11.278280
41	9.600	.999951	-6.211730	25.480843	.762908	-.330524	11.764257
42	9.840	.999976	-6.318456	26.117864	.762927	-.320438	12.250252
43	10.080	.999988	-6.425136	26.754885	.762936	-.310359	12.736255
44	10.320	.999995	-6.531793	27.391907	.762941	-.300282	13.222263
45	10.560	.999998	-6.638437	28.028928	.762943	-.290208	13.708273
46	10.800	.999999	-6.745075	28.665949	.762944	-.280134	14.194285
47	11.040	1.000000	-6.851710	29.302970	.762945	-.270062	14.680297
48	11.280	1.000000	-6.958344	29.939991	.762945	-.259989	15.166309
49	11.520	1.000000	-7.064976	30.577012	.762945	-.249916	15.652321
50	11.760	1.000000	-7.171609	31.214033	.762945	-.239844	16.138333
51	12.000	1.000000	-7.278242	31.851054	.762945	-.229771	16.624345
52	12.240	1.000000	-7.384874	32.488075	.762945	-.219699	17.110357

INTERPOLATED		
PSI	Y	Y
-.0050	2.90782	1.09160
0.0000	3.24586	
.0050	3.44582	
.0100	3.62925	
.0150	3.79615	
.0200	3.92130	
.0250	4.03570	
.0300	4.14529	
.0350	4.25008	
.0400	4.35007	
.0450	4.44526	
.0500	4.52531	
.1000	5.19446	
.1500	5.69422	
.2000	6.09633	
.2500	6.44840	
.3000	6.75609	
.3500	7.03857	
.4000	7.29212	
.4500	7.53151	
.5000	7.75323	
1.0000	9.47463	
1.5000	10.73860	
2.0000	11.78780	
2.5000	12.71329	
3.0000	13.55691	
3.5000	14.34589	
4.0000	15.09612	
4.5000	15.81849	
5.0000	16.52072	
6.0000	17.88575	
7.0000	19.22076	
8.0000	20.54149	
9.0000	21.85595	
10.0000	23.16794	

X(J) = 5,50000 DELSTR = 9,958263

K	ETA	U	V	Y	UST	VST	PSI
1	0,000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000
2	,240	-,006363	-,008351	,645215	-,004842	-,003422	-,001562
3	,480	-,006269	-,033933	1,290431	-,004770	-,013245	-,004663
4	,720	,000224	-,077802	1,935646	,000170	-,028907	-,006147
5	,960	,013020	-,140997	2,580861	,009908	-,049860	-,002896
6	1,200	,031969	-,224441	3,226076	,024328	-,075548	,008149
7	1,440	,056877	-,328923	3,871292	,043283	-,105404	,029961
8	1,680	,087507	-,455080	4,516507	,066592	-,138859	,065407
9	1,920	,123567	-,603276	5,161722	,094033	-,175314	,117226
10	2,160	,164703	-,773509	5,806937	,125337	-,214116	,187996
11	2,400	,210490	-,965322	6,452153	,160180	-,254551	,280106
12	2,640	,260421	-1,177732	7,097368	,198176	-,295836	,395714
13	2,880	,313894	-1,409167	7,742583	,238868	-,337129	,536708
14	3,120	,370202	-1,657437	8,387798	,281718	-,377544	,704653
15	3,360	,428525	-1,919730	9,033014	,326101	-,416182	,900740
16	3,600	,487937	-2,192655	9,678229	,371312	-,452172	1,125731
17	3,840	,547419	-2,472339	10,323444	,416578	-,484719	1,379910
18	4,080	,605897	-2,754576	10,968659	,461078	-,513158	1,663049
19	4,320	,662284	-3,035033	11,613875	,503988	-,536995	1,974386
20	4,560	,715547	-3,309498	12,259090	,544520	-,555951	2,312643
21	4,800	,764773	-3,574142	12,904305	,581981	-,569973	2,676061
22	5,040	,809231	-3,825766	13,549521	,615812	-,579236	3,062478
23	5,280	,848422	-4,062005	14,194736	,645637	-,584114	3,469431
24	5,520	,882112	-4,281438	14,839951	,671274	-,585132	3,894276
25	5,760	,910327	-4,483614	15,485166	,692745	-,582909	4,334319
26	6,000	,933335	-4,668974	16,130382	,710253	-,578094	4,786937
27	6,240	,951591	-4,838696	16,775597	,724146	-,571311	5,249686
28	6,480	,965682	-4,994486	17,420812	,734869	-,563117	5,720375
29	6,720	,976260	-5,138351	18,066027	,742919	-,553973	6,197121
30	6,960	,983980	-5,272392	18,711243	,748794	-,544239	6,678359
31	7,200	,989458	-5,398630	19,356458	,752962	-,534176	7,162837
32	7,440	,993237	-5,518885	20,001673	,755838	-,523958	7,649587
33	7,680	,995772	-5,634705	20,646888	,757767	-,513693	8,137888
34	7,920	,997424	-5,747348	21,292104	,759024	-,503440	8,627216
35	8,160	,998471	-5,857784	21,937319	,759821	-,493223	9,117207
36	8,400	,999117	-5,966738	22,582534	,760313	-,483050	9,607614
37	8,640	,999503	-6,074727	23,227749	,760607	-,472917	10,098274
38	8,880	,999728	-6,182107	23,872965	,760778	-,462815	10,589085
39	9,120	,999855	-6,289114	24,518180	,760874	-,452737	11,079981
40	9,360	,999925	-6,395899	25,163395	,760928	-,442675	11,570926
41	9,600	,999962	-6,502556	25,808611	,760956	-,432623	12,061897
42	9,840	,999982	-6,609142	26,453826	,760971	-,422577	12,552882
43	10,080	,999991	-6,715690	27,099041	,760978	-,412535	13,043875
44	10,320	,999996	-6,822217	27,744256	,760982	-,402495	13,534870
45	10,560	,999998	-6,928734	28,389472	,760983	-,392456	14,025868
46	10,800	,999999	-7,035246	29,034687	,760984	-,382418	14,516866
47	11,040	1,000000	-7,141756	29,679902	,760984	-,372381	15,007865
48	11,280	1,000000	-7,248264	30,325117	,760985	-,362343	15,498864
49	11,520	1,000000	-7,354772	30,970333	,760985	-,352305	15,989863
50	11,760	1,000000	-7,461279	31,615548	,760985	-,342268	16,480862
51	12,000	1,000000	-7,567787	32,260763	,760985	-,332230	16,971860
52	12,240	1,000000	-7,674294	32,905978	,760985	-,322193	17,462859

