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THE NUMERICAL CALCULATION OF LAMINAR BOUNDARY-LAYER SEPARATION

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16. Abstract

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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*

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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 accuracy 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).

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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:

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

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

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

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

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

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

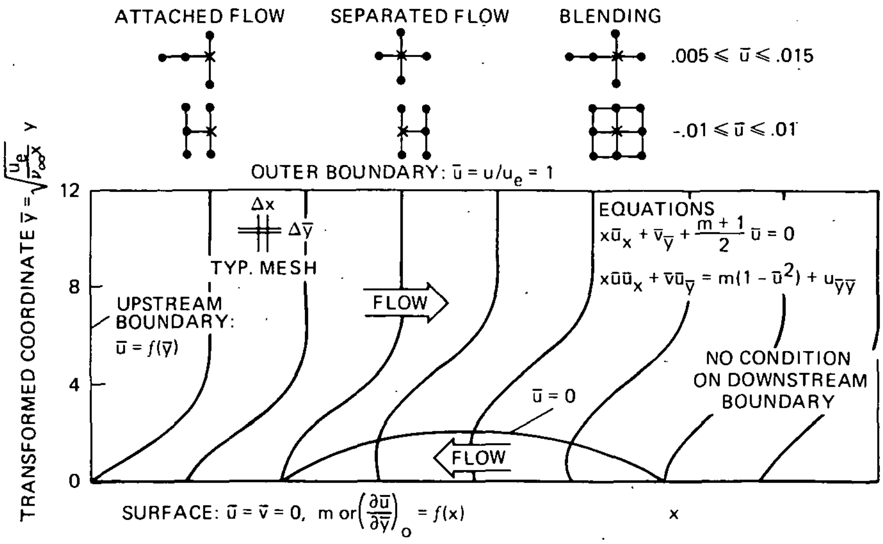

Figure 1.- Difference operators and boundary conditions for relaxation calculation.

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

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

so that the model equation becomes

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

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

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

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

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

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

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

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

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

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

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

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 $\Delta x << (\Delta y)^2$. 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 $\Delta x \geq O(\Delta y^2)$ and $\Delta y \geq O(\Delta x^2)$. (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 $A^{-1}\vec{\varepsilon} \to 0$ 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

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

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

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:

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

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

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

In the intermediate zone, $0.005 \le \bar{u} \le 0.015$, 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 $0 \le \bar{u} \le 0.01$ 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:

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

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:

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

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

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

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

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

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):

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

For a poor guess of the initial solution, ω is initially kept small, $\omega = O(0.05)$. 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 $\omega = 0(0.5)$ for equation (31). For line SUR, the optimum relaxation parameter is 0(0.4) and ω is the 0(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

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

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

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

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

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

and

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

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

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.

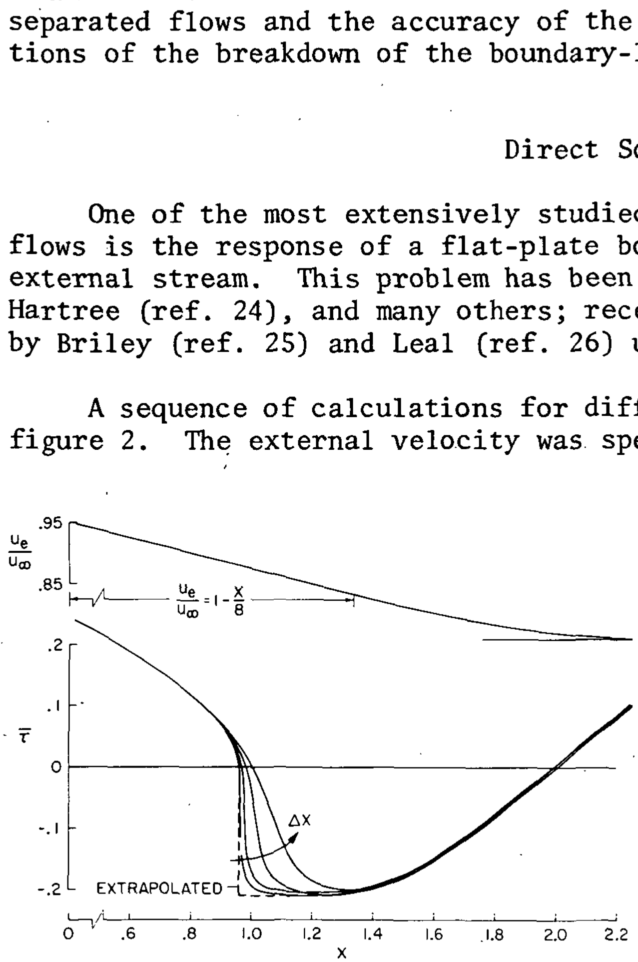

Figure 2.- Calculation for linearly retarded flow.

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

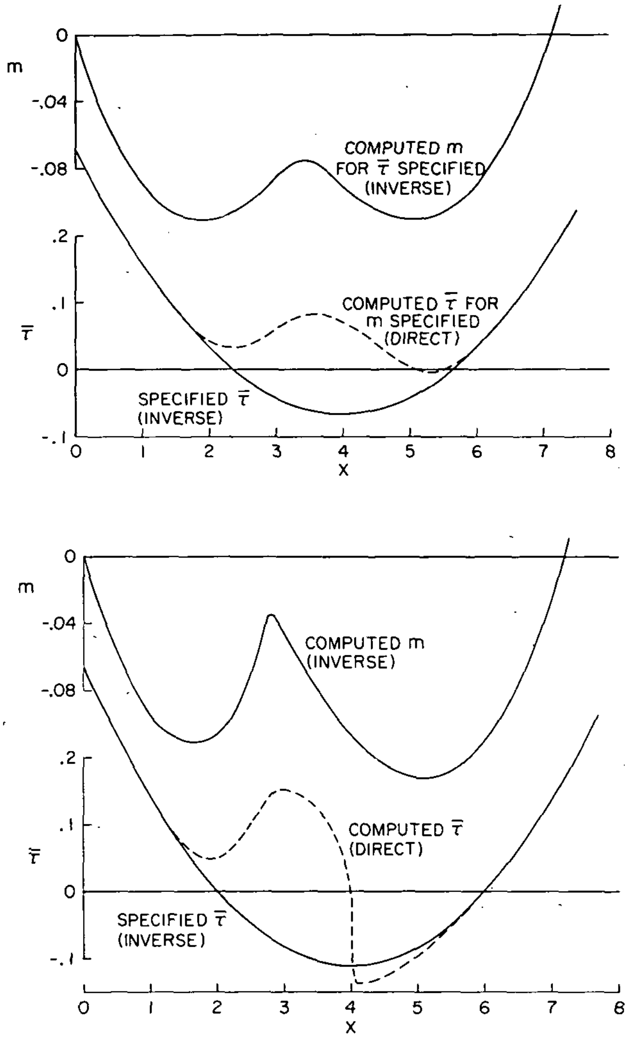

Figure 3.- Inverse/direct calculations that indicate existence of saddle point.

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:

$$\left.\begin{aligned} f_4 - f_1f_1' &= 0 \\ f_5 - 2f_1f_2' &= 0 \\ f_6 - 2f_2f_2' &= 0 \\ f_7 - 4f_1f_4' + 5f_4f_1' &= 0 \\ f_8 - 5f_1f_5' - 9f_2f_4' + 5f_4f_2' + 9f_5f_1' &= 0 \\ &\vdots \end{aligned}\right\} \qquad (39)$$

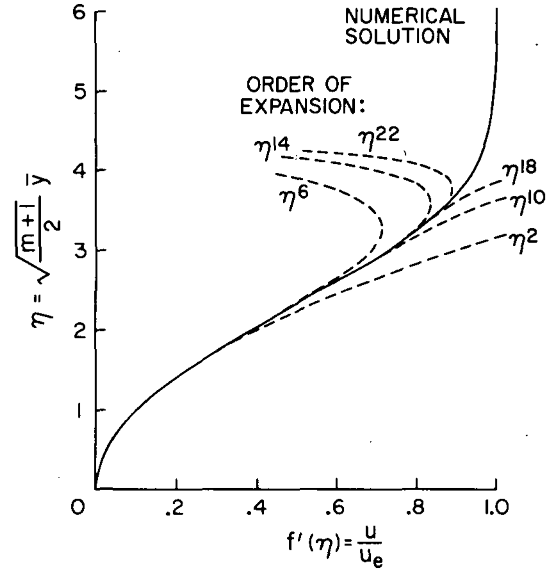

Figure 4.- Series expansion for similar separation profile.

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:

$$f_1f_1' = f_4 \qquad (40a)$$

$$\left.\begin{aligned} 4f_1{}^2f_4' &= f_1f_7 + 5f_4{}^2 \\ 14f_1{}^3f_7' &= 2f_1{}^2[f_{10} + 8p_x(2p_{xx}^2 - 5p_xp_{xx})] \\ &\quad + 33f_1f_4f_7 - 35f_4{}^2 \\ &\vdots \end{aligned}\right\} \qquad (40b)$$

The remaining coefficients are given by the algebraic relations:

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

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:

$$2\tau f_2' = f_5 \qquad (42a)$$

$$\left.\begin{aligned} 10\tau f_5' &= 2f_8 + 23\tau_xf_5 - 18f_2(\tau\tau_{xx} + \tau_x{}^2) \\ 40\tau f_8' &= 5f_{11} + 93\tau_xf_8 + 3f_5(160\tau\tau_{xx} - 201\tau_x{}^2) \\ &\quad + 27f_2(19\tau_x{}^3 - 16\tau\tau_x\tau_{xx} - 20\tau^2\tau_{xxx}) \\ &\;\;\vdots \end{aligned}\right\} \qquad (42b)$$

including the algebraic relations

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

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:

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

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.

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.

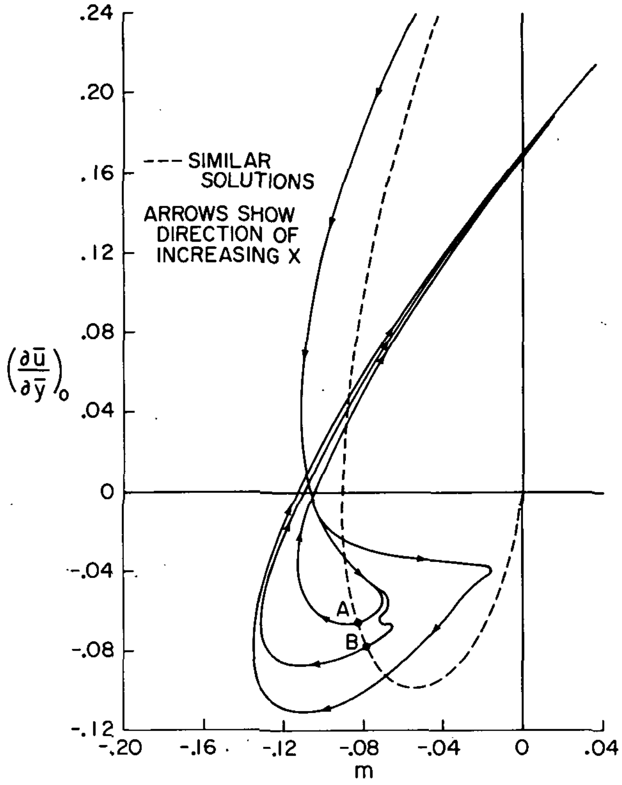

Figure 5.- Phase space representation.

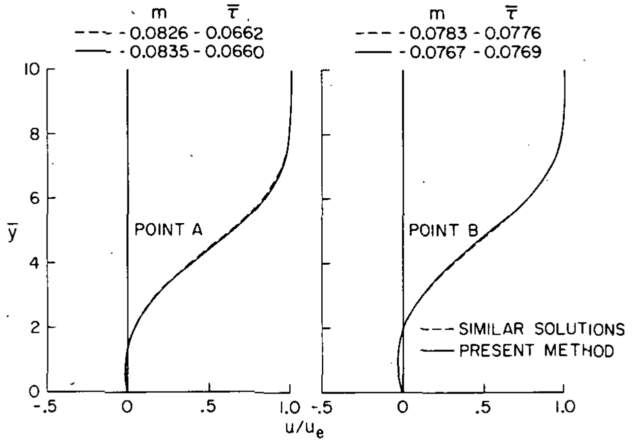

Figure 6.- Comparison with similar solutions.

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

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

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.

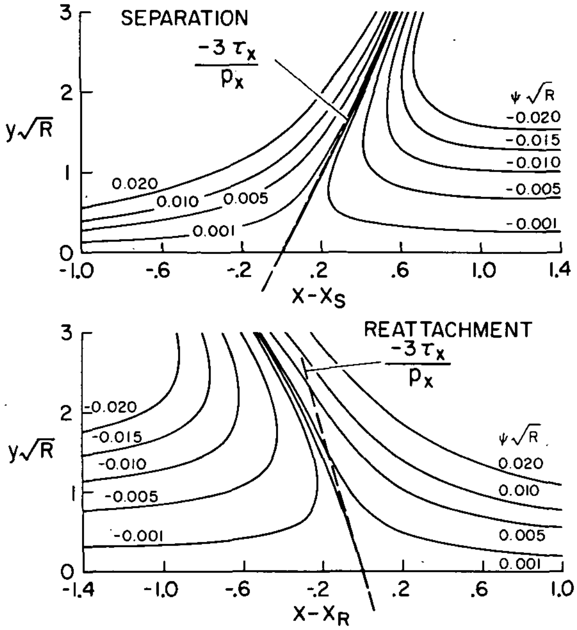

Figure 7.- Detailed flow field in the vicinity of $\tau = 0$.

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

$$\left.\begin{aligned} C_f\sqrt{R} &= 2u_e\sqrt{\frac{u_e}{x}}\,\bar{\tau} \\ &\text{and} \\ \psi\sqrt{R} &= \sqrt{xu_e}\int_0^{\bar{y}}\bar{u}\,d\bar{y} \end{aligned}\right\}\qquad(50)$$

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

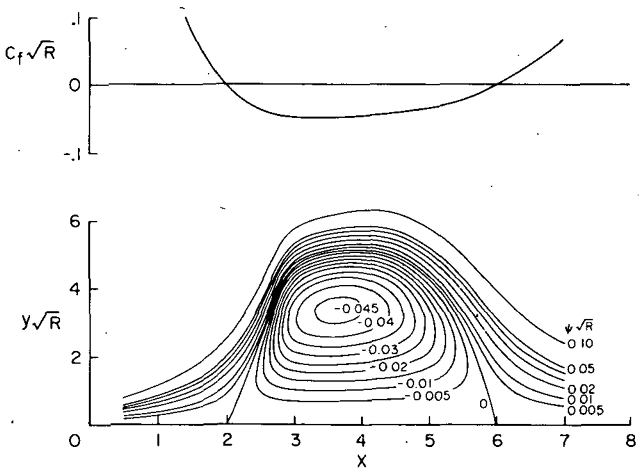

Figure 8.- Streamlines for specified shear distribution.

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.

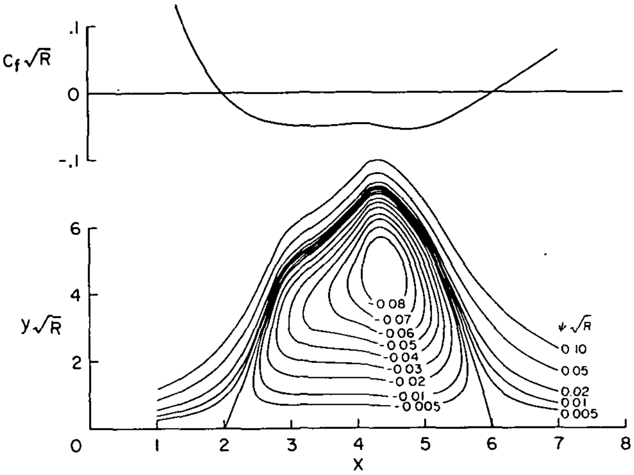

Figure 9.- Streamlines for specified shear distribution.

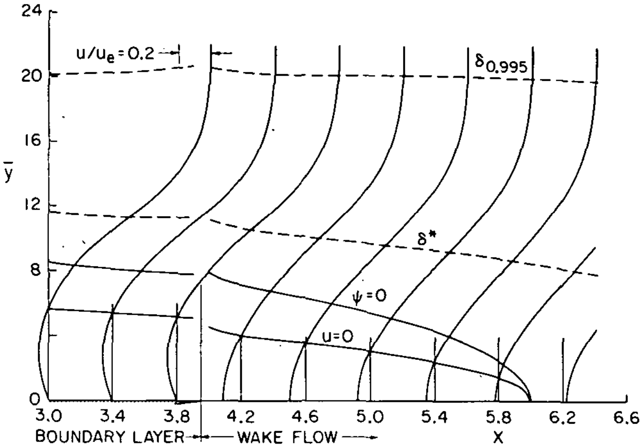

Figure 10.- Velocity profiles for trailing-edge flow.

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.

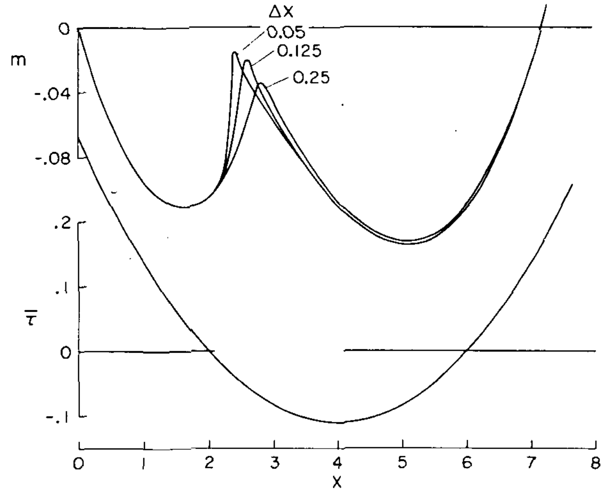

Figure 11.- Evidence of weak solutions for highly separated flow.