INTERPOLATED

PSI	Y	Y
-,0050	2,43365	1,41782
0,0000	2,77073	
,0050	3,06394	
,0100	3,28817	
,0150	3,44910	
,0200	3,60010	
,0250	3,74116	
,0300	3,87210	
,0350	3,97312	
,0400	4,07084	
,0450	4,16527	
,0500	4,25641	
,1000	4,96344	
,1500	5,47667	
,2000	5,89761	
,2500	6,25406	
,3000	6,57064	
,3500	6,85475	
,4000	7,11837	
,4500	7,35698	
,5000	7,58370	
1,0000	9,32624	
1,5000	10,60390	
2,0000	11,66424	
2,5000	12,59637	
3,0000	13,44735	
3,5000	14,24189	
4,0000	14,99658	
4,5000	15,72297	
5,0000	16,42880	
6,0000	17,79998	
7,0000	19,13993	
8,0000	20,46483	
9,0000	21,78303	
10,0000	23,09854	

X(J) = 5.62500 DELSTR = 9.838104

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.004568	-.010363	.653332	-.003467	-.004031	-.001133
3	.480	-.002668	-.041690	1.306663	-.002025	-.015576	-.002927
4	.720	.005643	-.094475	1.959995	.004283	-.033875	-.002189
5	.960	.020272	-.169218	2.613327	.015387	-.058185	.004236
6	1.200	.041054	-.266394	3.266658	.031162	-.087792	.019443
7	1.440	.067791	-.386439	3.919990	.051458	-.122008	.046432
8	1.680	.100229	-.529657	4.573322	.076080	-.160158	.088094
9	1.920	.138049	-.696110	5.226653	.104787	-.201548	.147177
10	2.160	.180861	-.885497	5.879985	.137285	-.245450	.226254
11	2.400	.228198	-1.097052	6.533317	.173217	-.291077	.327684
12	2.640	.279505	-1.329455	7.186648	.212162	-.337578	.453574
13	2.880	.334126	-1.580770	7.839980	.253622	-.384041	.605730
14	3.120	.391301	-1.848412	8.493312	.297022	-.429516	.785607
15	3.360	.450162	-2.129165	9.146644	.341701	-.473042	.994256
16	3.600	.509741	-2.419242	9.799975	.386925	-.513691	1.232273
17	3.840	.568992	-2.714405	10.453307	.431900	-.550621	1.499755
18	4.080	.626831	-3.010147	11.106639	.475804	-.583129	1.796271
19	4.320	.682187	-3.301923	11.759970	.517822	-.610699	2.120855
20	4.560	.734065	-3.585423	12.413302	.557202	-.633039	2.472028
21	4.800	.781617	-3.856840	13.066634	.593296	-.650096	2.847857
22	5.040	.824191	-4.113121	13.719965	.625613	-.662054	3.246032
23	5.280	.861386	-4.352143	14.373297	.653846	-.669302	3.663988
24	5.520	.893062	-4.572809	15.026629	.677890	-.672383	4.099020
25	5.760	.919337	-4.775025	15.679960	.697834	-.671936	4.548422
26	6.000	.940553	-4.959595	16.333292	.713938	-.668634	5.009600
27	6.240	.957219	-5.128023	16.986624	.726589	-.663123	5.480171
28	6.480	.969951	-5.282290	17.639955	.736254	-.655984	5.958032
29	6.720	.979409	-5.424611	18.293287	.743433	-.647704	6.441395
30	6.960	.986240	-5.557226	18.946619	.748618	-.638668	6.928797
31	7.200	.991035	-5.682233	19.599950	.752258	-.629162	7.419081
32	7.440	.994308	-5.801484	20.253282	.754742	-.619386	7.911367
33	7.680	.996478	-5.916521	20.906614	.756389	-.609472	8.405002
34	7.920	.997877	-6.028578	21.559945	.757451	-.599497	8.899522
35	8.160	.998754	-6.138591	22.213277	.758117	-.589506	9.394606
36	8.400	.999288	-6.247248	22.866609	.758522	-.579519	9.890040
37	8.640	.999604	-6.355034	23.519941	.758762	-.569545	10.385685
38	8.880	.999786	-6.462275	24.173272	.758900	-.559583	10.881454
39	9.120	.999887	-6.569188	24.826604	.758977	-.549633	11.377292
40	9.360	.999942	-6.675909	25.479936	.759019	-.539690	11.873170
41	9.600	.999971	-6.782520	26.133267	.759041	-.529753	12.369068
42	9.840	.999986	-6.889070	26.786599	.759052	-.519820	12.864977
43	10.080	.999994	-6.995589	27.439931	.759058	-.509889	13.360892
44	10.320	.999997	-7.102090	28.093262	.759060	-.499958	13.856809
45	10.560	.999999	-7.208583	28.746594	.759062	-.490029	14.352728
46	10.800	.999999	-7.315072	29.399926	.759062	-.480100	14.848647
47	11.040	1.000000	-7.421560	30.053257	.759062	-.470171	15.344566
48	11.280	1.000000	-7.528046	30.706589	.759063	-.460242	15.840486
49	11.520	1.000000	-7.634532	31.359921	.759063	-.450313	16.336405
50	11.760	1.000000	-7.741017	32.013252	.759063	-.440384	16.832325
51	12.000	1.000000	-7.847503	32.666584	.759063	-.430455	17.328245
52	12.240	1.000000	-7.953989	33.319916	.759063	-.420526	17.824164

INTERPOLATED

PSI	Y	Y
0.0000	2.20776	
.0050	2.65103	
.0100	2.88515	
.0150	3.09704	
.0200	3.28198	
.0250	3.41598	
.0300	3.54377	
.0350	3.66534	
.0400	3.78071	
.0450	3.88987	
.0500	3.98218	
.1000	4.71634	
.1500	5.25215	
.2000	5.67706	
.2500	6.04309	
.3000	6.36624	
.3500	6.65658	
.4000	6.92110	
.4500	7.16951	
.5000	7.39578	
1.0000	9.16321	
1.5000	10.45387	
2.0000	11.52226	
2.5000	12.46315	
3.0000	13.31983	
3.5000	14.11995	
4.0000	14.87973	
4.5000	15.61036	
5.0000	16.31982	
6.0000	17.69690	
7.0000	19.04167	
8.0000	20.37068	
9.0000	21.69258	
10.0000	23.01157	

X(J) = 5.75000 DELSTR = 9.702114

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	-.002434	-.012697	.661366	-.001843	-.004725	-.000610
3	.480	.001548	-.050612	1.322731	.001172	-.018216	-.000831
4	.720	.011898	-.113451	1.984097	.009009	-.039442	.002535
5	.960	.028517	-.200986	2.645463	.021593	-.067413	.012655
6	1.200	.051254	-.313086	3.306829	.038809	-.101209	.032629
7	1.440	.079907	-.449713	3.968194	.060505	-.139985	.065470
8	1.680	.114208	-.610768	4.629560	.086478	-.182937	.114075
9	1.920	.153817	-.795958	5.290926	.116469	-.229272	.181186
10	2.160	.198308	-1.004653	5.952292	.150158	-.278174	.269355
11	2.400	.247172	-1.235752	6.613657	.187157	-.328782	.380899
12	2.640	.299802	-1.487585	7.275023	.227008	-.380177	.517856
13	2.880	.355491	-1.757843	7.936389	.269175	-.431387	.681936
14	3.120	.413425	-2.043557	8.597755	.313043	-.481399	.874465
15	3.360	.472690	-2.341121	9.259120	.357918	-.529202	1.096341
16	3.600	.532278	-2.646385	9.920486	.403038	-.573826	1.347975
17	3.840	.591125	-2.954798	10.581852	.447596	-.614397	1.629265
18	4.080	.648143	-3.261618	11.243217	.490770	-.650198	1.939567
19	4.320	.702288	-3.562172	11.904583	.531768	-.680708	2.277703
20	4.560	.752614	-3.852139	12.565949	.569874	-.705647	2.641997
21	4.800	.798342	-4.127827	13.227315	.604499	-.724983	3.030342
22	5.040	.838914	-4.386414	13.888680	.635221	-.738928	3.440296
23	5.280	.874027	-4.626097	14.550046	.661807	-.747899	3.869201
24	5.520	.903638	-4.846150	15.211412	.684229	-.752472	4.314313
25	5.760	.927956	-5.046870	15.872778	.702642	-.753313	4.772927
26	6.000	.947389	-5.229423	16.534143	.717357	-.751118	5.242496
27	6.240	.962494	-5.395629	17.195509	.728795	-.746557	5.720714
28	6.480	.973912	-5.547709	17.856875	.737440	-.740228	6.205573
29	6.720	.982301	-5.688046	18.518241	.743792	-.732636	6.695391
30	6.960	.988293	-5.818972	19.179606	.748329	-.724183	7.188810
31	7.200	.992453	-5.942625	19.840972	.751479	-.715171	7.684770
32	7.440	.995259	-6.060843	20.502338	.753604	-.705815	8.182475
33	7.680	.997099	-6.175139	21.163703	.754997	-.696261	8.681344
34	7.920	.998271	-6.286693	21.825069	.755885	-.686601	9.180966
35	8.160	.998997	-6.396393	22.486435	.756434	-.676889	9.681064
36	8.400	.999434	-6.504878	23.147801	.756765	-.667156	10.181453
37	8.640	.999689	-6.612592	23.809166	.756958	-.657417	10.682016
38	8.880	.999834	-6.719832	24.470532	.757068	-.647679	11.182678
39	9.120	.999914	-6.826788	25.131898	.757128	-.637943	11.683397
40	9.360	.999957	-6.933581	25.793264	.757161	-.628211	12.184147
41	9.600	.999979	-7.040281	26.454629	.757178	-.618481	12.684912
42	9.840	.999990	-7.146932	27.115995	.757186	-.608752	13.185686
43	10.080	.999995	-7.253556	27.777361	.757190	-.599025	13.686465
44	10.320	.999998	-7.360167	28.438727	.757192	-.589298	14.187245
45	10.560	.999999	-7.466772	29.100092	.757193	-.579571	14.688026
46	10.800	1.000000	-7.573373	29.761458	.757193	-.569845	15.188808
47	11.040	1.000000	-7.679972	30.422824	.757194	-.560118	15.689589
48	11.280	1.000000	-7.786571	31.084189	.757194	-.550392	16.190371
49	11.520	1.000000	-7.893170	31.745555	.757194	-.540665	16.691153
50	11.760	1.000000	-7.999769	32.406921	.757194	-.530939	17.191935
51	12.000	1.000000	-8.106367	33.068287	.757194	-.521213	17.692717
52	12.240	1.000000	-8.212966	33.729652	.757194	-.511486	18.193499