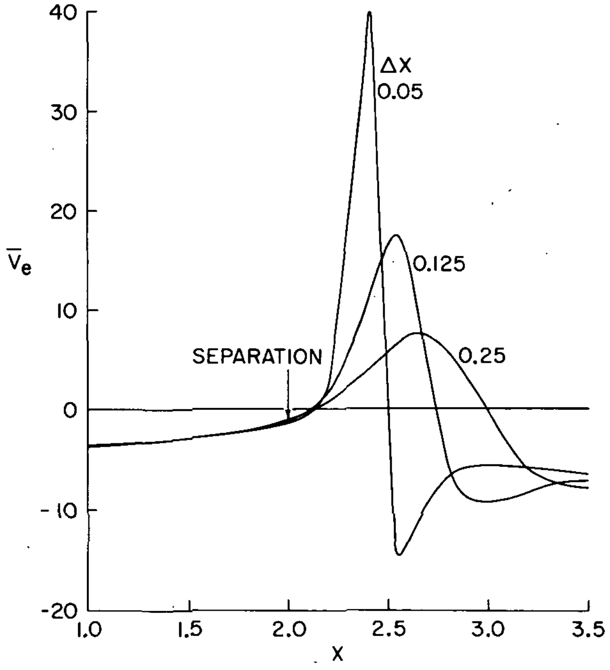

Figure 12.- Normal velocity distribution for highly separated flow.

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.

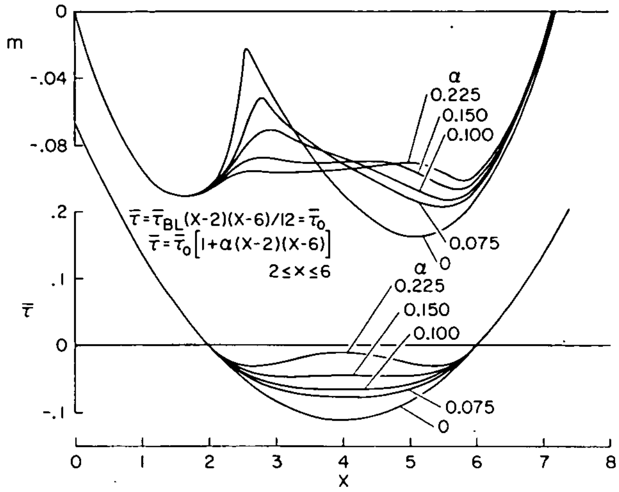

Figure 13.- Effect of shear variation in separated region.

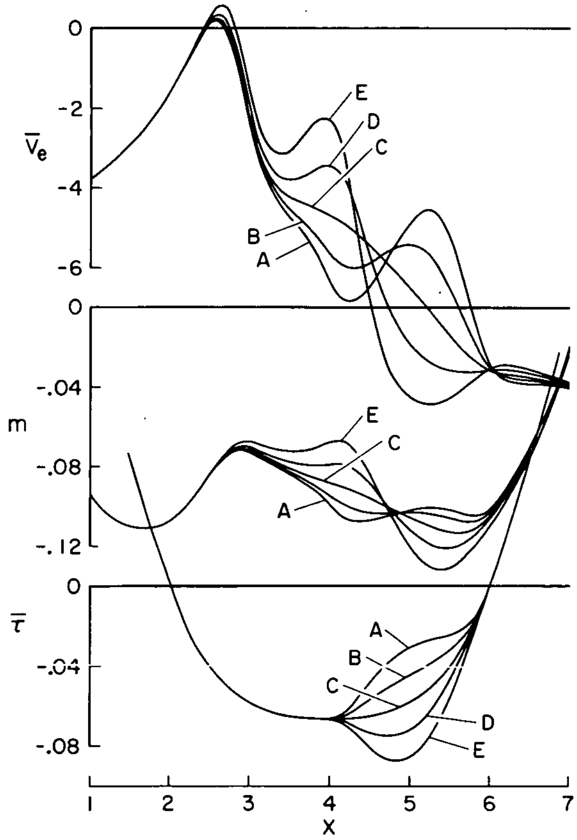

Figure 14.- Effect of shear variation in vicinity of reattachment.

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.

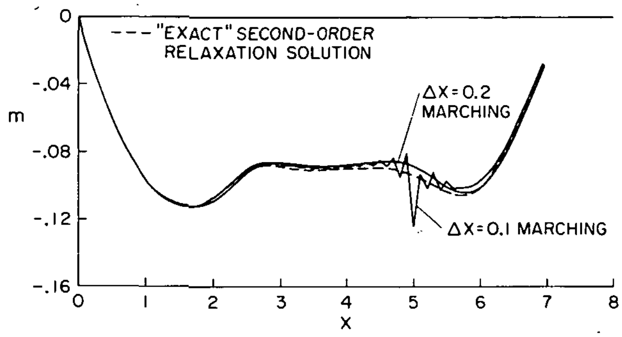

Figure 15.- Comparison with forward-marching procedure.

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:

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

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

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

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:

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

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

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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, $3 \leq \text{JMAX} \leq 120$
KMAX = maximum number of points in y, $4 \leq \text{KMAX} \leq 100$
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   , UEXO ,
     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   , UEX0 ,
     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) = UEX0
      F(1) = ALOG(UEX0)
      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   -1,11592E-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
                                                                                          INTERPOLATED
 K   ETA       U          V              Y         UST        VST         PSI           PSI       Y          Y
 1  0.000   0.000000   0.000000      0.000000   0.000000    0.000000   0.000000       0.0000   0.00000
 2   .240    .079721   -.004783       .000759    .079721    1.512570    .000030        .0050    .01016
 3   .480    .159351   -.019125       .001518    .159351    6.046137    .000121        .0100    .01542
 4   .720    .238629   -.043000       .002277    .238629   13.568177    .000272        .0150    .02044
 5   .960    .317094   -.076346       .003036    .317094   23.988683    .000483        .0200    .02544
 6  1.200    .394136   -.119024       .003795    .394136   37.143304    .000753        .0250    .03044
 7  1.440    .469015   -.170811       .004554    .469015   52.771958    .001080        .0300    .03544
 8  1.680    .540885   -.231401       .005313    .540885   70.500395    .001464        .0350    .04044
 9  1.920    .608863   -.300391       .006072    .608863   89.845902    .001900        .0400    .04544
10  2.160    .672113   -.377245       .006831    .672113  110.248742    .002386        .0450    .05044
11  2.400    .729876   -.461360       .007589    .729876  131.073778    .002918        .0500    .05544
12  2.640    .781573   -.552047       .008348    .781573  151.672110    .003492        .1000    .10544
13  2.880    .826843   -.648554       .009107    .826843  171.427126    .004102        .1500    .15544
14  3.120    .865576   -.750093       .009866    .865576  189.801730    .004744        .2000    .20544
15  3.360    .897908   -.855898       .010625    .897908  206.366305    .005413        .2500    .25544
16  3.600    .924218   -.965218       .011384    .924218  220.845149    .006105        .3000    .30544
17  3.840    .945066  -1.077369       .012143    .945066  233.109622    .006814        .3500    .35544
18  4.080    .961141  -1.191736       .012902    .961141  243.176456    .007537        .4000    .40544
19  4.320    .973200  -1.307792       .013661    .973200  251.186190    .008271        .4500    .45544
20  4.560    .981988  -1.425101       .014420    .981988  257.356443    .009013        .5000    .50544
21  4.800    .988209  -1.543308       .015179    .988209  261.961209    .009761       1.0000   1.00544
22  5.040    .992490  -1.662149       .015938    .992490  265.291613    .010513       1.5000   1.50544
23  5.280    .995344  -1.781421       .016697    .995344  267.619265    .011267       2.0000   2.00544
24  5.520    .997198  -1.900972       .017456    .997198  269.202597    .012023       2.5000   2.50544
25  5.760    .998356  -2.020702       .018215    .998356  270.236148    .012780       3.0000   3.00544
26  6.000    .999060  -2.140550       .018974    .999060  270.890191    .013538       3.5000   3.50544
27  6.240    .999476  -2.260463       .019733    .999476  271.292966    .014297       4.0000   4.00544
28  6.480    .999715  -2.380413       .020492    .999715  271.533033    .015055       4.5000   4.50544
29  6.720    .999848  -2.500383       .021251    .999848  271.672945    .015814       5.0000   5.00544
30  6.960    .999921  -2.620371       .022009    .999921  271.752181    .016573       6.0000   6.00544
31  7.200    .999955  -2.740371       .022768    .999955  271.787165    .017332       7.0000   7.00544
32  7.440    .999976  -2.860361       .023527    .999976  271.813465    .018091       8.0000   8.00544
33  7.680    .999988  -2.980360       .024286    .999988  271.827718    .018850       9.0000   9.00544
34  7.920    .999990  -3.100360       .025045    .999990  271.829514    .019609      10.0000  10.00544
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
```

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X(J) =      .50000  DELSTR =    1.453258
                                                                                            INTERPOLATED
 K    ETA        U          V            Y          UST        VST        PSI              PSI        Y          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
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X(J) =      1.00000  DELSTR =     2.458977
                                                                                                        INTERPOLATED
  K    ETA         U           V              Y            UST         VST          PSI                 PSI       Y          Y
  1   0.000     0.000000    0.000000       0.000000     0.000000    0.000000     0.000000             0.0000    0.00000
  2    .240      .035955     .002658        .253497      .032229     .006989      .004085               .0050     .27416
  3    .480      .077305     .009985        .506994      .069292     .028682      .016952               .0100     .37994
  4    .720      .123854     .020670        .760492      .111016     .065781      .039806               .0150     .47367
  5    .960      .175262     .033375       1.013989      .157095     .118788      .073789               .0200     .54466
  6   1.200      .231024     .046720       1.267486      .207078     .187896      .119947               .0250     .60387
  7   1.440      .290468     .059294       1.520983      .260360     .272891      .179195               .0300     .65990
  8   1.680      .352747     .069661       1.774481      .316184     .373053      .252271               .0350     .71272
  9   1.920      .416857     .076392       2.027978      .373649     .487085      .339706               .0400     .76210
 10   2.160      .481664     .078095       2.281475      .431738     .613082      .441787               .0450     .80291
 11   2.400      .545944     .073470       2.534972      .489355     .748554      .558535               .0500     .84249
 12   2.640      .608448     .061361       2.788470      .545380     .890501      .689686               .1000    1.16396
 13   2.880      .667973     .040816       3.041967      .598736    1.035562      .834701               .1500    1.40144
 14   3.120      .723437     .011142       3.295464      .648450    1.180219      .992780               .2000    1.59702
 15   3.360      .773949    -.028057       3.548961      .693727    1.321034     1.162899               .2500    1.76717
 16   3.600      .818872    -.076859       3.802458      .733993    1.454894     1.343861               .3000    1.91702
 17   3.840      .857852    -.135024       4.055956      .768933    1.579238     1.534355               .3500    2.05489
 18   4.080      .890828    -.202028       4.309453      .798491    1.692216     1.733023               .4000    2.18130
 19   4.320      .918008    -.277109       4.562950      .822853    1.792772     1.938527               .4500    2.30016
 20   4.560      .939822    -.359342       4.816447      .842406    1.880639     2.149596               .5000    2.41115
 21   4.800      .956863    -.447707       5.069945      .857681    1.956253     2.365080              1.0000    3.30652
 22   5.040      .969815    -.541167       5.323442      .869290    2.020604     2.583971              1.5000    4.01099
 23   5.280      .979391    -.638729       5.576939      .877874    2.075055     2.805421              2.0000    4.63731
 24   5.520      .986277    -.739493       5.830436      .884046    2.121161     3.028742              2.5000    5.22654
 25   5.760      .991090    -.842677       6.083934      .888361    2.160504     3.253392              3.0000    5.79789
 26   6.000      .994363    -.947638       6.337431      .891294    2.194568     3.478961              3.5000    6.36103
 27   6.240      .996525   -1.053861       6.590928      .893232    2.224662     3.705147              4.0000    6.92073
 28   6.480      .997913   -1.160956       6.844425      .894476    2.251871     3.931737              4.5000    7.47914
 29   6.720      .998780   -1.268633       7.097922      .895253    2.277057     4.158582              5.0000    8.03713
 30   6.960      .999306   -1.376689       7.351420      .895724    2.300871     4.385586              6.0000    9.15281
 31   7.200      .999616   -1.484983       7.604917      .896002    2.323784     4.612685              7.0000   10.26846
 32   7.440      .999793   -1.593423       7.858414      .896161    2.346126     4.839839              8.0000   11.38409
 33   7.680      .999892   -1.701949       8.111911      .896250    2.368116     5.067025              9.0000   12.49973
 34   7.920      .999945   -1.810525       8.365409      .896298    2.389898     5.294228             10.0000   13.61537
 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
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X(J) =      1.50000  DELSTR =    3.606936
                                                                                                  INTERPOLATED
  K    ETA         U           V              Y          UST         VST         PSI          PSI          Y          Y
  1   0.000    0.000000    0.000000       0.000000    0.000000    0.000000    0.000000      0.0000     0.00000
  2    .240     .018125     .004952        .317053     .015578     .005576     .002470       .0050      .42509
  3    .480     .042565     .019336        .634107     .036585     .023221     .010739       .0100      .61000
  4    .720     .073229     .042178        .951160     .062941     .054081     .026516       .0150      .72864
  5    .960     .109938     .072422       1.268214     .094492     .099166     .051474       .0200      .83116
  6   1.200     .152406     .108893       1.585267     .130994     .159273     .087219       .0250      .92461
  7   1.440     .200222     .150259       1.902320     .172092     .234886     .135266       .0300     1.00014
  8   1.680     .252822     .195018       2.219374     .217302     .326087     .196996       .0350     1.06776
  9   1.920     .309481     .241482       2.536427     .266001     .432463     .273612       .0400     1.13223
 10   2.160     .369307     .287794       2.853481     .317421     .553024     .366100       .0450     1.19353
 11   2.400     .431250     .331964       3.170534     .370662     .686165     .475180       .0500     1.25168
 12   2.640     .494132     .371927       3.487588     .424709     .829656     .601268       .1000     1.67561
 13   2.880     .556692     .405630       3.804641     .478480     .980700     .744447       .1500     1.98299
 14   3.120     .617647     .431130       4.121694     .530871    1.136049     .904456       .2000     2.23273
 15   3.360     .675767     .446709       4.438748     .580826    1.292178    1.080690       .2500     2.44397
 16   3.600     .729951     .450978       4.755801     .627397    1.445515    1.272226       .3000     2.63140
 17   3.840     .779302     .442970       5.072855     .669815    1.592688    1.477868       .3500     2.80147
 18   4.080     .823180     .422192       5.389908     .707529    1.730767    1.696214       .4000     2.95626
 19   4.320     .861236     .388647       5.706961     .740238    1.857462    1.925724       .4500     3.10087
 20   4.560     .893413     .342805       6.024015     .767893    1.971257    2.164803       .5000     3.23575
 21   4.800     .919919     .285532       6.341068     .790676    2.071456    2.411878      1.0000     4.29660
 22   5.040     .941186     .217997       6.658122     .808955    2.158136    2.665462      1.5000     5.10568
 23   5.280     .957798     .141558       6.975175     .823233    2.232037    2.924207      2.0000     5.80654
 24   5.520     .970427     .057643       7.292229     .834087    2.294393    3.186937      2.5000     6.45196
 25   5.760     .979770    -.032346       7.609282     .842118    2.346745    3.452660      3.0000     7.06700
 26   6.000     .986496    -.127113       7.926335     .847899    2.390766    3.720573      3.5000     7.66544
 27   6.240     .991206    -.225524       8.243389     .851947    2.428102    3.990044      4.0000     8.25507
 28   6.480     .994415    -.326625       8.560442     .854705    2.460262    4.260594      4.5000     8.84028
 29   6.720     .996542    -.429655       8.877496     .856533    2.488555    4.531871      5.0000     9.42343
 30   6.960     .997912    -.534023       9.194549     .857712    2.514053    4.803625      6.0000    10.58761
 31   7.200     .998772    -.639294       9.511602     .858451    2.537597    5.075682      7.0000    11.75114
 32   7.440     .999296    -.745156       9.828656     .858901    2.559819    5.347928      8.0000    12.91461
 33   7.680     .999607    -.851393      10.145709     .859168    2.581174    5.620288      9.0000    14.07807
 34   7.920     .999786    -.957860      10.462763     .859322    2.601980    5.892715     10.0000    15.24153
 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
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X(J) =     1.87500  DELSTR =     4.652430
                                                                                                     INTERPOLATED
 K    ETA         U          V              Y          UST         VST         PSI             PSI         Y              Y
 1   0.000    0.000000   0.000000       0.000000    0.000000    0.000000    0.000000          0.0000     0.00000
 2    .240     .006572    .006111        .358878     .005511     .004672     .000989           .0050      .72247
 3    .480     .019427    .024310        .717755     .016290     .019716     .004901           .0100      .94123
 4    .720     .038542    .054297       1.076633     .032320     .046604     .013623           .0150     1.11277
 5    .960     .063861    .095669       1.435511     .053551     .086717     .029032           .0200     1.23730
 6   1.200     .095273    .147865       1.794389     .079891     .141288     .052976           .0250     1.35129
 7   1.440     .132590    .210108       2.153266     .111184     .211324     .087263           .0300     1.45175
 8   1.680     .175518    .281347       2.512144     .147181     .297516     .133623           .0350     1.53329
 9   1.920     .223632    .360212       2.871022     .187528     .400143     .193683           .0400     1.61095
10   2.160     .276352    .444984       3.229899     .231736     .518976     .268916           .0450     1.68473
11   2.400     .332929    .533586       3.588777     .279179     .653189     .360594           .0500     1.75462
12   2.640     .392444    .623604       3.947655     .329085     .801298     .469740           .1000     2.25897
13   2.880     .453822    .712353       4.306532     .380554     .961144     .597077           .1500     2.61637
14   3.120     .515864    .796967       4.665410     .432579    1.129919     .742984           .2000     2.90339
15   3.360     .577300    .874534       5.024288     .484097    1.304273     .907472           .2500     3.14513
16   3.600     .636858    .942257       5.383166     .534039    1.480472    1.090165           .3000     3.35746
17   3.840     .693336    .997622       5.742043     .581400    1.654624    1.290318           .3500     3.54999
18   4.080     .745688   1.038561       6.100921     .625299    1.822939    1.506847           .4000     3.72381
19   4.320     .793084   1.063589       6.459799     .665043    1.981993    1.738384           .4500     3.88625
20   4.560     .834965   1.071886       6.818676     .700162    2.128968    1.983355           .5000     4.03679
21   4.800     .871061   1.063327       7.177554     .730432    2.261830    2.240060          1.0000     5.20978
22   5.040     .901392   1.038439       7.536432     .755866    2.379420    2.506759          1.5000     6.08992
23   5.280     .926228    .998312       7.895310     .776691    2.481456    2.781759          2.0000     6.84235
24   5.520     .946036    .944461       8.254187     .793302    2.568444    3.063477          2.5000     7.52747
25   5.760     .961423    .878667       8.613065     .806205    2.641525    3.350491          3.0000     8.17390
26   6.000     .973060    .802823       8.971943     .815963    2.702280    3.641571          3.5000     8.79786
27   6.240     .981627    .718793       9.330820     .823147    2.752530    3.935691          4.0000     9.40886
28   6.480     .987768    .628308       9.689698     .828296    2.794154    4.232024          4.5000    10.01258
29   6.720     .992052    .532887      10.048576     .831888    2.828942    4.529925          5.0000    10.61239
30   6.960     .994960    .433809      10.407454     .834328    2.858499    4.828909          6.0000    11.80720
31   7.200     .996883    .332102      10.766331     .835940    2.884181    5.128620          7.0000    13.00009
32   7.440     .998119    .228561      11.125209     .836976    2.907086    5.428806          8.0000    14.19266
33   7.680     .998894    .123778      11.484087     .837626    2.928064    5.729295          9.0000    15.38520
34   7.920     .999365    .018179      11.842964     .838021    2.947745    6.029971         10.0000    16.57773
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
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X(J) =     2.00000  DELSTR =     5.055079
                                                                                                   INTERPOLATED
  K    ETA         U          V              Y           UST         VST         PSI              PSI        Y          Y
  1   0.000    0.000000   0.000000       0.000000    0.000000    0.000000    0.000000           0.0000    0.00000
  2    .240     .003070    .006252        .371942     .002556     .004297     .000475            .0050     .88699
  3    .480     .012279    .025039        .743883     .010225     .018261     .002852            .0100    1.15025
  4    .720     .027624    .056396       1.115825     .023003     .043491     .009032            .0150    1.31643
  5    .960     .049082    .100251       1.487766     .040872     .081511     .020911            .0200    1.46314
  6   1.200     .076598    .156364       1.859708     .063786     .133713     .040374            .0250    1.57402
  7   1.440     .110056    .224264       2.231649     .091647     .201291     .069280            .0300    1.67363
  8   1.680     .149253    .303183       2.603591     .124287     .285155     .109437            .0350    1.76678
  9   1.920     .193872    .391997       2.975532     .161443     .385837     .162575            .0400    1.85348
 10   2.160     .243453    .489178       3.347474     .202730     .503392     .230300            .0450    1.92509
 11   2.400     .297374    .592769       3.719415     .247631     .637299     .314054            .0500    1.99326
 12   2.640     .354839    .700387       4.091357     .295485     .786385     .415058            .1000    2.52321
 13   2.880     .414883    .809259       4.463298     .345485     .948779     .534260            .1500    2.89388
 14   3.120     .476390    .916307       4.835240     .396703    1.121917     .672285            .2000    3.18894
 15   3.360     .538136   1.018277       5.207181     .448121    1.302604     .829397            .2500    3.44014
 16   3.600     .598846   1.111895       5.579123     .498676    1.487152    1.005474            .3000    3.66102
 17   3.840     .657266   1.194064       5.951064     .547324    1.671578    1.199999            .3500    3.85775
 18   4.080     .712245   1.262055       6.323006     .593106    1.851853    1.412086            .4000    4.03921
 19   4.320     .762806   1.313687       6.694947     .635210    2.024182    1.640517            .4500    4.20526
 20   4.560     .808213   1.347467       7.066889     .673022    2.185264    1.883810            .5000    4.36121
 21   4.800     .848008   1.362667       7.438830     .706160    2.332521    2.140297           1.0000    5.56806
 22   5.040     .882024   1.359330       7.810772     .734486    2.464238    2.408215           1.5000    6.46876
 23   5.280     .910369   1.338211       8.182713     .758090    2.579621    2.685790           2.0000    7.23730
 24   5.520     .933387   1.300651       8.554655     .777257    2.678753    2.971320           2.5000    7.93489
 25   5.760     .951595   1.248421       8.926596     .792420    2.762474    3.263234           3.0000    8.59147
 26   6.000     .965624   1.183540       9.298538     .804102    2.832198    3.560141           3.5000    9.22358
 27   6.240     .976150   1.108105       9.670479     .812867    2.889712    3.860849           4.0000    9.84130
 28   6.480     .983839   1.024146      10.042421     .819270    2.936968    4.164379           4.5000   10.45082
 29   6.720     .989308    .933518      10.414362     .823825    2.975912    4.469947           5.0000   11.05576
 30   6.960     .993095    .837834      10.786304     .826978    3.008351    4.776948           6.0000   12.25969
 31   7.200     .995648    .738430      11.158245     .829104    3.035866    5.084931           7.0000   13.46110
 32   7.440     .997324    .636372      11.530187     .830500    3.059775    5.393569           8.0000   14.66205
 33   7.680     .998395    .532475      11.902128     .831391    3.081126    5.702632           9.0000   15.86293
 34   7.920     .999061    .427341      12.274070     .831946    3.100719    6.011964          10.0000   17.06380
 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
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X(J) =     2.12500  DELSTR =    5.488996
                                                                                                        INTERPOLATED
  K   ETA        U           V             Y           UST         VST         PSI                 PSI         Y          Y
  1  0.000    0.000000    0.000000      0.000000    0.000000    0.000000    0.000000            0.0000      .39345
  2   .240    -.000112     .006051       .384607    -.000093     .003767    -.000018             .0050     1.17815