INTERPOLATED

PSI	Y	Y
0.0000	1.78402	
.0050	2.16539	
.0100	2.49318	
.0150	2.73326	
.0200	2.91145	
.0250	3.07736	
.0300	3.23098	
.0350	3.36037	
.0400	3.47032	
.0450	3.57627	
.0500	3.67820	
.1000	4.45380	
.1500	5.00058	
.2000	5.44232	
.2500	5.81759	
.3000	6.14497	
.3500	6.44148	
.4000	6.71187	
.4500	6.95978	
.5000	7.19443	
1.0000	8.98095	
1.5000	10.28523	
2.0000	11.36478	
2.5000	12.31287	
3.0000	13.17686	
3.5000	13.98216	
4.0000	14.74638	
4.5000	15.48103	
5.0000	16.19408	
6.0000	17.57728	
7.0000	18.92693	
8.0000	20.26004	
9.0000	21.58559	
10.0000	22.90800	

X(J) = 5.87500 DELSTR = 9.552461

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	.000079	-.015362	.669310	.000060	-.005505	.000020
3	.480	.006439	-.060675	1.338621	.004864	-.021142	.001668
4	.720	.019044	-.134494	2.007931	.014386	-.045500	.008110
5	.960	.037806	-.235619	2.677241	.028558	-.077270	.022481
6	1.200	.062595	-.363169	3.346552	.047284	-.115287	.047862
7	1.440	.093219	-.516507	4.015862	.070417	-.158513	.087252
8	1.680	.129405	-.695075	4.685173	.097752	-.206005	.143531
9	1.920	.170794	-.898208	5.354483	.129017	-.256864	.219420
10	2.160	.216929	-1.124949	6.023793	.163868	-.310199	.317436
11	2.400	.267258	-1.373878	6.693104	.201886	-.365085	.439837
12	2.640	.321125	-1.642998	7.362414	.242577	-.420549	.588579
13	2.880	.377770	-1.929659	8.031724	.285366	-.475570	.765258
14	3.120	.436327	-2.230543	8.701035	.329600	-.529098	.971060
15	3.360	.495837	-2.541714	9.370345	.374553	-.580088	1.206708
16	3.600	.555261	-2.858725	10.039656	.419443	-.627552	1.472423
17	3.840	.613520	-3.176794	10.708966	.463451	-.670614	1.767888
18	4.080	.669537	-3.491042	11.378276	.505766	-.708564	2.092242
19	4.320	.722298	-3.796767	12.047587	.545621	-.740907	2.444094
20	4.560	.770918	-4.089744	12.716897	.582349	-.767398	2.821575
21	4.800	.814700	-4.366496	13.386207	.615422	-.788048	3.222415
22	5.040	.853180	-4.624510	14.055518	.644490	-.803113	3.644051
23	5.280	.886158	-4.862360	14.724828	.669401	-.813053	4.083751
24	5.520	.913689	-5.079725	15.394138	.690198	-.818479	4.538748
25	5.760	.936063	-5.277293	16.063449	.707099	-.820085	5.006361
26	6.000	.953753	-5.456574	16.732759	.720462	-.818586	5.484102
27	6.240	.967355	-5.619658	17.402070	.730737	-.814665	5.969753
28	6.480	.977522	-5.768954	18.071380	.738417	-.808928	6.461413
29	6.720	.984908	-5.906953	18.740690	.743997	-.801885	6.957511
30	6.960	.990124	-6.036024	19.410001	.747936	-.793940	7.456794
31	7.200	.993702	-6.158287	20.079311	.750640	-.785401	7.958300
32	7.440	.996088	-6.275534	20.748621	.752442	-.776485	8.461314
33	7.680	.997634	-6.389206	21.417932	.753610	-.767343	8.965322
34	7.920	.998607	-6.500413	22.087242	.754344	-.758072	9.469967
35	8.160	.999202	-6.609975	22.756553	.754794	-.748732	9.975008
36	8.400	.999555	-6.718473	23.425863	.755061	-.739356	10.480288
37	8.640	.999759	-6.826304	24.095173	.755215	-.729965	10.985710
38	8.880	.999873	-6.933730	24.764484	.755301	-.720568	11.491212
39	9.120	.999935	-7.040918	25.433794	.755348	-.711168	11.996758
40	9.360	.999968	-7.147970	26.103104	.755373	-.701769	12.502328
41	9.600	.999984	-7.254948	26.772415	.755385	-.692370	13.007911
42	9.840	.999993	-7.361884	27.441725	.755392	-.682972	13.513501
43	10.080	.999997	-7.468800	28.111035	.755395	-.673573	14.019093
44	10.320	.999999	-7.575706	28.780346	.755396	-.664176	14.524687
45	10.560	.999999	-7.682606	29.449656	.755397	-.654778	15.030281
46	10.800	1.000000	-7.789504	30.118967	.755397	-.645380	15.535876
47	11.040	1.000000	-7.896401	30.788277	.755397	-.635983	16.041471
48	11.280	1.000000	-8.003297	31.457587	.755397	-.626585	16.547066
49	11.520	1.000000	-8.110193	32.126898	.755397	-.617188	17.052661
50	11.760	1.000000	-8.217090	32.796208	.755397	-.607790	17.558256
51	12.000	1.000000	-8.323986	33.465518	.755397	-.598393	18.063851
52	12.240	1.000000	-8.430882	34.134829	.755397	-.588995	18.569446

INTERPOLATED

PSI	Y	Y
0.0000	0.00000	
.0050	1.71337	
.0100	2.10795	
.0150	2.35502	
.0200	2.57667	
.0250	2.75200	
.0300	2.89496	
.0350	3.03068	
.0400	3.15916	
.0450	3.28040	
.0500	3.38712	
.1000	4.18038	
.1500	4.74737	
.2000	5.19576	
.2500	5.57603	
.3000	5.91340	
.3500	6.21231	
.4000	6.48701	
.4500	6.74191	
.5000	6.97548	
1.0000	8.78707	
1.5000	10.10453	
2.0000	11.19304	
2.5000	12.14910	
3.0000	13.01880	
3.5000	13.82988	
4.0000	14.59905	
4.5000	15.33783	
5.0000	16.05444	
6.0000	17.44342	
7.0000	18.79776	
8.0000	20.13485	
9.0000	21.46394	
10.0000	22.78966	

X(J) = 6.00000 DELSTR = 9.392881

K	ETA	U	V	Y	UST	VST	PSI	INTERPOLATED PSI	INTERPOLATED Y	Y
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0000	0.00000	
2	.240	.003012	-.017954	.677155	.002270	-.006222	.000769	.0050	1.38482	
3	.480	.012047	-.070380	1.354310	.009080	-.023812	.004611	.0100	1.74726	
4	.720	.027093	-.154579	2.031465	.020420	-.050968	.014599	.0150	2.04765	
5	.960	.048105	-.268318	2.708620	.036257	-.086059	.033789	.0200	2.24225	
6	1.200	.074993	-.409905	3.385774	.056522	-.127665	.065202	.0250	2.42329	
7	1.440	.107589	-.578074	4.062929	.081090	-.174558	.111794	.0300	2.59076	
8	1.680	.145628	-.771801	4.740084	.109760	-.225655	.176411	.0350	2.73803	
9	1.920	.188740	-.990059	5.417239	.142253	-.279968	.261737	.0400	2.85661	
10	2.160	.236440	-1.231590	6.094394	.178205	-.336537	.370237	.0450	2.97069	
11	2.400	.288135	-1.494693	6.771549	.217167	-.394395	.504101	.0500	3.08027	
12	2.640	.343119	-1.777087	7.448704	.258608	-.452533	.665187	.1000	3.90648	
13	2.880	.400579	-2.075837	8.125859	.301916	-.509905	.854968	.1500	4.48043	
14	3.120	.459603	-2.387345	8.803014	.346402	-.565446	1.074474	.2000	4.94002	
15	3.360	.519188	-2.707418	9.480168	.391312	-.618107	1.324248	.2500	5.33165	
16	3.600	.578272	-3.031404	10.157323	.435843	-.666911	1.604303	.3000	5.66915	
17	3.840	.635768	-3.354392	10.834478	.479177	-.711002	1.914109	.3500	5.97681	
18	4.080	.690616	-3.671470	11.511633	.520517	-.749712	2.252583	.4000	6.25393	
19	4.320	.741848	-3.978020	12.188788	.559130	-.782595	2.618126	.4500	6.51039	
20	4.560	.788645	-4.270012	12.865943	.594400	-.809463	3.008686	.5000	6.75235	
21	4.800	.830397	-4.544264	13.543098	.625869	-.830387	3.421841	1.0000	8.58187	
22	5.040	.866741	-4.798634	14.220253	.653262	-.845677	3.854926	1.5000	9.91234	
23	5.280	.897577	-5.032106	14.897408	.676503	-.855837	4.305154	2.0000	11.01088	
24	5.520	.923055	-5.244761	15.574562	.695705	-.861513	4.769753	2.5000	11.97455	
25	5.760	.943540	-5.437651	16.251717	.711145	-.863417	5.246080	3.0000	12.85127	
26	6.000	.959561	-5.612576	16.928872	.723220	-.862273	5.731724	3.5000	13.66717	
27	6.240	.971742	-5.771831	17.606027	.732401	-.858760	6.224564	4.0000	14.44070	
28	6.480	.980744	-5.917942	18.283182	.739186	-.853477	6.722810	4.5000	15.18340	
29	6.720	.987210	-6.053434	18.960337	.744058	-.846920	7.225003	5.0000	15.90349	
30	6.960	.991721	-6.180651	19.637492	.747459	-.839485	7.729997	6.0000	17.29839	
31	7.200	.994780	-6.301642	20.314647	.749764	-.831467	8.236923	7.0000	18.65741	
32	7.440	.996795	-6.418107	20.991802	.751283	-.823078	8.745144	8.0000	19.99838	
33	7.680	.998084	-6.531389	21.668956	.752255	-.814462	9.254208	9.0000	21.33090	
34	7.920	.998886	-6.642506	22.346111	.752859	-.805714	9.763806	10.0000	22.65980	
35	8.160	.999370	-6.752196	23.023266	.753223	-.796893	10.273731			
36	8.400	.999653	-6.860976	23.700421	.753437	-.788032	10.783852			
37	8.640	.999814	-6.969193	24.377576	.753559	-.779152	11.294087			
38	8.880	.999904	-7.077074	25.054731	.753626	-.770263	11.804386			
39	9.120	.999951	-7.184759	25.731886	.753662	-.761371	12.314720			
40	9.360	.999976	-7.292334	26.409041	.753681	-.752477	12.825072			
41	9.600	.999989	-7.399849	27.086196	.753690	-.743582	13.335434			
42	9.840	.999995	-7.507332	27.763350	.753695	-.734687	13.845800			
43	10.080	.999998	-7.614799	28.440505	.753697	-.725793	14.356169			
44	10.320	.999999	-7.722258	29.117660	.753698	-.716898	14.866539			
45	10.560	1.000000	-7.829714	29.794815	.753698	-.708004	15.376909			
46	10.800	1.000000	-7.937167	30.471970	.753698	-.699109	15.887280			
47	11.040	1.000000	-8.044620	31.149125	.753699	-.690215	16.397650			
48	11.280	1.000000	-8.152072	31.826280	.753699	-.681320	16.908021			
49	11.520	1.000000	-8.259525	32.503435	.753699	-.672426	17.418391			
50	11.760	1.000000	-8.366977	33.180590	.753699	-.663532	17.928762			
51	12.000	1.000000	-8.474429	33.857744	.753699	-.654637	18.439133			
52	12.240	1.000000	-8.581881	34.534899	.753699	-.645743	18.949504			