  3   .480     .005683     .024449       .769214     .004702     .016195     .000869             .0100     1.41920
  4   .720     .017395     .055656      1.153820     .014393     .039038     .004541             .0150     1.59961
  5   .960     .035043     .100044      1.538427     .028996     .074001     .012885             .0200     1.73556
  6  1.200     .058622     .157813      1.923034     .048507     .122676     .027789             .0250     1.85930
  7  1.440     .088089     .228908      2.307641     .072890     .186475     .051134             .0300     1.96359
  8  1.680     .123333     .312956      2.692248     .102053     .266561     .084776             .0350     2.05213
  9  1.920     .164145     .409191      3.076855     .135823     .363749     .130521             .0400     2.13624
 10  2.160     .210191     .516392      3.461461     .173925     .478407     .190086             .0450     2.21592
 11  2.400     .260985     .632840      3.846068     .215955     .610358     .265062             .0500     2.29118
 12  2.640     .315869     .756295      4.230675     .261370     .758783     .356853             .1000     2.82885
 13  2.880     .374009     .884017      4.615282     .309478     .922157     .466629             .1500     3.21033
 14  3.120     .434400    1.012824      4.999889     .359449    1.098224     .595266             .2000     3.51595
 15  3.360     .495896    1.139207      5.384496     .410335    1.284026     .743298             .2500     3.77389
 16  3.600     .557256    1.259481      5.769102     .461107    1.476001     .910879             .3000     3.99923
 17  3.840     .617207    1.369990      6.153709     .510715    1.670154    1.097764             .3500     4.20394
 18  4.080     .674523    1.467323      6.538316     .558142    1.862285    1.303308             .4000     4.38804
 19  4.320     .728102    1.548536      6.922923     .602476    2.048266    1.526499             .4500     4.56036
 20  4.560     .777037    1.611344      7.307530     .642968    2.224325    1.766002             .5000     4.71956
 21  4.800     .820677    1.654261      7.692136     .679078    2.387309    2.020236            1.0000     5.95666
 22  5.040     .858653    1.676666      8.076743     .710501    2.534878    2.287457            1.5000     6.87858
 23  5.280     .890884    1.678788      8.461350     .737172    2.665628    2.565849            2.0000     7.66219
 24  5.520     .917553    1.661620      8.845957     .759239    2.779102    2.853614            2.5000     8.37149
 25  5.760     .939059    1.626766      9.230564     .777035    2.875711    3.149045            3.0000     9.03749
 26  6.000     .955955    1.576256      9.615171     .791016    2.956589    3.450586            3.5000     9.67752
 27  6.240     .968886    1.512348      9.999777     .801716    3.023384    3.756874            4.0000    10.30181
 28  6.480     .978525    1.437347     10.384384     .809691    3.078054    4.066753            4.5000    10.91685
 29  6.720     .985522    1.353450     10.768991     .815481    3.122658    4.379279            5.0000    11.52670
 30  6.960     .990469    1.262640     11.153598     .819574    3.159194    4.693706            6.0000    12.73918
 31  7.200     .993874    1.166622     11.538205     .822392    3.189479    5.009461            7.0000    13.94847
 32  7.440     .996156    1.066795     11.922812     .824280    3.215077    5.326122            8.0000    15.15711
 33  7.680     .997646     .964267     12.307418     .825513    3.237273    5.643383            9.0000    16.36564
 34  7.920     .998594     .859878     12.692025     .826297    3.257074    5.961032           10.0000    17.57416
 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
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X(J) =     2.25000  DELSTR =     5.954823
                                                                                            INTERPOLATED
  K      ETA           U           V             Y         UST         VST         PSI          PSI         Y           Y
  1    0.000    0.000000    0.000000      0.000000    0.000000    0.000000    0.000000       0.0000   1.15596
  2     .240    -.002856     .005651       .396888    -.002350     .003190    -.000466        .0050   1.56507
  3     .480    -.000126     .023045       .793775    -.000103     .013915    -.000953        .0100   1.77948
  4     .720     .008215     .053037      1.190663     .006759     .034033     .000367        .0150   1.95840
  5     .960     .022204     .096425      1.587551     .018268     .065378     .005334        .0200   2.08762
  6    1.200     .041895     .153876      1.984439     .034469     .109723     .015800        .0250   2.20266
  7    1.440     .067313     .225818      2.381326     .055382     .168700     .033630        .0300   2.30925
  8    1.680     .098435     .312355      2.778214     .080988     .243727     .060692        .0350   2.40372
  9    1.920     .135165     .413191      3.175102     .111207     .335926     .098832        .0400   2.48336
 10    2.160     .177297     .527538      3.571989     .145872     .446012     .149847        .0450   2.55974
 11    2.400     .224489     .654050      3.968877     .184699     .574189     .215447        .0500   2.63285
 12    2.640     .276234     .790779      4.365765     .227273     .720044     .297200        .1000   3.18506
 13    2.880     .331848     .935165      4.762653     .273029     .882460     .396482        .1500   3.57299
 14    3.120     .390463    1.084065      5.159540     .321254    1.059564     .514414        .2000   3.88171
 15    3.360     .451043    1.233847      5.556428     .371097    1.248724     .651807        .2500   4.14434
 16    3.600     .512420    1.380529      5.953316     .421596    1.446603     .809112        .3000   4.37774
 17    3.840     .573343    1.519972      6.350204     .471720    1.649297     .986385        .3500   4.58398
 18    4.080     .632546    1.648118      6.747091     .520429    1.852532    1.183271        .4000   4.77524
 19    4.320     .688832    1.761238      7.143979     .566739    2.051925    1.399013        .4500   4.94920
 20    4.560     .741146    1.856180      7.540867     .609780    2.243278    1.632486        .5000   5.11382
 21    4.800     .788647    1.930566      7.937754     .648862    2.422869    1.882256       1.0000   6.37871
 22    5.040     .830758    1.982936      8.334642     .683509    2.587698    2.146657       1.5000   7.31872
 23    5.280     .867187    2.012791      8.731530     .713481    2.735665    2.423881       2.0000   8.11671
 24    5.520     .897923    2.020563      9.128418     .738769    2.865657    2.712071       2.5000   8.83753
 25    5.760     .923208    2.007492      9.525305     .759573    2.977525    3.009408       3.0000   9.51289
 26    6.000     .943482    1.975452      9.922193     .776253    3.071975    3.314183       3.5000  10.16026
 27    6.240     .959323    1.926737     10.319081     .789286    3.150395    3.624855       4.0000  10.79083
 28    6.480     .971382    1.863846     10.715968     .799208    3.214637    3.940081       4.5000  11.41120
 29    6.720     .980325    1.789290     11.112856     .806565    3.266800    4.258737       5.0000  12.02563
 30    6.960     .986785    1.705435     11.509744     .811881    3.309033    4.579908       6.0000  13.24612
 31    7.200     .991331    1.614393     11.906632     .815621    3.343377    4.902875       7.0000  14.46263
 32    7.440     .994446    1.517963     12.303519     .818184    3.371658    5.227094       8.0000  15.67824
 33    7.680     .996526    1.417613     12.700407     .819895    3.395427    5.552161       9.0000  16.89370
 34    7.920     .997879    1.314495     13.097295     .821008    3.415942    5.877788      10.0000  18.10913
 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
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X(J) =     2.37500  DELSTR =     6.453745
                                                                                           INTERPOLATED
  K    ETA        U          V              Y          UST         VST         PSI          PSI        Y          Y
  1   0.000    0.000000   0.000000      0.000000    0.000000    0.000000    0.000000      0.0000    1.75770
  2    .240    -.005201    .005219       .408799    -.004258     .002665    -.000870       .0050    2.06014
  3    .480    -.005183    .021457       .817598    -.004243     .011801    -.002608       .0100    2.23675
  4    .720     .000084    .049859      1.226396     .000069     .029291    -.003461       .0150    2.39389
  5    .960     .010652    .091526      1.635195     .008720     .057007    -.001665       .0200    2.51790
  6   1.200     .026601    .147491      2.043994     .021775     .096808     .004569       .0250    2.62337
  7   1.440     .048018    .218616      2.452793     .039307     .150480     .017054       .0300    2.72251
  8   1.680     .074960    .305473      2.861591     .061361     .219650     .037631       .0350    2.81531
  9   1.920     .107430    .408257      3.270390     .087942     .305707     .068148       .0400    2.89675
 10   2.160     .145351    .526683      3.679189     .118983     .409706     .110443       .0450    2.96905
 11   2.400     .188524    .659895      4.087988     .154324     .532247     .166307       .0500    3.03879
 12   2.640     .236605    .806377      4.496786     .193683     .673359     .237440       .1000    3.58621
 13   2.880     .289074    .963915      4.905585     .236633     .832394     .325396       .1500    3.97663
 14   3.120     .345224   1.129588      5.314384     .282597    1.007944     .431526       .2000    4.29034
 15   3.360     .404164   1.299827      5.723183     .330845    1.197801     .556914       .2500    4.55905
 16   3.600     .464832   1.470528      6.131981     .380507    1.398978     .702313       .3000    4.79407
 17   3.840     .526041   1.637230      6.540780     .430612    1.607794     .868106       .3500    5.00548
 18   4.080     .586533   1.795351      6.949579     .480131    1.820040    1.054261       .4000    5.19896
 19   4.320     .645053   1.940455      7.358378     .528035    2.031211    1.260329       .4500    5.37789
 20   4.560     .700430   2.068536      7.767176     .573366    2.236792    1.485455       .5000    5.54409
 21   4.800     .751652   2.176281      8.175975     .615296    2.432559    1.728416      1.0000    6.83429
 22   5.040     .797936   2.261277      8.584774     .653183    2.614872    1.987693      1.5000    7.79235
 23   5.280     .838766   2.322136      8.993573     .686606    2.780910    2.261545      2.0000    8.60353
 24   5.520     .873914   2.358531      9.402371     .715378    2.928820    2.548109      2.5000    9.33476
 25   5.760     .903428   2.371126      9.811170     .739538    3.057769    2.845493      3.0000   10.01851
 26   6.000     .927594   2.361430     10.219969     .759320    3.167895    3.151859      3.5000   10.67320
 27   6.240     .946884   2.331594     10.628768     .775111    3.260169    3.465496      4.0000   11.30964
 28   6.480     .961890   2.284173     11.037566     .787395    3.336198    3.784871      4.5000   11.93503
 29   6.720     .973267   2.221895     11.446365     .796708    3.398004    4.108661      5.0000   12.55380
 30   6.960     .981671   2.147465     11.855164     .803587    3.447801    4.435760      6.0000   13.78166
 31   7.200     .987721   2.063398     12.263963     .808539    3.487805    4.765278      7.0000   15.00471
 32   7.440     .991963   1.971921     12.672761     .812012    3.520084    5.096517      8.0000   16.22659
 33   7.680     .994862   1.874915     13.081560     .814385    3.546466    5.428952      9.0000   17.44824
 34   7.920     .996792   1.773902     13.490359     .815965    3.568485    5.762195     10.0000   18.66986
 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
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X(J) =     2.50000  DELSTR =    6.982925
                                                                                       INTERPOLATED
  K     ETA          U          V             Y        UST        VST        PSI            PSI         Y          Y
  1   0.000   0.000000   0.000000      0.000000   0.000000   0.000000   0.000000       -.0050   2.15445     .87715
  2    .240   -.007186    .004757       .420358   -.005856    .002182   -.001231       0.0000   2.44317
  3    .480   -.009543    .019669       .840715   -.007777    .009813   -.004096        .0050   2.63298
  4    .720   -.007037    .046016      1.261073   -.005735    .024705   -.006936        .0100   2.78340
  5    .960    .000392    .085055      1.681431    .000320    .048678   -.008074        .0150   2.91895
  6   1.200    .012832    .138006      2.101789    .010457    .083557   -.005809        .0200   3.02448
  7   1.440    .030413    .206024      2.522146    .024785    .131176    .001598        .0250   3.12059
  8   1.680    .053257    .290046      2.942504    .043401    .193278    .015929        .0300   3.21165
  9   1.920    .081451    .390665      3.362862    .066377    .271427    .039002        .0350   3.29766
 10   2.160    .115027    .508062      3.783219    .093740    .366937    .072655        .0400   3.37670
 11   2.400    .153924    .641890      4.203577    .125438    .480765    .118722        .0450   3.44478
 12   2.640    .197954    .791158      4.623935    .161321    .613377    .178993        .0500   3.51075
 13   2.880    .246772    .954148      5.044292    .201104    .764627    .255167        .1000   4.04309
 14   3.120    .299847   1.128364      5.464650    .244356    .933643    .348793        .1500   4.43140
 15   3.360    .356453   1.310542      5.885008    .290487   1.118758    .461206        .2000   4.74688
 16   3.600    .415673   1.496727      6.305366    .338748   1.317478    .593457        .2500   5.01800
 17   3.840    .476425   1.682418      6.725723    .388257   1.526529    .746258        .3000   5.25355
 18   4.080    .537501   1.862782      7.146081    .438030   1.741969    .919926        .3500   5.46947
 19   4.320    .597636   2.032925      7.566439    .487036   1.959384   1.114356        .4000   5.66332
 20   4.560    .655581   2.188192      7.986796    .534258   2.174146   1.329010        .4500   5.84571
 21   4.800    .710187   2.324471      8.407154    .578758   2.381714   1.562942        .5000   6.01375
 22   5.040    .760481   2.438461      8.827512    .619745   2.577942   1.814842       1.0000   7.32376
 23   5.280    .805728   2.527870      9.247869    .656618   2.759360   2.083107       1.5000   8.29689
 24   5.520    .845469   2.591520      9.668227    .689005   2.923388   2.365928       2.0000   9.11990
 25   5.760    .879532   2.629351     10.088585    .716764   3.068456   2.661391       2.5000   9.86076
 26   6.000    .908011   2.642320     10.508943    .739973   3.194025   2.967566       3.0000  10.55265
 27   6.240    .931233   2.632225     10.929300    .758897   3.300506   3.282597       3.5000  11.21374
 28   6.480    .949695   2.601473     11.349658    .773943   3.389099   3.604768       4.0000  11.85572
 29   6.720    .964004   2.552833     11.770016    .785603   3.461586   3.932551       4.5000  12.48575
 30   6.960    .974812   2.489199     12.190373    .794411   3.520101   4.264637       5.0000  13.10853
 31   7.200    .982770   2.413386     12.610731    .800897   3.566918   4.599937       6.0000  14.34315
 32   7.440    .988481   2.327980     13.031089    .805551   3.604267   4.937578       7.0000  15.57209
 33   7.680    .992475   2.235243     13.451446    .808805   3.634199   5.276881       8.0000  16.79955
 34   7.920    .995197   2.137067     13.871804    .811024   3.658503   5.617335       9.0000  18.02670
 35   8.160    .997005   2.034971     14.292162    .812497   3.678667   5.958565      10.0000  19.25380
 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
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X(J) =     2.62500  DELSTR =    7.525652
                                                                                                        INTERPOLATED
 K   ETA       U          V              Y         UST        VST        PSI                 PSI       Y          Y
 1  0.000   0.000000   0.000000       0.000000   0.000000   0.000000   0.000000            -.0150   2.42487   2.12359
 2   .240   -.008836    .004234        .431586   -.007172    .001719   -.001548            -.0100   2.71835   1.29314
 3   .480   -.013209    .017484        .863173   -.010722    .007824   -.005409            -.0050   2.96445    .82044
 4   .720   -.013086    .040855       1.294759   -.010623    .019897   -.010015            0.0000   3.13034
 5   .960   -.008406    .075460       1.726346   -.006823    .039545   -.013780             .0050   3.26817
 6  1.200    .000927    .122417       2.157932    .000752    .068408   -.015090             .0100   3.39427
 7  1.440    .015029    .182862       2.589518    .012200    .108170   -.012295             .0150   3.49984
 8  1.680    .034096    .257925       3.021105    .027677    .160587   -.003690             .0200   3.59067
 9  1.920    .058273    .348501       3.452691    .047302    .227312    .012490             .0250   3.67737
10  2.160    .087675    .455098       3.884278    .071169    .309802    .038055             .0300   3.75994
11  2.400    .122354    .577808       4.315864    .099319    .409273    .074846             .0350   3.83838
12  2.640    .162262    .716180       4.747450    .131714    .526576    .124701             .0400   3.90949
13  2.880    .207215    .869098       5.179037    .168204    .662058    .189422             .0450   3.97310
14  3.120    .256858   1.034691       5.610623    .208502    .815435    .270712             .0500   4.03493
15  3.360    .310644   1.210289       6.042210    .252162    .985682    .370120             .1000   4.54440
16  3.600    .367819   1.392449       6.473796    .298573   1.170967    .488965             .1500   4.92544
17  3.840    .427436   1.577052       6.905383    .346966   1.368640    .628268             .2000   5.23920
18  4.080    .488378   1.759478       7.336969    .396435   1.575294    .788689             .2500   5.50738
19  4.320    .549413   1.934851       7.768555    .445980   1.786908    .970477             .3000   5.74446
20  4.560    .609261   2.098332       8.200142    .494561   1.999064   1.173439             .3500   5.96005
21  4.800    .666678   2.245429       8.631728    .541169   2.207219   1.396942             .4000   6.15621
22  5.040    .720535   2.372300       9.063315    .584887   2.407007   1.639937             .4500   6.33872
23  5.280    .769899   2.476001       9.494901    .624957   2.594547   1.901013             .5000   6.50991
24  5.520    .814086   2.554648       9.926487    .660825   2.766693   2.178476            1.0000   7.83368
25  5.760    .852697   2.607488      10.358074    .692167   2.921221   2.470443            1.5000   8.81829
26  6.000    .885619   2.634855      10.789660    .718891   3.056911   2.774940            2.0000   9.65127
27  6.240    .913004   2.638042      11.221247    .741120   3.173538   3.090000            2.5000  10.40059
28  6.480    .935219   2.619091      11.652833    .759153   3.271757   3.413749            3.0000  11.09913
29  6.720    .952792   2.580561      12.084419    .773418   3.352938   3.744468            3.5000  11.76606
30  6.960    .966345   2.525273      12.516006    .784420   3.418947   4.080639            4.0000  12.41296
31  7.200    .976536   2.456096      12.947592    .792692   3.471928   4.420969            4.5000  13.04716
32  7.440    .984005   2.375756      13.379179    .798755   3.514102   4.764392            5.0000  13.67356
33  7.680    .989341   2.286714      13.810765    .803087   3.547604   5.110058            6.0000  14.91429
34  7.920    .993059   2.191084      14.242351    .806104   3.574369   5.457311            7.0000  16.14851
35  8.160    .995582   2.090612      14.673938    .808153   3.596059   5.805657            8.0000  17.38093
36  8.400    .997253   1.986682      15.105524    .809509   3.614041   6.154737            9.0000  18.61295
37  8.640    .998331   1.880350      15.537111    .810384   3.629395   6.504299           10.0000  19.84488
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
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X(J) =     2.75000  DELSTR =     8.043320
                                                                                              INTERPOLATED
  K    ETA        U          V             Y          UST         VST         PSI          PSI       Y          Y
  1   0.000    0.000000   0.000000      0.000000   0.000000    0.000000    0.000000      -.0200   3.08916    1.64859
  2    .240    -.010158    .003636       .442515   -.008217     .001263    -.001818      -.0150   3.31812    1.48161
  3    .480    -.016119    .014802       .885031   -.013039     .005777    -.006521      -.0100   3.51539    1.13689
  4    .720    -.017855    .034022      1.327546   -.014443     .014712    -.012601      -.0050   3.65192     .75149
  5    .960    -.015311    .061867      1.770061   -.012385     .029278    -.018537      0.0000   3.77365
  6   1.200    -.008404    .098968      2.212576   -.006798     .050742    -.022782       .0050   3.88680
  7   1.440     .002976    .146035      2.655092    .002407     .080449    -.023753       .0100   3.99005
  8   1.680     .018961    .203930      3.097607    .015337     .119869    -.019827       .0150   4.07357
  9   1.920     .039801    .273598      3.540122    .032196     .170617    -.009310       .0200   4.15392
 10   2.160     .065662    .355787      3.982637    .053115     .234221     .009565       .0250   4.23109
 11   2.400     .096670    .450938      4.425153    .078197     .312060     .038619       .0300   4.30507
 12   2.640     .132882    .559118      4.867668    .107489     .405291     .079704       .0350   4.37588
 13   2.880     .174245    .679884      5.310183    .140948     .514720     .134672       .0400   4.44158
 14   3.120     .220558    .812155      5.752698    .178411     .640658     .205333       .0450   4.50015
 15   3.360     .271440    .954131      6.195214    .219570     .782791     .293389       .0500   4.55731
 16   3.600     .326302   1.103262      6.637729    .263948     .940078     .400371       .1000   5.04107
 17   3.840     .384342   1.256292      7.080244    .310897    1.110690     .527560       .1500   5.41279
 18   4.080     .444560   1.409381      7.522759    .359608    1.292023     .675915       .2000   5.72202