X(J) = 6.12500 DELSTR = 9.228745

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	.006257	-.019955	.684888	.004706	-.006704	.001612
3	.480	.018184	-.077891	1.369776	.013676	-.025615	.007907
4	.720	.035805	-.170201	2.054663	.026930	-.054682	.021812
5	.960	.059134	-.293857	2.739551	.044476	-.092051	.046265
6	1.200	.088132	-.446474	3.424439	.066286	-.136106	.084194
7	1.440	.122668	-.626214	4.109327	.092262	-.185452	.138488
8	1.680	.162498	-.831594	4.794215	.122219	-.238882	.211936
9	1.920	.207247	-1.061226	5.479103	.155876	-.295315	.307168
10	2.160	.256408	-1.313550	6.163990	.192851	-.353733	.426587
11	2.400	.309348	-1.586601	6.848878	.232668	-.413129	.572303
12	2.640	.365313	-1.877847	7.533766	.274761	-.472476	.746069
13	2.880	.423440	-2.184113	8.218654	.318480	-.530718	.949221
14	3.120	.482771	-2.501580	8.903542	.363104	-.586795	1.182625
15	3.360	.542269	-2.825872	9.588430	.407854	-.639676	1.446635
16	3.600	.600850	-3.152216	10.273317	.451914	-.688415	1.741057
17	3.840	.657431	-3.475662	10.958205	.494470	-.732207	2.065141
18	4.080	.710978	-3.791363	11.643093	.534744	-.770441	2.417589
19	4.320	.760574	-4.094872	12.327981	.572046	-.802741	2.796602
20	4.560	.805476	-4.382432	13.012869	.605818	-.828991	3.199955
21	4.800	.845165	-4.651215	13.697757	.635669	-.849328	3.625094
22	5.040	.879378	-4.899480	14.382644	.661402	-.864119	4.069268
23	5.280	.908113	-5.126620	15.067532	.683014	-.873913	4.529655
24	5.520	.931609	-5.333099	15.752420	.700686	-.879379	5.003495
25	5.760	.950298	-5.520279	16.437308	.714742	-.881238	5.488199
26	6.000	.964754	-5.690189	17.122196	.725615	-.880207	5.981441
27	6.240	.975623	-5.845256	17.807083	.733790	-.876946	6.481205
28	6.480	.983563	-5.988050	18.491971	.739762	-.872031	6.985814
29	6.720	.989200	-6.121066	19.176859	.744002	-.865935	7.493920
30	6.960	.993087	-6.246564	19.861747	.746925	-.859028	8.004478
31	7.200	.995691	-6.366483	20.546635	.748884	-.851584	8.516709
32	7.440	.997385	-6.482400	21.231523	.750158	-.843799	9.030047
33	7.680	.998456	-6.595540	21.916410	.750963	-.835806	9.544097
34	7.920	.999113	-6.706815	22.601298	.751457	-.827692	10.058591
35	8.160	.999505	-6.816878	23.286186	.751752	-.819508	10.573356
36	8.400	.999731	-6.926178	23.971074	.751922	-.811288	11.088280
37	8.640	.999858	-7.035013	24.655962	.752018	-.803050	11.603295
38	8.880	.999927	-7.143573	25.340850	.752070	-.794802	12.118361
39	9.120	.999964	-7.251976	26.025737	.752097	-.786550	12.633454
40	9.360	.999983	-7.360292	26.710625	.752111	-.778296	13.148561
41	9.600	.999992	-7.468561	27.395513	.752118	-.770041	13.663675
42	9.840	.999996	-7.576806	28.080401	.752122	-.761787	14.178793
43	10.080	.999998	-7.685038	28.765289	.752123	-.753532	14.693912
44	10.320	.999999	-7.793265	29.450177	.752124	-.745277	15.209033
45	10.560	1.000000	-7.901488	30.135064	.752124	-.737022	15.724153
46	10.800	1.000000	-8.009711	30.819952	.752124	-.728767	16.239274
47	11.040	1.000000	-8.117933	31.504840	.752124	-.720512	16.754395
48	11.280	1.000000	-8.226154	32.189728	.752124	-.712257	17.269516
49	11.520	1.000000	-8.334376	32.874616	.752124	-.704002	17.784637
50	11.760	1.000000	-8.442597	33.559503	.752124	-.695748	18.299758
51	12.000	1.000000	-8.550819	34.244391	.752124	-.687493	18.814878
52	12.240	1.000000	-8.659040	34.929279	.752124	-.679238	19.329999

INTERPOLATED

PSI	Y	Y
0.0000	0.00000	
.0050	1.08258	
.0100	1.48658	
.0150	1.74592	
.0200	1.97756	
.0250	2.15478	
.0300	2.30525	
.0350	2.44775	
.0400	2.58227	
.0450	2.70881	
.0500	2.81454	
.1000	3.63948	
.1500	4.22569	
.2000	4.69220	
.2500	5.08273	
.3000	5.43184	
.3500	5.73756	
.4000	6.02114	
.4500	6.28084	
.5000	6.52165	
1.0000	8.37400	
1.5000	9.71700	
2.0000	10.82478	
2.5000	11.79542	
3.0000	12.67762	
3.5000	13.49921	
4.0000	14.27740	
4.5000	15.02399	
5.0000	15.74742	
6.0000	17.14775	
7.0000	18.51114	
8.0000	19.85575	
9.0000	21.19146	
10.0000	22.52332	