 19   4.320     .505791   1.558297      7.965275    .409138    1.480775     .846005       .2500   5.98600
 20   4.560     .566767   1.698670      8.407790    .458462    1.673106    1.037969       .3000   6.22442
 21   4.800     .626193   1.826282      8.850305    .506532    1.864864    1.251481       .3500   6.43738
 22   5.040     .682831   1.937355      9.292820    .552347    2.051863    1.485766       .4000   6.63630
 23   5.280     .735589   2.028813      9.735336    .595023    2.230173    1.739630       .4500   6.81733
 24   5.520     .783592   2.098475     10.177851    .633854    2.396394    2.011528       .5000   6.98930
 25   5.760     .826236   2.145164     10.620366    .668349    2.547877    2.299650      1.0000   8.32362
 26   6.000     .863208   2.168717     11.062881    .698255    2.682867    2.602022      1.5000   9.31838
 27   6.240     .894480   2.169901     11.505397    .723552    2.800542    2.916607      2.0000  10.15958
 28   6.480     .920282   2.150257     11.947912    .744423    2.900975    3.241408      2.5000  10.91546
 29   6.720     .941042   2.111893     12.390427    .761216    2.985003    3.574542      3.0000  11.62006
 30   6.960     .957330   2.057260     12.832942    .774391    3.054050    3.914307      3.5000  12.29215
 31   7.200     .969790   1.988937     13.275458    .784470    3.109929    4.259217      4.0000  12.94334
 32   7.440     .979082   1.909451     13.717973    .791987    3.154639    4.608020      4.5000  13.58132
 33   7.680     .985839   1.821134     14.160488    .797452    3.190191    4.959695      5.0000  14.21100
 34   7.920     .990628   1.726038     14.603003    .801326    3.218477    5.313437      6.0000  15.45723
 35   8.160     .993938   1.625887     15.045519    .804004    3.241179    5.668629      7.0000  16.69620
 36   8.400     .996168   1.522075     15.488034    .805808    3.259719    6.024812      8.0000  17.93306
 37   8.640     .997633   1.415684     15.930549    .806993    3.275249    6.381656      9.0000  19.16942
 38   8.880     .998572   1.307528     16.373064    .807752    3.288666    6.738931     10.0000  20.40568
 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
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X(J) =     2.87500  DELSTR =     8.487083
                                                                                                   INTERPOLATED
 K    ETA        U          V            Y          UST        VST        PSI               PSI         Y          Y
 1   0.000    0.000000   0.000000     0.000000   0.000000   0.000000   0.000000           -.0300     3.26539    2.44480
 2    .240    -.011163    .003016      .453184   -.009001    .000838   -.002039           -.0250     3.59400    1.96216
 3    .480    -.018233    .011919      .906368   -.014702    .003830   -.007410           -.0200     3.77890    1.67436
 4    .720    -.021191    .026435     1.359552   -.017087    .009673   -.014613           -.0150     3.93637    1.38054
 5    .960    -.019997    .046352     1.812737   -.016124    .019103   -.022139           -.0100     4.07773    1.07148
 6   1.200    -.014589    .071549     2.265921   -.011764    .032927   -.028458           -.0050     4.18226     .71517
 7   1.440    -.004883    .102043     2.719105   -.003938    .052046   -.032016           0.0000     4.28148
 8   1.680     .009223    .138003     3.172289    .007437    .077478   -.031223            .0050     4.37558
 9   1.920     .027889    .179918     3.625473    .022488    .110467   -.024442            .0100     4.46455
10   2.160     .051347    .228465     4.078657    .041402    .152443   -.009965            .0150     4.54630
11   2.400     .079754    .284248     4.531841    .064308    .204814    .013988            .0200     4.61646
12   2.640     .113230    .347741     4.985026    .091300    .268928    .049247            .0250     4.68453
13   2.880     .151811    .419127     5.438210    .122409    .345949    .097672            .0300     4.75051
14   3.120     .195414    .498161     5.891394    .157567    .436714    .161112            .0350     4.81441
15   3.360     .243791    .584045     6.344578    .196575    .541592    .241358            .0400     4.87622
16   3.600     .296497    .675359     6.797762    .239073    .660350    .340073            .0450     4.93594
17   3.840     .352870    .770051     7.250946    .284528    .792064    .458717            .0500     4.99278
18   4.080     .412027    .865500     7.704130    .332228    .935072    .598469            .1000     5.45632
19   4.320     .472889    .958645     8.157315    .381303   1.087003    .760149            .1500     5.81807
20   4.560     .534231   1.046182     8.610499    .430764   1.244868    .944157            .2000     6.12051
21   4.800     .594748   1.124794     9.063683    .479561   1.405233   1.150430            .2500     6.38701
22   5.040     .653142   1.191398     9.516867    .526646   1.564443   1.378428            .3000     6.62213
23   5.280     .708218   1.243375     9.970051    .571055   1.718886   1.627158            .3500     6.83809
24   5.520     .758958   1.278761    10.423235    .611968   1.865253   1.895222            .4000     7.03452
25   5.760     .804599   1.296360    10.876420    .648769   2.000777   2.180895            .4500     7.21979
26   6.000     .844663   1.295784    11.329604    .681075   2.123402   2.482227            .5000     7.39075
27   6.240     .878976   1.277415    11.782788    .708741   2.231877   2.797148           1.0000     8.73724
28   6.480     .907637   1.242292    12.235972    .731852   2.325766   3.123575           1.5000     9.74230
29   6.720     .930984   1.191956    12.689156    .750677   2.405373   3.459505           2.0000    10.59211
30   6.960     .949527   1.128276    13.142340    .765629   2.471610   3.803087           2.5000    11.35560
31   7.200     .963887   1.053270    13.595524    .777207   2.525831   4.152682           3.0000    12.06590
32   7.440     .974727    .968951    14.048709    .785949   2.569650   4.506881           3.5000    12.74297
33   7.680     .982706    .877208    14.501893    .792382   2.604779   4.864518           4.0000    13.39832
34   7.920     .988431    .779720    14.955077    .796998   2.632890   5.224659           4.5000    14.03995
35   8.160     .992435    .677918    15.408261    .800227   2.655514   5.586577           5.0000    14.67264
36   8.400     .995166    .572967    15.861445    .802429   2.673983   5.949726           6.0000    15.92408
37   8.640     .996981    .465784    16.314629    .803893   2.689398   6.313706           7.0000    17.16747
38   8.880     .998158    .357061    16.767813    .804842   2.702638   6.678232           8.0000    18.40843
39   9.120     .998902    .247305    17.220998    .805441   2.714370   7.043110           9.0000    19.64878
40   9.360     .999361    .136876    17.674182    .805811   2.725090   7.408207          10.0000    20.88900
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
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X(J) =     3.00000  DELSTR =    8.830110
                                                                                                   INTERPOLATED
  K    ETA         U          V            Y          UST        VST         PSI             PSI        Y          Y
  1   0.000    0.000000   0.000000     0.000000   0.000000   0.000000    0.000000         -.0350   3.62082   2.06384
  2    .240    -.011893    .002469      .463635   -.009560    .000487    -.002216         -.0300   3.83279   2.15273
  3    .480    -.019648    .009406      .927269   -.015794    .002253    -.008094         -.0250   4.02176   1.86968
  4    .720    -.023252    .019883     1.390904   -.018692    .005649    -.016088         -.0200   4.18435   1.59470
  5    .960    -.022682    .033028     1.854539   -.018233    .011057    -.024648         -.0150   4.30142   1.32952
  6   1.200    -.017896    .048056     2.318174   -.014386    .018919    -.032210         -.0100   4.41189   1.04050
  7   1.440    -.008843    .064306     2.781808   -.007109    .029755    -.037193         -.0050   4.51578    .69619
  8   1.680     .004545    .081277     3.245443    .003654    .044191    -.037994         0.0000   4.61308
  9   1.920     .022344    .098717     3.709078    .017962    .063001    -.032983          .0050   4.69499
 10   2.160     .044739    .116717     4.172713    .035965    .087225    -.020482          .0100   4.77093
 11   2.400     .071873    .135646     4.636347    .057777    .118067     .001249          .0150   4.84432
 12   2.640     .103873    .155995     5.099982    .083501    .156820     .033999          .0200   4.91516
 13   2.880     .140816    .178247     5.563617    .113199    .204768     .079598          .0250   4.98346
 14   3.120     .182687    .202732     6.027252    .146859    .263057     .139884          .0300   5.04922
 15   3.360     .229332    .229485     6.490886    .184356    .332544     .216665          .0350   5.11120
 16   3.600     .280413    .258135     6.954521    .225419    .413654     .311658          .0400   5.16655
 17   3.840     .335380    .287846     7.418156    .269605    .506253     .426413          .0450   5.22074
 18   4.080     .393456    .317320     7.881791    .316292    .609568     .562234          .0500   5.27375
 19   4.320     .453649    .344859     8.345425    .364680    .722152     .720095          .1000   5.73033
 20   4.560     .514790    .368493     8.809060    .413830    .841928     .900568          .1500   6.09288
 21   4.800     .575596    .386140     9.272695    .462711    .966299    1.103765          .2000   6.39701
 22   5.040     .634752    .395788     9.736329    .510265   1.092319    1.329318          .2500   6.66182
 23   5.280     .691007    .395672    10.199964    .555488   1.216913    1.576378          .3000   6.90151
 24   5.520     .743263    .384428    10.663599    .597495   1.337113    1.843659          .3500   7.11676
 25   5.760     .790651    .361189    11.127234    .635590   1.450285    2.129510          .4000   7.31728
 26   6.000     .832586    .325636    11.590868    .669300   1.554315    2.432006          .4500   7.50297
 27   6.240     .868785    .277976    12.054503    .698400   1.647733    2.749063          .5000   7.67678
 28   6.480     .899258    .218880    12.518138    .722897   1.729758    3.078544         1.0000   9.04138
 29   6.720     .924270    .149377    12.981773    .743003   1.800274    3.418365         1.5000  10.06023
 30   6.960     .944285    .070730    13.445407    .759092   1.859738    3.766577         2.0000  10.92025
 31   7.200     .959897   -.015683    13.909042    .771643   1.909054    4.121428         2.5000  11.69174
 32   7.440     .971767   -.108484    14.372677    .781185   1.949421    4.481401         3.0000  12.40887
 33   7.680     .980566   -.206377    14.836312    .788258   1.982187    4.845225         3.5000  13.09124
 34   7.920     .986922   -.308206    15.299946    .793368   2.008722    5.211873         4.0000  13.75113
 35   8.160     .991399   -.412990    15.763581    .796967   2.030319    5.580541         4.5000  14.39646
 36   8.400     .994472   -.519928    16.227216    .799437   2.048126    5.950615         5.0000  15.03234
 37   8.640     .996528   -.628391    16.690851    .801090   2.063117    6.321645         6.0000  16.28897
 38   8.880     .997870   -.737904    17.154485    .802169   2.076077    6.693308         7.0000  17.53667
 39   9.120     .998724   -.848120    17.618120    .802855   2.087617    7.065380         8.0000  18.78158
 40   9.360     .999253   -.958794    18.081755    .803280   2.098192    7.437710         9.0000  20.02575
 41   9.600     .999573  -1.069758    18.545390    .803538   2.108130    7.810199        10.0000  21.26975
 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
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X(J) =     3.12500  DELSTR =     9.083181
                                                                                                INTERPOLATED
  K    ETA        U           V               Y           UST         VST          PSI           PSI       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
                                                                                      INTERPOLATED
  K     ETA           U           V             Y        UST        VST         PSI         PSI         Y         Y
  1   0.000    0.000000    0.000000      0.000000   0.000000   0.000000    0.000000      -.0400   3.82462   2.44111
  2    .240    -.012796     .001722       .483997   -.010226    .000034    -.002475      -.0350   4.03862   2.32887
  3    .480    -.021193     .006219       .967994   -.016936    .000369    -.009048      -.0300   4.22902   2.03993
  4    .720    -.025186     .012160      1.451991   -.020127    .001191    -.018017      -.0250   4.38672   1.79582
  5    .960    -.024767     .018242      1.935988   -.019792    .002701    -.027677      -.0200   4.50453   1.54643
  6   1.200    -.019922     .023201      2.419985   -.015920    .005125    -.036320      -.0150   4.61582   1.29290
  7   1.440    -.010632     .025823      2.903981   -.008496    .008719    -.042228      -.0100   4.72059   1.02095
  8   1.680     .003127     .024964      3.387978    .002499    .013781    -.043680      -.0050   4.81885    .68288
  9   1.920     .021383     .019563      3.871975    .017088    .020657    -.038940      0.0000   4.90120
 10   2.160     .044177     .008719      4.355972    .035304    .029789    -.026261       .0050   4.97790
 11   2.400     .071555    -.008225      4.839969    .057182    .041752    -.003880       .0100   5.05212
 12   2.640     .103554    -.031662      5.323966    .082754    .057257     .029985       .0150   5.12386
 13   2.880     .140190    -.061696      5.807963    .112031    .077155     .077122       .0200   5.19311
 14   3.120     .181429    -.098166      6.291960    .144986    .102386     .139320       .0250   5.25988
 15   3.360     .227143    -.140708      6.775957    .181518    .133902     .218334       .0300   5.32414
 16   3.600     .277070    -.188852      7.259954    .221417    .172544     .315843       .0350   5.38027
 17   3.840     .330768    -.242122      7.743950    .264329    .218904     .433393       .0400   5.43526
 18   4.080     .387585    -.300125      8.227947    .309733    .273190     .572315       .0450   5.48911
 19   4.320     .446653    -.362601      8.711944    .356936    .335133     .733648       .0500   5.54182
 20   4.560     .506908    -.429426      9.195941    .405088    .403930     .918056       .1000   5.99654
 21   4.800     .567143    -.500586      9.679938    .453224    .478270    1.125767       .1500   6.36218
 22   5.040     .626079    -.576126     10.163935    .500322    .556408    1.356524       .2000   6.67098
 23   5.280     .682463    -.656085     10.647932    .545381    .636307    1.609582       .2500   6.94134
 24   5.520     .735159    -.740442     11.131929    .587492    .715816    1.883736       .3000   7.18641
 25   5.760     .783236    -.829079     11.615926    .625912    .792851    2.177378       .3500   7.40763
 26   6.000     .826029    -.921761     12.099923    .660109    .865579    2.488593       .4000   7.61340
 27   6.240     .863174   -1.018144     12.583919    .689793    .932549    2.815267       .4500   7.80508
 28   6.480     .894607   -1.117795     13.067916    .714912    .992777    3.155204       .5000   7.98377
 29   6.720     .920532   -1.220230     13.551913    .735630   1.045774    3.506233      1.0000   9.39235
 30   6.960     .941369   -1.324949     14.035910    .752281   1.091508    3.866305      1.5000  10.44274
 31   7.200     .957688   -1.431476     14.519907    .765323   1.130336    4.233563      2.0000  11.32674
 32   7.440     .970143   -1.539377     15.003904    .775276   1.162898    4.606385      2.5000  12.11714
 33   7.680     .979404   -1.648287     15.487901    .782677   1.190011    4.983407      3.0000  12.84881
 34   7.920     .986114   -1.757906     15.971898    .788039   1.212567    5.363518      3.5000  13.54342
 35   8.160     .990853   -1.868007     16.455895    .791826   1.231449    5.745843      4.0000  14.21293
 36   8.400     .994113   -1.978420     16.939892    .794431   1.247470    6.129715      4.5000  14.86634
 37   8.640     .996299   -2.089026     17.423889    .796178   1.261336    6.514640      5.0000  15.50909
 38   8.880     .997727   -2.199747     17.907885    .797320   1.273630    6.900264      6.0000  16.77649
 39   9.120     .998637   -2.310531     18.391882    .798047   1.284813    7.286341      7.0000  18.03295
 40   9.360     .999202   -2.421349     18.875879    .798498   1.295234    7.672702      8.0000  19.28571
 41   9.600     .999544   -2.532181     19.359876    .798771   1.305149    8.059239      9.0000  20.53739
 42   9.840     .999745   -2.643020     19.843873    .798933   1.314736    8.445881     10.0000  21.78881
 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
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X(J) =     3.37500  DELSTR =    9.432014
                                                                                                       INTERPOLATED
 K    ETA        U           V              Y           UST         VST         PSI               PSI       Y          Y
 1   0.000    0.000000    0.000000       0.000000    0.000000    0.000000    0.000000          -.0400    3.93160    2.31023
 2    .240    -.013067     .001462        .493939    -.010412    -.000111    -.002571          -.0350    4.13401    2.30031
 3    .480    -.021601     .005188        .987878    -.017212    -.000196    -.009394          -.0300    4.31542    2.03236
 4    .720    -.025601     .009862       1.481816    -.020399    -.000039    -.018682          -.0250    4.46899    1.78723
 5    .960    -.025064     .014191       1.975755    -.019971     .000590    -.028653          -.0200    4.58325    1.54335
 6   1.200    -.019980     .016908       2.469694    -.015920     .001932    -.037517          -.0150    4.69160    1.28990
 7   1.440    -.010339     .016784       2.963633    -.008238     .004253    -.043483          -.0100    4.79404    1.02112
 8   1.680     .003875     .012634       3.457572     .003087     .007845    -.044755          -.0050    4.89057     .68251
 9   1.920     .022677     .003331       3.951511     .018069     .013029    -.039530          0.0000    4.97551
10   2.160     .046084    -.012153       4.445449     .036720     .020182    -.025999           .0050    5.05080
11   2.400     .074109    -.034695       4.939388     .059050     .029753    -.002347           .0100    5.12381
12   2.640     .106746    -.064971       5.433327     .085056     .042284     .033243           .0150    5.19455
13   2.880     .143967    -.103400       5.927266     .114713     .058417     .082580           .0200    5.26301
14   3.120     .185690    -.150121       6.421205     .147958     .078885     .147451           .0250    5.32919
15   3.360     .231751    -.204987       6.915143     .184660     .104464     .229598           .0300    5.39310
16   3.600     .281869    -.267609       7.409082     .224593     .135895     .330671           .0350    5.45267
17   3.840     .335597    -.337429       7.903021     .267404     .173766     .452179           .0400    5.50702
18   4.080     .392299    -.413797       8.396960     .312584     .218394     .595418           .0450    5.56031
19   4.320     .451134    -.496049       8.890899     .359464     .269711     .761394           .0500    5.61255
20   4.560     .511071    -.583548       9.384837     .407222     .327195     .950742           .1000    6.06891
21   4.800     .570933    -.675708       9.878776     .454920     .389861    1.163665           .1500    6.43778
22   5.040     .629472    -.771985      10.372715     .501564     .456308    1.399887           .2000    6.74673
23   5.280     .685456    -.871868      10.866654     .546172     .524831    1.658646           .2500    7.02093
24   5.520     .737765    -.974857      11.360593     .587852     .593571    1.938715           .3000    7.26717
25   5.760     .785476   -1.080455      11.854532     .625869     .660684    2.238467           .3500    7.49226
26   6.000     .827933   -1.188170      12.348470     .659698     .724507    2.555963           .4000    7.69934
27   6.240     .864772   -1.297524      12.842409     .689051     .783688    2.889062           .4500    7.89477
28   6.480     .895929   -1.408069      13.336348     .713877     .837275    3.235543           .5000    8.07490
29   6.720     .921609   -1.519406      13.830287     .734339     .884752    3.593208          1.0000    9.50321
30   6.960     .942231   -1.631198      14.324226     .750771     .926013    3.959984          1.5000   10.56810
31   7.200     .958366   -1.743182      14.818164     .763627     .961307    4.333995          2.0000   11.46376
32   7.440     .970665   -1.855167      15.312103     .773427     .991150    4.713600          2.5000   12.26305
33   7.680     .979797   -1.967031      15.806042     .780703    1.016227    5.097422          3.0000   13.00222
34   7.920     .986404   -2.078708      16.299981     .785968    1.037302    5.484342          3.5000   13.70273
35   8.160     .991061   -2.190174      16.793920     .789678    1.055140    5.873479          4.0000   14.37742
36   8.400     .994259   -2.301436      17.287858     .792226    1.070452    6.264161          4.5000   15.03483
37   8.640     .996399   -2.412518      17.781797     .793932    1.083858    6.655893          5.0000   15.68104
38   8.880     .997794   -2.523452      18.275736     .795043    1.095872    7.048321          6.0000   16.95403
39   9.120     .998681   -2.634270      18.769675     .795750    1.106902    7.441199          7.0000   18.21495
40   9.360     .999230   -2.745001      19.263614     .796187    1.117258    7.834358          8.0000   19.47164
41   9.600     .999561   -2.855672      19.757553     .796451    1.127165    8.227691          9.0000   20.72707
42   9.840     .999756   -2.966300      20.251491     .796606    1.136782    8.621128         10.0000   21.98218
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
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X(J) =     3.50000  DELSTR =    9.568845
                                                                                                          INTERPOLATED
  K     ETA          U           V                 Y          UST         VST          PSI                 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
```