X(J) = 6.25000 DELSTR = 9.064248

K	ETA	U	V	Y	UST	VST	PSI
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	.240	.009684	-.021614	.692502	.007270	-.007052	.002517
3	.480	.024631	-.084121	1.385004	.018490	-.026919	.011436
4	.720	.044913	-.183146	2.077506	.033716	-.057360	.029513
5	.960	.070598	-.314981	2.770008	.052997	-.096352	.059537
6	1.200	.101701	-.476647	3.462510	.076346	-.142123	.104322
7	1.440	.138137	-.665802	4.155012	.103698	-.193147	.166663
8	1.680	.179688	-.880539	4.847514	.134890	-.248107	.249274
9	1.920	.225981	-1.119118	5.540017	.169641	-.305840	.354718
10	2.160	.276490	-1.379679	6.232519	.207558	-.365268	.485324
11	2.400	.330547	-1.659992	6.925021	.248138	-.425351	.643109
12	2.640	.387353	-1.957292	7.617523	.290782	-.485043	.829711
13	2.880	.446000	-2.268187	8.310025	.334807	-.543292	1.046322
14	3.120	.505485	-2.588679	9.002527	.379462	-.599051	1.293638
15	3.360	.564743	-2.914263	9.695029	.423947	-.651322	1.571820
16	3.600	.622679	-3.240104	10.387531	.467439	-.699206	1.880463
17	3.840	.678218	-3.561284	11.080033	.509131	-.741957	2.218601
18	4.080	.730362	-3.873087	11.772535	.548275	-.779038	2.584729
19	4.320	.778252	-4.171299	12.465037	.584226	-.810150	2.976858
20	4.560	.821226	-4.452486	13.157539	.616486	-.835256	3.392606
21	4.800	.858858	-4.714206	13.850041	.644736	-.854562	3.829305
22	5.040	.890984	-4.955132	14.542543	.668852	-.868493	4.284136
23	5.280	.917694	-5.175055	15.235046	.688904	-.877634	4.754260
24	5.520	.939308	-5.374783	15.927548	.705128	-.882672	5.236945
25	5.760	.956317	-5.555947	16.620050	.717897	-.884327	5.729669
26	6.000	.969330	-5.720747	17.312552	.727666	-.883301	6.230197
27	6.240	.979004	-5.871684	18.005054	.734928	-.880226	6.736622
28	6.480	.985993	-6.011318	18.697556	.740174	-.875648	7.247377
29	6.720	.990896	-6.142070	19.390058	.743855	-.870005	7.761224
30	6.960	.994238	-6.266085	20.082560	.746364	-.863637	8.277214
31	7.200	.996449	-6.385168	20.775062	.748024	-.856794	8.794647
32	7.440	.997871	-6.500758	21.467564	.749091	-.849651	9.313025
33	7.680	.998758	-6.613957	22.160066	.749757	-.842326	9.832003
34	7.920	.999296	-6.725573	22.852568	.750161	-.834896	10.351351
35	8.160	.999612	-6.836172	23.545070	.750398	-.827406	10.870921
36	8.400	.999792	-6.946140	24.237572	.750533	-.819884	11.390620
37	8.640	.999892	-7.055729	24.930075	.750608	-.812345	11.910392
38	8.880	.999945	-7.165096	25.622577	.750649	-.804799	12.430204
39	9.120	.999973	-7.274339	26.315079	.750669	-.797249	12.950036
40	9.360	.999987	-7.383514	27.007581	.750680	-.789697	13.469880
41	9.600	.999994	-7.492653	27.700083	.750685	-.782145	13.989730
42	9.840	.999997	-7.601773	28.392585	.750688	-.774592	14.509581
43	10.080	.999999	-7.710884	29.085087	.750689	-.767039	15.029435
44	10.320	1.000000	-7.819991	29.777589	.750689	-.759486	15.549288
45	10.560	1.000000	-7.929096	30.470091	.750689	-.751934	16.069142
46	10.800	1.000000	-8.038200	31.162593	.750689	-.744381	16.588996
47	11.040	1.000000	-8.147304	31.855095	.750689	-.736828	17.108850
48	11.280	1.000000	-8.256407	32.547597	.750690	-.729275	17.628704
49	11.520	1.000000	-8.365511	33.240099	.750690	-.721722	18.148558
50	11.760	1.000000	-8.474614	33.932601	.750690	-.714169	18.668412
51	12.000	1.000000	-8.583717	34.625104	.750690	-.706616	19.188266
52	12.240	1.000000	-8.692821	35.317606	.750690	-.699064	19.708120

INTERPOLATED

PSI	Y
0.0000	0.00000
.0050	.90856
.0100	1.28914
.0150	1.53791
.0200	1.73889
.0250	1.92402
.0300	2.09020
.0350	2.21775
.0400	2.34021
.0450	2.45759
.0500	2.56989
.1000	3.40279
.1500	3.98423
.2000	4.45032
.2500	4.85269
.3000	5.19553
.3500	5.51158
.4000	5.79235
.4500	6.05588
.5000	6.30106
1.0000	8.16868
1.5000	9.52245
2.0000	10.63815
2.5000	11.61622
3.0000	12.50444
3.5000	13.33035
4.0000	14.11253
4.5000	14.86272
5.0000	15.58935
6.0000	16.99506
7.0000	18.36267
8.0000	19.71076
9.0000	21.04949
10.0000	22.38411