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X(J) =     3.62500  DELSTR =     9.693414
                                                                                              INTERPOLATED
 K    ETA        U          V              Y          UST        VST         PSI           PSI        Y           Y
 1   0.000   0.000000   0.000000       0.000000   0.000000   0.000000    0.000000         -.0450    3.84917     3.43727
 2    .240   -.013372    .001052        .513385   -.010593   -.000321    -.002719         -.0400    4.05003     1.91898
 3    .480   -.021980    .003574       1.026770   -.017413   -.000999    -.009908         -.0350    4.23504     2.29786
 4    .720   -.025829    .006310       1.540155   -.020462   -.001757    -.019631         -.0300    4.40421     2.05538
 5    .960   -.024919    .008019       2.053540   -.019741   -.002306    -.029950         -.0250    4.55755     1.79707
 6   1.200   -.019253    .007485       2.566925   -.015252   -.002348    -.038933         -.0200    4.68021     1.55712
 7   1.440   -.008827    .003525       3.080310   -.006993   -.001569    -.044643         -.0150    4.78388     1.29923
 8   1.680    .006359   -.005008       3.593694    .005038    .000362    -.045145         -.0100    4.88284     1.03174
 9   1.920    .026304   -.019209       4.107079    .020839    .003802    -.038503         -.0050    4.97708      .68857
10   2.160    .050999   -.040104       4.620464    .040402    .009131    -.022783         0.0000    5.06661
11   2.400    .080415   -.068619       5.133849    .063706    .016765     .003941          .0050    5.14910
12   2.640    .114499   -.105552       5.647234    .090708    .027156     .043578          .0100    5.21994
13   2.880    .153153   -.151526       6.160619    .121331    .040792     .098007          .0150    5.28892
14   3.120    .196219   -.206945       6.674004    .155448    .058193     .169054          .0200    5.35602
15   3.360    .243454   -.271948       7.187389    .192868    .079889     .258464          .0250    5.42125
16   3.600    .294501   -.346391       7.700774    .233309    .106383     .367860          .0300    5.48461
17   3.840    .348861   -.429840       8.214159    .276374    .138088     .498692          .0350    5.54610
18   4.080    .405870   -.521608       8.727544    .321537    .175243     .652171          .0400    5.60572
19   4.320    .464686   -.620807       9.240929    .368133    .217825     .829204          .0450    5.66197
20   4.560    .524300   -.726412       9.754314    .415360    .265478    1.030321          .0500    5.71323
21   4.800    .583575   -.837327      10.267699    .462318    .317478    1.255614          .1000    6.17630
22   5.040    .641309   -.952437      10.781083    .508056    .372753    1.504702          .1500    6.54548
23   5.280    .696323  -1.070657      11.294468    .551639    .429953    1.776718          .2000    6.86124
24   5.520    .747550  -1.190963      11.807853    .592222    .487569    2.070339          .2500    7.14240
25   5.760    .794117  -1.312430      12.321238    .629113    .544073    2.383846          .3000    7.39133
26   6.000    .835412  -1.434257      12.834623    .661827    .598059    2.715221          .3500    7.62219
27   6.240    .871114  -1.555788      13.348008    .690111    .648369    3.062253          .4000    7.83335
28   6.480    .901195  -1.676526      13.861393    .713942    .694168    3.422663          .4500    8.03124
29   6.720    .925886  -1.796133      14.374778    .733503    .734984    3.794211          .5000    8.21880
30   6.960    .945629  -1.914421      14.888163    .749143    .770698    4.174795         1.0000    9.68024
31   7.200    .961003  -2.031336      15.401548    .761323    .801493    4.562521         1.5000   10.77178
32   7.440    .972663  -2.146924      15.914933    .770560    .827783    4.955744         2.0000   11.68774
33   7.680    .981275  -2.261304      16.428318    .777383    .850130    5.353089         2.5000   12.50377
34   7.920    .987471  -2.374640      16.941703    .782291    .869167    5.753445         3.0000   13.25729
35   8.160    .991812  -2.487113      17.455088    .785730    .885530    6.155945         3.5000   13.96925
36   8.400    .994774  -2.598900      17.968472    .788077    .899812    6.559929         4.0000   14.65354
37   8.640    .996744  -2.710162      18.481857    .789638    .912526    6.964917         4.5000   15.31925
38   8.880    .998020  -2.821038      18.995242    .790648    .924102    7.370565         5.0000   15.97230
39   9.120    .998824  -2.931638      19.508627    .791286    .934874    7.776635         6.0000   17.25640
40   9.360    .999319  -3.042047      20.022012    .791677    .945098    8.182970         7.0000   18.52628
41   9.600    .999615  -3.152328      20.535397    .791912    .954960    8.589465         8.0000   19.79086
42   9.840    .999788  -3.262527      21.048782    .792049    .964590    8.996056         9.0000   21.05376
43  10.080    .999886  -3.372674      21.562167    .792127    .974074    9.402702        10.0000   22.31618
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
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X(J) =     3.75000  DELSTR =     9.808576
                                                                                                INTERPOLATED
  K    ETA        U          V              Y          UST        VST        PSI              PSI       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
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X(J) =     3.87500  DELSTR =    9.914699
                                                                                                      INTERPOLATED
  K    ETA        U           V                Y           UST         VST         PSI              PSI        Y          Y
  1   0.000   0.000000    0.000000         0.000000    0.000000    0.000000    0.000000            -.0400    3.97200    2.72617
  2    .240   -.013449     .000711          .532290    -.010595    -.000470    -.002820            -.0350    4.25968    2.33803
  3    .480   -.021933     .002199         1.064581    -.017278    -.001587    -.010238            -.0300    4.41953    2.09821
  4    .720   -.025458     .003187         1.596871    -.020055    -.003052    -.020174            -.0250    4.56777    1.83100
  5    .960   -.024033     .002416         2.129161    -.018932    -.004561    -.030551            -.0200    4.70440    1.58773
  6   1.200   -.017666    -.001343         2.661452    -.013917    -.005797    -.039293            -.0150    4.82213    1.32244
  7   1.440   -.006367    -.009278         3.193742    -.005016    -.006429    -.044332            -.0100    4.91801    1.04929
  8   1.680    .009853    -.022529         3.726033     .007762    -.006104    -.043601            -.0050    5.01020     .70069
  9   1.920    .030976    -.042167         4.258323     .024402    -.004448    -.035041            0.0000    5.09870
 10   2.160    .056967    -.069179         4.790613     .044877    -.001058    -.016603             .0050    5.18350
 11   2.400    .087772    -.104449         5.322904     .069144     .004492     .013743             .0100    5.26460
 12   2.640    .123297    -.148727         5.855194     .097129     .012654     .057996             .0150    5.33966
 13   2.880    .163398    -.202600         6.387484     .128720     .023893     .118104             .0200    5.40539
 14   3.120    .207861    -.266454         6.919775     .163746     .038677     .195943             .0250    5.46960
 15   3.360    .256377    -.340434         7.452065     .201965     .057458     .293275             .0300    5.53228
 16   3.600    .308521    -.424413         7.984356     .243042     .080631     .411712             .0350    5.59345
 17   3.840    .363728    -.517966         8.516646     .286532     .108497     .552655             .0400    5.65310
 18   4.080    .421281    -.620381         9.048936     .331871     .141202     .717240             .0450    5.71122
 19   4.320    .480305    -.730678         9.581227     .378368     .178673     .906267             .0500    5.76783
 20   4.560    .539779    -.847666        10.113517     .425219     .220568    1.120138             .1000    6.23828
 21   4.800    .598580    -.970015        10.645807     .471540     .266246    1.358806             .1500    6.61706
 22   5.040    .655539   -1.096330        11.178098     .516411     .314774    1.621744             .2000    6.94367
 23   5.280    .709526   -1.225235        11.710388     .558940     .364988    1.907944             .2500    7.22597
 24   5.520    .759534   -1.355441        12.242679     .598335     .415580    2.215947             .3000    7.48437
 25   5.760    .804756   -1.485808        12.774969     .633959     .465228    2.543916             .3500    7.71669
 26   6.000    .844645   -1.615388        13.307259     .665383     .512712    2.889730             .4000    7.93518
 27   6.240    .878946   -1.743459        13.839550     .692403     .557024    3.251098             .4500    8.13594
 28   6.480    .907684   -1.869528        14.371840     .715042     .597444    3.625683             .5000    8.32604
 29   6.720    .931136   -1.993328        14.904130     .733517     .633567    4.011210            1.0000    9.82095
 30   6.960    .949774   -2.114786        15.436421     .748199     .665296    4.405562            1.5000   10.93679
 31   7.200    .964196   -2.233991        15.968711     .759561     .692799    4.806845            2.0000   11.87277
 32   7.440    .975062   -2.351142        16.501001     .768120     .716444    5.213430            2.5000   12.70524
 33   7.680    .983033   -2.466511        17.033292     .774400     .736725    5.623964            3.0000   13.47164
 34   7.920    .988727   -2.580397        17.565582     .778885     .754194    6.037363            3.5000   14.19490
 35   8.160    .992686   -2.693095        18.097873     .782004     .769404    6.452786            4.0000   14.88882
 36   8.400    .995368   -2.804878        18.630163     .784117     .782863    6.869602            4.5000   15.56231
 37   8.640    .997137   -2.915980        19.162453     .785510     .795012    7.287350            5.0000   16.22222
 38   8.880    .998273   -3.026591        19.694744     .786405     .806215    7.705708            6.0000   17.51758
 39   9.120    .998983   -3.136859        20.227034     .786965     .816755    8.124453            7.0000   18.79640
 40   9.360    .999416   -3.246897        20.759324     .787306     .826847    8.543437            8.0000   20.06887
 41   9.600    .999673   -3.356782        21.291615     .787508     .836644    8.962566            9.0000   21.33915
 42   9.840    .999821   -3.466572        21.823905     .787625     .846253    9.381780           10.0000   22.60877
 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
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X(J) =     4.00000  DELSTR =   10.010948
                                                                                                  INTERPOLATED
  K    ETA        U          V             Y          UST        VST        PSI           PSI        Y          Y
  1   0.000   0.000000   0.000000      0.000000   0.000000   0.000000   0.000000      -.0400    3.92101    2.80297
  2    .240   -.013420    .000539       .541556   -.010543   -.000538   -.002855      -.0350    4.20171    2.37015
  3    .480   -.021775    .001488      1.083112   -.017106   -.001860   -.010341      -.0300    4.40319    2.13103
  4    .720   -.025073    .001523      1.624668   -.019697   -.003677   -.020307      -.0250    4.54845    1.85578
  5    .960   -.023327   -.000659      2.166225   -.018325   -.005691   -.030603      -.0200    4.68390    1.60824
  6   1.200   -.016549   -.006325      2.707781   -.013001   -.007591   -.039085      -.0150    4.80952    1.33839
  7   1.440   -.004755   -.016694      3.249337   -.003736   -.009049   -.043617      -.0100    4.91631    1.06093
  8   1.680    .012035   -.032925      3.790893    .009455   -.009717   -.042068      -.0050    5.00722     .70855
  9   1.920    .033792   -.056096      4.332449    .026547   -.009218   -.032320      0.0000    5.09489
 10   2.160    .060471   -.087188      4.874005    .047505   -.007149   -.012268       .0050    5.17931
 11   2.400    .092000   -.127062      5.415561    .072274   -.003079    .020165       .0100    5.26050
 12   2.640    .128268   -.176439      5.957117    .100766    .003445    .067021       .0150    5.33844
 13   2.880    .169109   -.235864      6.498674    .132850    .012889    .130279       .0200    5.41315
 14   3.120    .214283   -.305673      7.040230    .168338    .025715    .211834       .0250    5.47697
 15   3.360    .263450   -.385956      7.581786    .206963    .042363    .313457       .0300    5.53914
 16   3.600    .316154   -.476525      8.123342    .248367    .063211    .436751       .0350    5.59995
 17   3.840    .371800   -.576893      8.664898    .292082    .088539    .583092       .0400    5.65940
 18   4.080    .429641   -.686270      9.206454    .337521    .118473    .753575       .0450    5.71749
 19   4.320    .488782   -.803587      9.748010    .383981    .152935    .948942       .0500    5.77421
 20   4.560    .548191   -.927543     10.289566    .430653    .191595   1.169528       .1000    6.25270
 21   4.800    .606747  -1.056680     10.831123    .476654    .233845   1.415206       .1500    6.63836
 22   5.040    .663295  -1.189471     11.372679    .521077    .278812   1.685370       .2000    6.96755
 23   5.280    .716728  -1.324407     11.914235    .563054    .325408   1.978929       .2500    7.25370
 24   5.520    .766071  -1.460083     12.455791    .601817    .372415   2.294351       .3000    7.51501
 25   5.760    .810553  -1.595274     12.997347    .636762    .418598   2.629731       .3500    7.75043
 26   6.000    .849668  -1.728984     13.538903    .667490    .462821   2.982893       .4000    7.97008
 27   6.240    .883194  -1.860479     14.080459    .693827    .504144   3.351508       .4500    8.17529
 28   6.480    .911190  -1.989296     14.622015    .715821    .541896   3.733210       .5000    8.36610
 29   6.720    .933960  -2.115220     15.163572    .733709    .575701   4.125711      1.0000    9.87802
 30   6.960    .951992  -2.238257     15.705128    .747875    .605470   4.526891      1.5000   11.00555
 31   7.200    .965895  -2.358581     16.246684    .758796    .631362   4.934865      2.0000   11.95139
 32   7.440    .976330  -2.476480     16.788240    .766995    .653718   5.348016      2.5000   12.79101
 33   7.680    .983956  -2.592307     17.329796    .772985    .672997   5.765008      3.0000   13.56444
 34   7.920    .989381  -2.706434     17.871352    .777247    .689710   6.184777      3.5000   14.29288
 35   8.160    .993139  -2.819218     18.412908    .780199    .704366   6.606499      4.0000   14.99138
 36   8.400    .995673  -2.930978     18.954464    .782190    .717433   7.029560      4.5000   15.66911
 37   8.640    .997337  -3.041983     19.496021    .783497    .729315   7.453514      5.0000   16.33239
 38   8.880    .998401  -3.152451     20.037577    .784333    .740343   7.878048      6.0000   17.63327
 39   9.120    .999063  -3.262548     20.579133    .784853    .750775   8.302949      7.0000   18.91666
 40   9.360    .999465  -3.372396     21.120689    .785169    .760807   8.728076      8.0000   20.19304
 41   9.600    .999702  -3.482083     21.662245    .785355    .770575   9.153339      9.0000   21.46699
 42   9.840    .999838  -3.591668     22.203801    .785462    .780177   9.578682     10.0000   22.74018
 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
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X(J) =     4.12500  DELSTR =   10.095966
                                                                                    INTERPOLATED
 K   ETA        U          V            Y          UST         VST        PSI          PSI       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
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X(J) =      4.25000  DELSTR =    10.168214
                                                                                               INTERPOLATED
   K     ETA         U           V              Y        UST        VST         PSI          PSI        Y         Y
   1   0.000    0.000000    0.000000      0.000000   0.000000   0.000000    0.000000       -.0400   3.76777   3.18476
   2    .240    -.013228     .000125       .559745   -.010336   -.000689    -.002893       -.0350   4.02517   2.46023
   3    .480    -.021179    -.000243      1.119490   -.016548   -.002484    -.010417       -.0300   4.25453   2.22937
   4    .720    -.023867    -.002584      1.679235   -.018648   -.005130    -.020267       -.0250   4.45584   1.92405
   5    .960    -.021311    -.008343      2.238981   -.016651   -.008365    -.030146       -.0200   4.59251   1.66410
   6   1.200    -.013537    -.018914      2.798726   -.010577   -.011912    -.037766       -.0150   4.71615   1.38015
   7   1.440    -.000576    -.035622      3.358471   -.000450   -.015468    -.040852       -.0100   4.83296   1.09150
   8   1.680     .017532    -.059701      3.918216    .013698   -.018704    -.037144       -.0050   4.94296    .72807
   9   1.920     .040731    -.092271      4.477961    .031824   -.021260    -.024404       0.0000   5.04477
  10   2.160     .068946    -.134315      5.037706    .053869   -.022735    -.000421        .0050   5.12728
  11   2.400     .102071    -.186656      5.597452    .079750   -.022698     .036975        .0100   5.20736
  12   2.640     .139955    -.249936      6.157197    .109350   -.020690     .089899        .0150   5.28501
  13   2.880     .182385    -.324582      6.716942    .142501   -.016234     .160385        .0200   5.36022
  14   3.120     .229065    -.410777      7.276687    .178974   -.008860     .250357        .0250   5.43301
  15   3.360     .279598    -.508421      7.836432    .218457    .001878     .361587        .0300   5.50337
  16   3.600     .333464    -.617107      8.396177    .260543    .016368     .495646        .0350   5.57129
  17   3.840     .390003    -.736097      8.955923    .304719    .034893     .653847        .0400   5.63267
  18   4.080     .448414    -.864322      9.515668    .350356    .057597     .837185        .0450   5.69002
  19   4.320     .507754   -1.000408     10.075413    .396720    .084433    1.046271        .0500   5.74631
  20   4.560     .566970   -1.142729     10.635158    .442987    .115129    1.281282        .1000   6.24395
  21   4.800     .624940   -1.289491     11.194903    .488280    .149173    1.541918        .1500   6.64116
  22   5.040     .680534   -1.438838     11.754648    .531717    .185819    1.827387        .2000   6.97519
  23   5.280     .732697   -1.588965     12.314394    .572473    .224136    2.136420        .2500   7.27465
  24   5.520     .780524   -1.738231     12.874139    .609841    .263080    2.467317        .3000   7.53719
  25   5.760     .823328   -1.885251     13.433884    .643285    .301590    2.818033        .3500   7.78216
  26   6.000     .860690   -2.028963     13.993629    .672477    .338683    3.186279        .4000   8.00483
  27   6.240     .892473   -2.168659     14.553374    .697310    .373549    3.569645        .4500   8.21439
  28   6.480     .918810   -2.303980     15.113119    .717887    .405601    3.965720        .5000   8.41253
  29   6.720     .940060   -2.434883     15.672865    .734491    .434506    4.372201       1.0000   9.95655
  30   6.960     .956753   -2.561583     16.232610    .747533    .460176    4.786979       1.5000  11.10802
  31   7.200     .969516   -2.684478     16.792355    .757505    .482731    5.208198       2.0000  12.07170
  32   7.440     .979014   -2.804078     17.352100    .764926    .502448    5.634285       2.5000  12.92740
  33   7.680     .985894   -2.920939     17.911845    .770302    .519699    6.063953       3.0000  13.71318
  34   7.920     .990744   -3.035608     18.471590    .774091    .534902    6.496186       3.5000  14.45300
  35   8.160     .994073   -3.148584     19.031336    .776692    .548470    6.930208       4.0000  15.16075
  36   8.400     .996296   -3.260296     19.591081    .778430    .560780    7.365444       4.5000  15.84624
  37   8.640     .997742   -3.371095     20.150826    .779559    .572160    7.801482       5.0000  16.51648
  38   8.880     .998658   -3.481256     20.710571    .780274    .582872    8.238037       6.0000  17.82874
  39   9.120     .999222   -3.590984     21.270316    .780715    .593124    8.674915       7.0000  19.12116
  40   9.360     .999560   -3.700427     21.830061    .780979    .603066    9.111990       8.0000  20.40541
  41   9.600     .999757   -3.809690     22.389807    .781134    .612807    9.549183       9.0000  21.68665
  42   9.840     .999870   -3.918840     22.949552    .781221    .622423    9.986443      10.0000  22.96691
  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
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```
X(J) =     4.37500  DELSTR =   10.226161
                                                                                               INTERPOLATED
 K   ETA         U          V           Y          UST        VST        PSI            PSI         Y          Y
 1   0.000   0.000000   0.000000    0.000000   0.000000   0.000000   0.000000       -.0350    3.91404    2.53977
 2    .240   -.013056   -.000148     .568681   -.010173   -.000785   -.002893       -.0300    4.13500    2.25125
 3    .480   -.020718   -.001386    1.137362   -.016144   -.002880   -.010376       -.0250    4.33483    1.97131
 4    .720   -.023005   -.005290    1.706042   -.017926   -.006055   -.020063       -.0200    4.51351    1.70228
 5    .960   -.019941   -.013395    2.274723   -.015538   -.010071   -.029579       -.0150    4.64366    1.40751
 6   1.200   -.011559   -.027176    2.843404   -.009007   -.014670   -.036558       -.0100    4.75896    1.11149
 7   1.440    .002099   -.048020    3.412085    .001636   -.019568   -.038654       -.0050    4.86868     .74023
 8   1.680    .020983   -.077212    3.980765    .016350   -.024450   -.033540       0.0000    4.97281
 9   1.920    .045017   -.115895    4.549446    .035079   -.028963   -.018916        .0050    5.07135
10   2.160    .074111   -.165050    5.118127    .057749   -.032711    .007478        .0100    5.15760
11   2.400    .108138   -.225475    5.686808    .084264   -.035259    .047859        .0150    5.23431
12   2.640    .146922   -.297758    6.255488    .114486   -.036144    .104371        .0200    5.30894
13   2.880    .190226   -.382247    6.824169    .148229   -.034879    .179072        .0250    5.38150
14   3.120    .237724   -.479016    7.392850    .185241   -.030980    .273890        .0300    5.45199
15   3.360    .288987   -.587832    7.961531    .225186   -.023983    .390591        .0350    5.52040
16   3.600    .343461   -.708129    8.530211    .267634   -.013485    .530720        .0400    5.58674
17   3.840    .400454   -.838988    9.098892    .312044    .000824    .695546        .0450    5.65100
18   4.080    .459135   -.979139    9.667573    .357770    .019113    .886001        .0500    5.71053
19   4.320    .518540  -1.126997   10.236254    .404060    .041372   1.102620        .1000    6.21576
20   4.560    .577602  -1.280718   10.804934    .450082    .067377   1.345487        .1500    6.61549
21   4.800    .635198  -1.438296   11.373615    .494963    .096674   1.614202        .2000    6.95791
22   5.040    .690217  -1.597679   11.942296    .537835    .128591   1.907868        .2500    7.25857
23   5.280    .741631  -1.756900   12.510977    .577898    .162280   2.225116        .3000    7.52758
24   5.520    .788576  -1.914197   13.079657    .614479    .196781   2.564157        .3500    7.77353
25   5.760    .830412  -2.068118   13.648338    .647079    .231117   2.922869        .4000    8.00217
26   6.000    .866771  -2.217588   14.217019    .675410    .264381   3.298906        .4500    8.21219
27   6.240    .897563  -2.361941   14.785700    .699405    .295817   3.689821        .5000    8.41224
28   6.480    .922964  -2.500905   15.354380    .719198    .324874   4.093187       1.0000    9.97407
29   6.720    .943364  -2.634557   15.923061    .735094    .351232   4.506701       1.5000   11.13757
30   6.960    .959313  -2.763245   16.491742    .747522    .374794   4.928268       2.0000   12.11109
31   7.200    .971449  -2.887511   17.060423    .756978    .395653   5.356059       2.5000   12.97437
32   7.440    .980435  -3.007998   17.629103    .763981    .414044   5.788529       3.0000   13.76671
33   7.680    .986912  -3.125381   18.197784    .769028    .430291   6.224425       3.5000   14.51172
34   7.920    .991455  -3.240308   18.766465    .772567    .444757   6.662763       4.0000   15.22423
35   8.160    .994555  -3.353357   19.335146    .774984    .457804   7.102794       4.5000   15.91393
36   8.400    .996616  -3.465017   19.903826    .776589    .469763   7.543968       5.0000   16.58752
37   8.640    .997948  -3.575686   20.472507    .777627    .480917   7.985895       6.0000   17.90539
38   8.880    .998787  -3.685666   21.041188    .778281    .491498   8.428302       7.0000   19.20243
39   9.120    .999300  -3.795184   21.609869    .778681    .501682   8.871009       8.0000   20.49064
40   9.360    .999607  -3.904402   22.178549    .778920    .511603   9.313898       9.0000   21.77551
41   9.600    .999785  -4.013429   22.747230    .779058    .521353   9.756894      10.0000   23.05927
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
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X(J) =     4.50000  DELSTR =   10.268424
                                                                                                  INTERPOLATED
 K    ETA        U          V              Y         UST        VST        PSI             PSI       Y          Y
 1   0.000    0.000000   0.000000      0.000000   0.000000   0.000000   0.000000        -.0350   3.79292   2.95021
 2    .240   -.012820   -.000489       .577518   -.009963   -.000904   -.002877        -.0300   4.00221   1.93596
 3    .480   -.020123   -.002804      1.155037   -.015639   -.003365   -.010270        -.0250   4.19571   2.03277
 4    .720   -.021931   -.008622      1.732555   -.017044   -.007179   -.019707        -.0200   4.37342   1.74631
 5    .960   -.018274   -.019572      2.310073   -.014202   -.012128   -.028730        -.0150   4.53533   1.44111
 6   1.200   -.009195   -.037210      2.887591   -.007146   -.017976   -.034894        -.0100   4.66828   1.13590
 7   1.440    .005253   -.062991      3.465110    .004082   -.024455   -.035779        -.0050   4.77624    .75463
 8   1.680    .025005   -.098238      4.042628    .019433   -.031259   -.028989        0.0000   4.87968
 9   1.920    .049968   -.144110      4.620146    .038833   -.038042   -.012164         .0050   4.97859
10   2.160    .080030   -.201581      5.197664    .062195   -.044408    .017009         .0100   5.07298
11   2.400    .115040   -.271412      5.775183    .089403   -.049921    .060784         .0150   5.16284
12   2.640    .154800   -.354125      6.352701    .120303   -.054105    .121339         .0200   5.24140
13   2.880    .199041   -.449968      6.930219    .154684   -.056462    .200744         .0250   5.31311
14   3.120    .247407   -.558886      7.507737    .192272   -.056485    .300930         .0300   5.38307
15   3.360    .299434   -.680484      8.085256    .232705   -.053691    .423646         .0350   5.45127
16   3.600    .354535   -.814003      8.662774    .275526   -.047644    .570402         .0400   5.51773
17   3.840    .411982   -.958306      9.240292    .320171   -.038004    .742415         .0450   5.58243
18   4.080    .470915  -1.111888      9.817810    .365970   -.024562    .940545         .0500   5.64538
19   4.320    .530345  -1.272911     10.395329    .412156   -.007281   1.165236         .1000   6.16273
20   4.560    .589196  -1.439285     10.972847    .457892    .013671   1.416470         .1500   6.57337
21   4.800    .646346  -1.608767     11.550365    .502307    .037905   1.693736         .2000   6.92530
22   5.040    .700703  -1.779096     12.127883    .544550    .064827   1.996026         .2500   7.22606
23   5.280    .751271  -1.948138     12.705402    .583848    .093670   2.321861         .3000   7.50281
24   5.520    .797230  -2.114018     13.282920    .619565    .123561   2.669358         .3500   7.74901
25   5.760    .837995  -2.275233     13.860438    .651246    .153602   3.036316         .4000   7.98068
26   6.000    .873252  -2.430718     14.437956    .678646    .182954   3.420335         .4500   8.19472
27   6.240    .902965  -2.579876     15.015475    .701737    .210911   3.818933         .5000   8.39547
28   6.480    .927351  -2.722546     15.592993    .720689    .236952   4.229671        1.0000   9.97623
29   6.720    .946836  -2.858949     16.170511    .735832    .260763   4.650255        1.5000  11.15165
30   6.960    .961990  -2.989593     16.748029    .747608    .282233   5.078612        2.0000  12.13514
31   7.200    .973458  -3.115175     17.325548    .756521    .301421   5.512943        2.5000  13.00518
32   7.440    .981905  -3.236486     17.903066    .763085    .318517   5.951743        3.0000  13.80440
33   7.680    .987958  -3.354330     18.480584    .767790    .333792   6.393797        3.5000  14.55473
34   7.920    .992180  -3.469458     19.058102    .771070    .347554   6.838157        4.0000  15.27171
35   8.160    .995045  -3.582531     19.635621    .773297    .360111   7.284107        4.5000  15.96538
36   8.400    .996938  -3.694099     20.213139    .774768    .371746   7.731125        5.0000  16.64263
37   8.640    .998154  -3.804602     20.790657    .775713    .382701   8.178840        6.0000  17.96626
38   8.880    .998915  -3.914372     21.368175    .776305    .393171   8.627000        7.0000  19.26785
39   9.120    .999378  -4.023656     21.945694    .776665    .403310   9.075434        8.0000  20.56004
40   9.360    .999653  -4.132625     22.523212    .776878    .413226   9.524033        9.0000  21.84856
41   9.600    .999811  -4.241397     23.100730    .777001    .423001   9.972730       10.0000  23.13583
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
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X(J) =     4,62500  DELSTR =   10,293850
                                                                                                      INTERPOLATED
  K   ETA        U          V             Y          UST         VST         PSI              PSI        Y          Y
  1  0.000   0.000000   0.000000      0.000000   0.000000    0.000000    0.000000          -,0300    3,67614    2,60368
  2   ,240   -,012507   -,000918       ,586263   -,009694    -,001051    -,002842          -,0250    4,00729    2,11891
  3   ,480   -,019368   -,004571      1,172526   -,015012    -,003961    -,010084          -,0200    4,21679    1,79672
  4   ,720   -,020606   -,012731      1,758790   -,015971    -,008547    -,019166          -,0150    4,37702    1,48349
  5   ,960   -,016260   -,027117      2,345053   -,012603    -,014610    -,027542          -,0100    4,52554    1,16635
  6  1,200   -,006384   -,049357      2,931316   -,004948    -,021927    -,032687          -,0050    4,66235     ,77201
  7  1,440    ,008959   -,080966      3,517579    ,006944    -,030245    -,032102          0,0000    4,76940
  8  1,680    ,029681   -,123293      4,103842    ,023005    -,039264    -,023323           ,0050    4,86703
  9  1,920    ,055673   -,177498      4,690105    ,043151    -,048636    -,003930           ,0100    4,96104
 10  2,160    ,086798   -,244535      5,276369    ,067275    -,057963     ,028439           ,0150    5,05142
 11  2,400    ,122881   -,325114      5,862632    ,095243    -,066801     ,076079           ,0200    5,13817
 12  2,640    ,163694   -,419674      6,448895    ,126877    -,074663     ,141189           ,0250    5,22130
 13  2,880    ,208939   -,528343      7,035158    ,161945    -,081028     ,225852           ,0300    5,29768
 14  3,120    ,258223   -,650908      7,621421    ,200145    -,085367     ,331992           ,0350    5,36500
 15  3,360    ,311048   -,786783      8,207685    ,241089    -,087163     ,461331           ,0400    5,43085
 16  3,600    ,366788   -,934983      8,793948    ,284292    -,085946     ,615337           ,0450    5,49524
 17  3,840    ,424682  -1,094118      9,380211    ,329164    -,081332     ,795160           ,0500    5,55817
 18  4,080    ,483835  -1,262410      9,966474    ,375013    -,073065    1,001577           ,1000    6,09170
 19  4,320    ,543240  -1,437741     10,552737    ,421057    -,061054    1,234931           ,1500    6,51482
 20  4,560    ,601808  -1,617745     11,139000    ,466452    -,045403    1,495088           ,2000    6,86731
 21  4,800    ,658424  -1,799926     11,725264    ,510334    -,026431    1,781414           ,2500    7,17687
 22  5,040    ,712016  -1,981810     12,311527    ,551872    -,004654    2,092781           ,3000    7,45469
 23  5,280    ,761626  -2,161099     12,897790    ,590325     ,019241    2,427595           ,3500    7,70818
 24  5,520    ,806486  -2,335824     13,484053    ,625095     ,044464    2,783873           ,4000    7,94037
 25  5,760    ,846069  -2,504452     14,070316    ,655775     ,070189    3,159336           ,4500    8,15975
 26  6,000    ,880120  -2,665961     14,656580    ,682167     ,095640    3,551529           ,5000    8,36219
 27  6,240    ,908659  -2,819850     15,242843    ,704288     ,120153    3,957943          1,0000    9,96224
 28  6,480    ,931952  -2,966102     15,829106    ,722341     ,143229    4,376133          1,5000   11,14944
 29  6,720    ,950457  -3,105105     16,415369    ,736684     ,164554    4,803819          2,0000   12,14097
 30  6,960    ,964765  -3,237546     17,001632    ,747774     ,183996    5,238961          2,5000   13,01930
 31  7,200    ,975530  -3,364294     17,587896    ,756118     ,201578    5,679799          3,0000   13,82451
 32  7,440    ,983410  -3,486297     18,174159    ,762226     ,217440    6,124874          3,5000   14,58070
 33  7,680    ,989023  -3,604489     18,760422    ,766576     ,231798    6,573014          4,0000   15,30239
 34  7,920    ,992914  -3,719725     19,346685    ,769592     ,244905    7,023313          4,5000   15,99992
 35  8,160    ,995537  -3,832748     19,932948    ,771625     ,257014    7,475093          5,0000   16,68061
 36  8,400    ,997259  -3,944167     20,519211    ,772960     ,268360    7,927859          6,0000   18,01008
 37  8,640    ,998358  -4,054459     21,105475    ,773812     ,279145    8,381267          7,0000   19,31638
 38  8,880    ,999041  -4,163985     21,691738    ,774341     ,289530    8,835080          8,0000   20,61253
 39  9,120    ,999454  -4,273006     22,278001    ,774662     ,299643    9,289141          9,0000   21,90470
 40  9,360    ,999697  -4,381704     22,864264    ,774850     ,309574    9,743352         10,0000   23,19547
 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
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X(J) =     4.75000  DELSTR =   10.301566
                                                                                            INTERPOLATED
  K    ETA        U          V            Y          UST         VST          PSI          PSI        Y          Y
  1   0.000   0.000000   0.000000     0.000000   0.000000    0.000000     0.000000      -.0250    3.71955    2.26403
  2    .240   -.012101   -.001456      .594921   -.009355    -.001232     -.002783      -.0200    3.99157    1.84894
  3    .480   -.018420   -.006764     1.189841   -.014239    -.004691     -.009801      -.0150    4.20548    1.53889
  4    .720   -.018985   -.017774     1.784762   -.014676    -.010205     -.018402      -.0100    4.35107    1.20261
  5    .960   -.013843   -.036273     2.379682   -.010701    -.017583     -.025950      -.0050    4.48802     .79351
  6   1.200   -.003057   -.063948     2.974603   -.002363    -.026612     -.029837      0.0000    4.61635
  7   1.440    .013290   -.102353     3.569524    .010274    -.037042     -.027484       .0050    4.73606
  8   1.680    .035092   -.152852     4.164444    .027127    -.048575     -.016358       .0100    4.83246
  9   1.920    .062217   -.216591     4.759365    .048096    -.060858      .006018       .0150    4.92165
 10   2.160    .094505   -.294483     5.354285    .073055    -.073484      .042055       .0200    5.00796
 11   2.400    .131751   -.387168     5.949206    .101848    -.085995      .094082       .0250    5.09138
 12   2.640    .173698   -.494975     6.544126    .134274    -.097883      .164319       .0300    5.17193
 13   2.880    .220010   -.617886     7.139047    .170075    -.108604      .254851       .0350    5.24959
 14   3.120    .270260   -.755504     7.733968    .208920    -.117595      .367587       .0400    5.32438
 15   3.360    .323910   -.907016     8.328888    .250393    -.124301      .504214       .0450    5.39146
 16   3.600    .380294  -1.071180     8.923809    .293980    -.128209      .666144       .0500    5.45362
 17   3.840    .438614  -1.246317     9.518729    .339063    -.128886      .854448       .1000    6.00383
 18   4.080    .497945  -1.430346    10.113650    .384928    -.126019     1.069807       .1500    6.43230
 19   4.320    .557258  -1.620841    10.708571    .430779    -.119457     1.312447       .2000    6.79106
 20   4.560    .615455  -1.815142    11.303491    .475767    -.109238     1.582109       .2500    7.10982
 21   4.800    .671432  -2.010493    11.898412    .519039    -.095608     1.878024       .3000    7.38860
 22   5.040    .724143  -2.204209    12.493332    .559786    -.079009     2.198932       .3500    7.64735
 23   5.280    .772673  -2.393848    13.088253    .597302    -.060048     2.543120       .4000    7.88280
 24   5.520    .816311  -2.577369    13.683173    .631035    -.039442     2.908501       .4500    8.10300
 25   5.760    .854593  -2.753245    14.278094    .660629    -.017951     3.292720       .5000    8.31181
 26   6.000    .887332  -2.920530    14.873015    .685937     .003701     3.693270      1.0000    9.92770
 27   6.240    .914605  -3.078857    15.467935    .707020     .024886     4.107620      1.5000   11.12767
 28   6.480    .936727  -3.228382    16.062856    .724121     .045117     4.533327      2.0000   12.12911
 29   6.720    .954193  -3.369686    16.657776    .737623     .064074     4.968138      2.5000   13.01556
 30   6.960    .967610  -3.503652    17.252697    .747995     .081599     5.410050      3.0000   13.82700
 31   7.200    .977640  -3.631332    17.847618    .755748     .097674     5.857354      3.5000   14.58839
 32   7.440    .984933  -3.753832    18.442538    .761386     .112389     6.308641      4.0000   15.31492
 33   7.680    .990094  -3.872215    19.037459    .765375     .125905     6.762792      4.5000   16.01673
 34   7.920    .993646  -3.987441    19.632379    .768121     .138417     7.218946      5.0000   16.70091
 35   8.160    .996025  -4.100324    20.227300    .769960     .150128     7.676465      6.0000   18.03607
 36   8.400    .997575  -4.211526    20.822221    .771159     .161224     8.134886      7.0000   19.34705
 37   8.640    .998558  -4.321560    21.417141    .771918     .171869     8.593890      8.0000   20.64725
 38   8.880    .999164  -4.430806    22.012062    .772387     .182194     9.053260      9.0000   21.94310
 39   9.120    .999528  -4.539537    22.606982    .772668     .192300     9.512852     10.0000   23.23739
 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
```

```
X(J) =     4.87500  DELSTR =   10.290948
                                                                                                          INTERPOLATED
 K   ETA        U          V              Y           UST        VST         PSI                 PSI          Y          Y
 1   0.000   0.000000   0.000000      0.000000    0.000000   0.000000    0.000000             -.0250     3.45242    2.67615
 2    .240   -.011582   -.002126       .603495    -.008930   -.001455    -.002695             -.0200     3.70876    1.86553
 3    .480   -.017243   -.009469      1.206990    -.013294   -.005581    -.009400             -.0150     3.93976    1.61538
 4    .720   -.017017   -.023927      1.810485    -.013120   -.012203    -.017371             -.0100     4.14540    1.24719
 5    .960   -.010959   -.047326      2.413980    -.008449   -.021128    -.023879             -.0050     4.30048     .82084
 6   1.200    .000853   -.081380      3.017474     .000658   -.032139    -.026230             0.0000     4.42685
 7   1.440    .018324   -.127657      3.620969     .014127   -.044980    -.021769              .0050     4.54688
 8   1.680    .041319   -.187514      4.224464     .031857   -.059346    -.007893              .0100     4.66059
 9   1.920    .069686   -.262063      4.827959     .053728   -.074873     .017932              .0150     4.76795
10   2.160    .103237   -.352150      5.431454     .079595   -.091137     .058161              .0200     4.86257
11   2.400    .141737   -.458315      6.034949     .109278   -.107657     .115153              .0250     4.94463
12   2.640    .184892   -.580748      6.638444     .142550   -.123899     .191142              .0300     5.02442
13   2.880    .232330   -.719256      7.241939     .179125   -.139285     .288206              .0350     5.10195
14   3.120    .283585   -.873222      7.845434     .218642   -.153212     .408231              .0400     5.17720
15   3.360    .338075  -1.041579      8.448928     .260653   -.165083     .552857              .0450     5.25018
16   3.600    .395094  -1.222790      9.052423     .304614   -.174331     .723425              .0500     5.32090
17   3.840    .453807  -1.414859      9.655918     .349881   -.180470     .920918              .1000     5.88711
18   4.080    .513256  -1.615372     10.259413     .395716   -.183125    1.145900              .1500     6.32599
19   4.320    .572393  -1.821577     10.862908     .441310   -.182082    1.398471              .2000     6.69780
20   4.560    .630117  -2.030510     11.466403     .485815   -.177312    1.678228              .2500     7.01671
21   4.800    .685335  -2.239158     12.069898     .528388   -.168989    1.984261              .3000     7.30536
22   5.040    .737035  -2.444641     12.673393     .568248   -.157484    2.315168              .3500     7.56427
23   5.280    .784353  -2.644399     13.276888     .604730   -.143333    2.669112              .4000     7.80702
24   5.520    .826640  -2.836357     13.880383     .637333   -.127189    3.043901              .4500     8.02838
25   5.760    .863504  -3.019036     14.483877     .665755   -.109755    3.437104              .5000     8.23813
26   6.000    .894825  -3.191606     15.087372     .689903   -.091715    3.846170             1.0000     9.87513
27   6.240    .920745  -3.353873     15.690867     .709887   -.073671    4.268553             1.5000    11.08765
28   6.480    .941627  -3.506197     16.294362     .725987   -.056104    4.701825             2.0000    12.09946
29   6.720    .958000  -3.649376     16.897857     .738610   -.039347    5.143763             2.5000    12.99261
30   6.960    .970491  -3.784500     17.501352     .748241   -.023590    5.592417             3.0000    13.81112
31   7.200    .979761  -3.912808     18.104847     .755388   -.008893    6.046133             3.5000    14.57789
32   7.440    .986454  -4.035564     18.708342     .760548    .004783    6.503562             4.0000    15.30890
33   7.680    .991155  -4.153955     19.311837     .764172    .017543    6.963643             4.5000    16.01470
34   7.920    .994366  -4.269034     19.915331     .766648    .029529    7.425564             5.0000    16.70252
35   8.160    .996501  -4.381680     20.518826     .768294    .040892    7.888729             6.0000    18.04371
36   8.400    .997881  -4.492598     21.122321     .769358    .051779    8.352712             7.0000    19.35940
37   8.640    .998749  -4.602325     21.725816     .770028    .062313    8.817218             8.0000    20.66362
38   8.880    .999281  -4.711259     22.329311     .770437    .072598    9.282049             9.0000    21.96315
39   9.120    .999597  -4.819679     22.932806     .770681    .082714    9.747078            10.0000    23.26097
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
```

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X(J) =      5.00000  DELSTR =   10.261606
                                                                                                   INTERPOLATED
  K    ETA        U           V              Y          UST         VST         PSI            PSI       Y          Y
  1   0.000   0.000000    0.000000      0.000000    0.000000    0.000000    0.000000        -.0200   3.44695   1.34198
  2    .240   -.010926    -.002953       .611990    -.008402    -.001727    -.002571        -.0150   3.66283   1.73271
  3    .480   -.015794    -.012781      1.223980    -.012145    -.006655    -.008858        -.0100   3.86240   1.30390
  4    .720   -.014644    -.031386      1.835969    -.011261    -.014594    -.016020        -.0050   4.04566    .85672
  5    .960   -.007541    -.060595      2.447959    -.005798    -.025332    -.021240        0.0000   4.21261
  6   1.200    .005426    -.102112      3.059949     .004172    -.038633    -.021738         .0050   4.34618
  7   1.440    .024142    -.157466      3.671939     .018564    -.054217    -.014780         .0100   4.45789
  8   1.680    .048448    -.227960      4.283929     .037255    -.071755     .002300         .0150   4.56496
  9   1.920    .078166    -.314643      4.895918     .060107    -.090862     .032092         .0200   4.66739
 10   2.160    .113077    -.418270      5.507908     .086952    -.111089     .077091         .0250   4.76518
 11   2.400    .152914    -.539250      6.119898     .117585    -.131928     .139678         .0300   4.85832
 12   2.640    .197345    -.677608      6.731888     .151750    -.152808     .222093         .0350   4.93982
 13   2.880    .245958    -.832942      7.343878     .189132    -.173111     .326401         .0400   5.01389
 14   3.120    .298243   -1.004386      7.955867     .229337    -.192192     .454451         .0450   5.08618
 15   3.360    .353575   -1.190579      8.567857     .271885    -.209398     .607822         .0500   5.15670
 16   3.600    .411205   -1.389664      9.179847     .316200    -.224109     .787773         .1000   5.74666
 17   3.840    .470257   -1.599296      9.791837     .361609    -.235778     .995180         .1500   6.20276
 18   4.080    .529747   -1.816710     10.403827     .407355    -.243967    1.230479         .2000   6.57895
 19   4.320    .588607   -2.038815     11.015816     .452615    -.248397    1.493625         .2500   6.90560
 20   4.560    .645735   -2.262347     11.627806     .496545    -.248972    1.784063         .3000   7.19861
 21   4.800    .700061   -2.484048     12.239796     .538320    -.245803    2.100727         .3500   7.46357
 22   5.040    .750611   -2.700872     12.851786     .577190    -.239194    2.442067         .4000   7.70687
 23   5.280    .796579   -2.910180     13.463775     .612538    -.229622    2.806118         .4500   7.93614
 24   5.520    .837385   -3.109910     14.075765     .643916    -.217687    3.190586         .5000   8.14630
 25   5.760    .872713   -3.298676     14.687755     .671082    -.204046    3.592969        1.0000   9.80499
 26   6.000    .902518   -3.475816     15.299745     .694001    -.189353    4.010677        1.5000  11.02977
 27   6.240    .927005   -3.641342     15.911735     .712831    -.174197    4.441161        2.0000  12.04975
 28   6.480    .946588   -3.795851     16.523724     .727889    -.159061    4.882014        2.5000  12.95129
 29   6.720    .961828   -3.940372     17.135714     .739608    -.144298    5.331060        3.0000  13.77572
 30   6.960    .973365   -4.076214     17.747704     .748480    -.130130    5.786407        3.5000  14.54831
 31   7.200    .981862   -4.204800     18.359694     .755013    -.116662    6.246468        4.0000  15.28432
 32   7.440    .987948   -4.327543     18.971684     .759693    -.103906    6.709961        4.5000  15.99405
 33   7.680    .992189   -4.445745     19.583673     .762954    -.091807    7.175883        5.0000  16.68534
 34   7.920    .995063   -4.560536     20.195663     .765164    -.080276    7.643480        6.0000  18.03239
 35   8.160    .996958   -4.672849     20.807653     .766621    -.069207    8.112198        7.0000  19.35291
 36   8.400    .998172   -4.783420     21.419643     .767555    -.058494    8.581648        8.0000  20.66125
 37   8.640    .998930   -4.892802     22.031633     .768138    -.048046    9.051563        9.0000  21.96450
 38   8.880    .999390   -5.001400     22.643622     .768491    -.037784    9.521763       10.0000  23.26584
 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
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X(J) =     5.12500  DELSTR =    10.213431
                                                                                                       INTERPOLATED
 K   ETA         U          V              Y            UST          VST          PSI              PSI        Y         Y
 1   0.000    0.000000    0.000000      0.000000     0.000000     0.000000     0.000000          -.0150   3.18919   1.96737
 2    .240    -.010107    -.003962       .620408     -.007752     -.002052     -.002405          -.0100   3.51602   1.37165
 3    .480    -.014025    -.016786      1.240816     -.010757     -.007936     -.008146          -.0050   3.76726    .90574
 4    .720    -.011801    -.040317      1.861224     -.009051     -.017417     -.014290          0.0000   3.93050
 5    .960    -.003509    -.076320      2.481633     -.002691     -.030246     -.017933           .0050   4.08307
 6   1.200     .010749    -.126442      3.102041      .008244     -.046149     -.016210           .0100   4.22496
 7   1.440     .030831    -.192116      3.722449      .023645     -.064806     -.006318           .0150   4.35359
 8   1.680     .056561    -.274542      4.342857      .043379     -.085845      .014473           .0200   4.45357
 9   1.920     .087731    -.374671      4.963265      .067285     -.108848      .048801           .0250   4.55015
10   2.160     .124092    -.493130      5.583673      .095171     -.133334      .099196           .0300   4.64332
11   2.400     .165340    -.630172      6.204081      .126806     -.158757      .168054           .0350   4.73310
12   2.640     .211103    -.785624      6.824490      .161904     -.184505      .257613           .0400   4.81948
13   2.880     .260926    -.958842      7.444898      .200115     -.209914      .369913           .0450   4.90246
14   3.120     .314252   -1.148676      8.065306      .241012     -.234286      .506752           .0500   4.97965
15   3.360     .370410   -1.353444      8.685714      .284082     -.256912      .669639           .1000   5.59164
16   3.600     .428606   -1.570933      9.306122      .328715     -.277111      .859731           .1500   6.05347
17   3.840     .487927   -1.798433      9.926530      .374211     -.294272     1.077781           .2000   6.43817
18   4.080     .547359   -2.032810     10.546939      .419791     -.307896     1.324084           .2500   6.77609
19   4.320     .605822   -2.270637     11.167347      .464629     -.317639     1.598435           .3000   7.07044
20   4.560     .662220   -2.508358     11.787755      .507883     -.323346     1.900112           .3500   7.34220
21   4.800     .715508   -2.742501     12.408163      .548752     -.325067     2.227884           .4000   7.58908
22   5.040     .764760   -2.969892     13.028571      .586525     -.323054     2.580051           .4500   7.81899
23   5.280     .809236   -3.187865     13.648979      .620636     -.317736     2.954518           .5000   8.03682
24   5.520     .848434   -3.394422     14.269387      .650698     -.309671     3.348890          1.0000   9.71289
25   5.760     .882117   -3.588329     14.889796      .676531     -.299486     3.760602          1.5000  10.95091
26   6.000     .910317   -3.769133     15.510204      .698158     -.287817     4.187036          2.0000  11.98121
27   6.240     .933305   -3.937096     16.130612      .715789     -.275248     4.625648          2.5000  12.89069
28   6.480     .951543   -4.093072     16.751020      .729776     -.262273     5.074068          3.0000  13.72183
29   6.720     .965621   -4.238337     17.371428      .740573     -.249269     5.530177          3.5000  14.49954
30   6.960     .976191   -4.374415     17.991836      .748680     -.236494     5.992149          4.0000  15.24018
31   7.200     .983910   -4.502908     18.612244      .754600     -.224095     6.458472          4.5000  15.95426
32   7.440     .989393   -4.625365     19.232653      .758805     -.212132     6.927937          5.0000  16.64926
33   7.680     .993181   -4.743183     19.853061      .761710     -.200601     7.399607          6.0000  18.00232
34   7.920     .995725   -4.857556     20.473469      .763662     -.189456     7.872783          7.0000  19.32757
35   8.160     .997388   -4.969452     21.093877      .764937     -.178634     8.346961          8.0000  20.64000
36   8.400     .998445   -5.079626     21.714285      .765747     -.168065     8.821785          9.0000  21.94698
37   8.640     .999098   -5.188637     22.334693      .766248     -.157685     9.297016         10.0000  23.25187
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
```