Y

X(J) = 6.37500 DELSTR = 8.900685

K	ETA	U	V	Y	UST	VST	PSI	INTERPOLATED PSI	INTERPOLATED Y	Y
1	0.000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0000	0.00000	
2	.240	.013286	-.023312	.699993	.009956	-.007401	.003485	.0050	.80350	
3	.480	.031366	-.090449	1.399986	.023506	-.028218	.015196	.0100	1.11775	
4	.720	.054366	-.196176	2.099978	.040742	-.059998	.037683	.0150	1.39014	
5	.960	.082418	-.336052	2.799971	.061765	-.100539	.073560	.0200	1.56643	
6	1.200	.115603	-.506501	3.499964	.086634	-.147920	.125499	.0250	1.72992	
7	1.440	.153887	-.704691	4.199957	.115323	-.200496	.196183	.0300	1.88345	
8	1.680	.197079	-.928313	4.899950	.147692	-.256850	.288237	.0350	2.02704	
9	1.920	.244816	-1.175279	5.599942	.183466	-.315744	.404141	.0400	2.15053	
10	2.160	.296556	-1.443430	6.299935	.222240	-.376045	.546137	.0450	2.25710	
11	2.400	.351599	-1.730275	6.999928	.263490	-.436676	.716140	.0500	2.36023	
12	2.640	.409106	-2.032811	7.699921	.306586	-.496579	.915665	.1000	3.17596	
13	2.880	.468124	-2.347442	8.399914	.350814	-.554699	1.145752	.1500	3.75859	
14	3.120	.527616	-2.670003	9.099907	.395397	-.610008	1.406923	.2000	4.23152	
15	3.360	.586491	-2.995879	9.799899	.439518	-.661540	1.699141	.2500	4.62467	
16	3.600	.643649	-3.320202	10.499892	.482353	-.708442	2.021792	.3000	4.97626	
17	3.840	.698036	-3.638116	11.199885	.523110	-.750031	2.373700	.3500	5.28735	
18	4.080	.748693	-3.945069	11.899878	.561073	-.785841	2.753161	.4000	5.57692	
19	4.320	.794829	-4.237115	12.599871	.595648	-.815653	3.158009	.4500	5.83749	
20	4.560	.835864	-4.511171	13.299863	.626399	-.839505	3.585721	.5000	6.08401	
21	4.800	.871466	-4.765203	13.999856	.653079	-.857675	4.033533	1.0000	7.96555	
22	5.040	.901566	-4.998308	14.699849	.675637	-.870643	4.498579	1.5000	9.32968	
23	5.280	.926344	-5.210676	15.399842	.694205	-.879036	4.978019	2.0000	10.45437	
24	5.520	.946187	-5.403455	16.099835	.709075	-.883559	5.469162	2.5000	11.43759	
25	5.760	.961638	-5.578522	16.799827	.720654	-.884936	5.969562	3.0000	12.33100	
26	6.000	.973331	-5.738226	17.499820	.729418	-.883853	6.477082	3.5000	13.16203	
27	6.240	.981929	-5.885120	18.199813	.735861	-.880920	6.989924	4.0000	13.94832	
28	6.480	.988070	-6.021731	18.899806	.740463	-.876650	7.506632	4.5000	14.70195	
29	6.720	.992330	-6.150385	19.599799	.743655	-.871451	8.026068	5.0000	15.43144	
30	6.960	.995199	-6.273098	20.299791	.745805	-.865631	8.547374	6.0000	16.84201	
31	7.200	.997075	-6.391527	20.999784	.747211	-.859412	9.069924	7.0000	18.21350	
32	7.440	.998267	-6.506970	21.699777	.748104	-.852949	9.593279	8.0000	19.56473	
33	7.680	.999001	-6.620401	22.399770	.748655	-.846341	10.117139	9.0000	20.90618	
34	7.920	.999441	-6.732521	23.099763	.748984	-.839651	10.641308	10.0000	22.24328	
35	8.160	.999696	-6.843814	23.799756	.749175	-.832918	11.165658			
36	8.400	.999839	-6.954601	24.499748	.749283	-.826163	11.690113			
37	8.640	.999918	-7.065091	25.199741	.749341	-.819397	12.214626			
38	8.880	.999959	-7.175409	25.899734	.749372	-.812626	12.739170			
39	9.120	.999980	-7.285633	26.599727	.749388	-.805853	13.263731			
40	9.360	.999991	-7.395806	27.299720	.749396	-.799080	13.788300			
41	9.600	.999996	-7.505953	27.999712	.749400	-.792306	14.312874			
42	9.840	.999998	-7.616087	28.699705	.749402	-.785533	14.837449			
43	10.080	.999999	-7.726214	29.399698	.749403	-.778760	15.362025			
44	10.320	1.000000	-7.836339	30.099691	.749403	-.771986	15.886602			
45	10.560	1.000000	-7.946462	30.799684	.749403	-.765213	16.411178			
46	10.800	1.000000	-8.056585	31.499676	.749403	-.758440	16.935755			
47	11.040	1.000000	-8.166707	32.199669	.749403	-.751666	17.460332			
48	11.280	1.000000	-8.276830	32.899662	.749403	-.744893	17.984909			
49	11.520	1.000000	-8.386952	33.599655	.749403	-.738120	18.509486			
50	11.760	1.000000	-8.497074	34.299648	.749403	-.731346	19.034062			
51	12.000	1.000000	-8.607197	34.999640	.749403	-.724573	19.558639			
52	12.240	1.000000	-8.717319	35.699633	.749403	-.717800	20.083216			

NASA-Langley, 1974 A-5281

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

SPECIAL FOURTH-CLASS RATE
BOOK

POSTAGE AND FEES PAID
NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION
451

U.S.MAIL

655 001 C1 U 12 740719 S00120ES
PHILCO FORD CORP
AERONUTRONIC DIV
AEROSPACE & COMMUNICATIONS OPERATIONS
ATTN: TECHNICAL INFO SERVICES
FORD & JAMBOREE ROADS
NEWPORT BEACH CA 92663

POSTMASTER: If Undeliverable (Section 158 Postal Manual) Do Not Return

"The aeronautical and space activities of the United States shall be conducted so as to contribute . . . to the expansion of human knowledge of phenomena in the atmosphere and space. The Administration shall provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

—NATIONAL AERONAUTICS AND SPACE ACT OF 1958

NASA SCIENTIFIC AND TECHNICAL PUBLICATIONS

TECHNICAL REPORTS: Scientific and technical information considered important, complete, and a lasting contribution to existing knowledge.

TECHNICAL NOTES: Information less broad in scope but nevertheless of importance as a contribution to existing knowledge.

TECHNICAL MEMORANDUMS: Information receiving limited distribution because of preliminary data, security classification, or other reasons. Also includes conference proceedings with either limited or unlimited distribution.

CONTRACTOR REPORTS: Scientific and technical information generated under a NASA contract or grant and considered an important contribution to existing knowledge.

TECHNICAL TRANSLATIONS: Information published in a foreign language considered to merit NASA distribution in English.

SPECIAL PUBLICATIONS: Information derived from or of value to NASA activities. Publications include final reports of major projects, monographs, data compilations, handbooks, sourcebooks, and special bibliographies.

TECHNOLOGY UTILIZATION PUBLICATIONS: Information on technology used by NASA that may be of particular interest in commercial and other non-aerospace applications. Publications include Tech Briefs, Technology Utilization Reports and Technology Surveys.

Details on the availability of these publications may be obtained from:

SCIENTIFIC AND TECHNICAL INFORMATION OFFICE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Washington, D.C. 20546