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X(J) =     5.25000  DELSTR =   10.146579
                                                                                                         INTERPOLATED
  K    ETA        U           V              Y          UST          VST         PSI              PSI        Y          Y
  1   0.000    0.000000    0.000000      0.000000    0.000000    0.000000    0.000000          -.0100    3.11612    1.40696
  2    .240    -.009096    -.005178       .628752    -.006958    -.002439    -.002187          -.0050    3.37913     .97664
  3    .480    -.011886    -.021575      1.257503    -.009092    -.009444    -.007233          0.0000    3.61330
  4    .720    -.008424    -.050887      1.886255    -.006444    -.020709    -.012117           .0050    3.80631
  5    .960     .001208    -.094738      2.515007     .000924    -.035917    -.013852           .0100    3.94434
  6   1.200     .016894    -.154637      3.143759     .012923    -.054732    -.009499           .0150    4.07526
  7   1.440     .038466    -.231886      3.772510     .029424    -.076781     .003813           .0200    4.19908
  8   1.680     .065729    -.327553      4.401262     .050278    -.101642     .028870           .0250    4.31580
  9   1.920     .098448    -.442437      5.030014     .075306    -.128847     .068350           .0300    4.42143
 10   2.160     .136339    -.576996      5.658766     .104290    -.157870     .124811           .0350    4.50910
 11   2.400     .179060    -.731282      6.287517     .136969    -.188115     .200657           .0400    4.59427
 12   2.640     .226196    -.904889      6.916269     .173025    -.218924     .298112           .0450    4.67695
 13   2.880     .277246   -1.096897      7.545021     .212075    -.249577     .419178           .0500    4.75713
 14   3.120     .331604   -1.305838      8.173773     .253655    -.279317     .565592           .1000    5.39936
 15   3.360     .388552   -1.529680      8.802524     .297216    -.307376     .738773           .1500    5.88111
 16   3.600     .447249   -1.765830      9.431276     .342115    -.333009     .939763           .2000    6.28260
 17   3.840     .506745   -2.011194     10.060028     .387626    -.355542    1.169176           .2500    6.61954
 18   4.080     .566002   -2.262270     10.688780     .432954    -.374413    1.427147           .3000    6.92683
 19   4.320     .623931   -2.515299     11.317531     .477265    -.389221    1.713297           .3500    7.19782
 20   4.560     .679448   -2.766465     11.946283     .519732    -.399757    2.026729           .4000    7.45199
 21   4.800     .731544   -3.012117     12.575035     .559582    -.406023    2.366040           .4500    7.68478
 22   5.040     .779348   -3.249008     13.203787     .596149    -.408230    2.729374           .5000    7.90311
 23   5.280     .822193   -3.474503     13.832538     .628922    -.406772    3.114507          1.0000    9.60271
 24   5.520     .859660   -3.686730     14.461290     .657582    -.402182    3.518953          1.5000   10.85382
 25   5.760     .891599   -3.884662     15.090042     .682014    -.395070    3.940090          2.0000   11.89446
 26   6.000     .918120   -4.068103     15.718794     .702300    -.386066    4.375284          2.5000   12.81087
 27   6.240     .939558   -4.237597     16.347545     .718699    -.375759    4.822012          3.0000   13.64866
 28   6.480     .956420   -4.394275     16.976297     .731597    -.364660    5.277950          3.5000   14.43237
 29   6.720     .969323   -4.539663     17.605049     .741467    -.353174    5.741046          4.0000   15.17755
 30   6.960     .978926   -4.675496     18.233801     .748813    -.341593    6.209554          4.5000   15.89559
 31   7.200     .985876   -4.803540     18.862552     .754129    -.330108    6.682043          5.0000   16.59414
 32   7.440     .990768   -4.925458     19.491304     .757871    -.318822    7.157379          6.0000   17.95322
 33   7.680     .994116   -5.042723     20.120056     .760432    -.307774    7.634697          7.0000   19.28342
 34   7.920     .996344   -5.156572     20.748808     .762137    -.296959    8.113356          8.0000   20.60001
 35   8.160     .997786   -5.267994     21.377559     .763240    -.286350    8.592898          9.0000   21.91073
 36   8.400     .998694   -5.377745     22.006311     .763934    -.275908    9.073004         10.0000   23.21917
 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
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X(J) =      5.37500  DELSTR =   10.061357
                                                                                                 INTERPOLATED
  K     ETA          U          V             Y        UST        VST        PSI               PSI         Y          Y
  1   0.000   0.000000   0.000000      0.000000   0.000000   0.000000   0.000000             -.0050   2.90782    1.09160
  2    .240   -.007859   -.006632       .637021   -.005996   -.002894   -.001910             0.0000   3.24586
  3    .480   -.009322   -.027261      1.274042   -.007112   -.011208   -.006085              .0050   3.44582
  4    .720   -.004443   -.063332      1.911063   -.003389   -.024530   -.009430              .0100   3.62925
  5    .960    .006687   -.116239      2.548084    .005102   -.042449   -.008884              .0150   3.79615
  6   1.200    .023938   -.187240      3.185105    .018264   -.064529   -.001442              .0200   3.92130
  7   1.440    .047122   -.277423      3.822126    .035952   -.090314    .015826              .0250   4.03570
  8   1.680    .076023   -.387681      4.459148    .058002   -.119321    .045751              .0300   4.14529
  9   1.920    .110377   -.518618      5.096169    .084212   -.151023    .091048              .0350   4.25008
 10   2.160    .149866   -.670483      5.733190    .114339   -.184835    .154288              .0400   4.35007
 11   2.400    .194106   -.843092      6.370211    .148092   -.220106    .237875              .0450   4.44526
 12   2.640    .242639  -1.035767      7.007232    .185120   -.256119    .344007              .0500   4.52531
 13   2.880    .294913  -1.247279      7.644253    .225002   -.292096    .474635              .1000   5.19446
 14   3.120    .350273  -1.475812      8.281274    .267239   -.327217    .631419              .1500   5.69422
 15   3.360    .407950  -1.718952      8.918295    .311243   -.360648    .815672              .2000   6.09633
 16   3.600    .467060  -1.973713      9.555316    .356341   -.391581   1.028305              .2500   6.44840
 17   3.840    .526618  -2.236609     10.192337    .401780   -.419278   1.269774              .3000   6.75609
 18   4.080    .585562  -2.503776     10.829358    .446752   -.443123   1.540041              .3500   7.03857
 19   4.320    .642804  -2.771147     11.466379    .490424   -.462663   1.838541              .4000   7.29212
 20   4.560    .697279  -3.034683     12.103401    .531986   -.477645   2.164189              .4500   7.53151
 21   4.800    .748021  -3.290609     12.740422    .570699   -.488038   2.515406              .5000   7.75323
 22   5.040    .794225  -3.535668     13.377443    .605950   -.494025   2.890181             1.0000   9.47463
 23   5.280    .835306  -3.767322     14.014464    .637292   -.495983   3.286167             1.5000  10.73860
 24   5.520    .870932  -3.983891     14.651485    .664473   -.494433   3.700793             2.0000  11.78780
 25   5.760    .901043  -4.184611     15.288506    .687446   -.489982   4.131394             2.5000  12.71329
 26   6.000    .925826  -4.369586     15.925527    .706354   -.483266   4.575334             3.0000  13.55691
 27   6.240    .945680  -4.539669     16.562548    .721502   -.474889   5.030121             3.5000  14.34589
 28   6.480    .961154  -4.696277     17.199569    .733308   -.465381   5.493493             4.0000  15.09612
 29   6.720    .972885  -4.841186     17.836590    .742258   -.455177   5.963477             4.5000  15.81849
 30   6.960    .981533  -4.976324     18.473611    .748856   -.444604   6.438412             5.0000  16.52072
 31   7.200    .987733  -5.103598     19.110632    .753586   -.433891   6.916956             6.0000  17.88575
 32   7.440    .992054  -5.224764     19.747654    .756883   -.423180   7.398056             7.0000  19.22076
 33   7.680    .994982  -5.341348     20.384675    .759117   -.412547   7.880918             8.0000  20.54149
 34   7.920    .996912  -5.454606     21.021696    .760589   -.402023   8.364960             9.0000  21.85595
 35   8.160    .998149  -5.565529     21.658717    .761533   -.391610   8.849772            10.0000  23.16794
 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
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X(J) =     5.50000  DELSTR =     9.958263
                                                                                                  INTERPOLATED
  K    ETA        U          V                Y          UST         VST         PSI             PSI       Y          Y
  1   0.000   0.000000   0.000000         0.000000   0.000000    0.000000    0.000000         -.0050   2.43365   1.41782
  2    .240   -.006363   -.008351          .645215   -.004842    -.003422    -.001562         0.0000   2.77073
  3    .480   -.006269   -.033933         1.290431   -.004770    -.013245    -.004663          .0050   3.06394
  4    .720    .000224   -.077802         1.935646    .000170    -.028907    -.006147          .0100   3.28817
  5    .960    .013020   -.140997         2.580861    .009908    -.049860    -.002896          .0150   3.44910
  6   1.200    .031969   -.224441         3.226076    .024328    -.075548     .008149          .0200   3.60010
  7   1.440    .056877   -.328923         3.871292    .043283    -.105404     .029961          .0250   3.74116
  8   1.680    .087507   -.455080         4.516507    .066592    -.138859     .065407          .0300   3.87210
  9   1.920    .123567   -.603276         5.161722    .094033    -.175314     .117226          .0350   3.97312
 10   2.160    .164703   -.773509         5.806937    .125337    -.214116     .187996          .0400   4.07084
 11   2.400    .210490   -.965322         6.452153    .160180    -.254551     .280106          .0450   4.16527
 12   2.640    .260421  -1.177732         7.097368    .198176    -.295836     .395714          .0500   4.25641
 13   2.880    .313894  -1.409167         7.742583    .238868    -.337129     .536708          .1000   4.96344
 14   3.120    .370202  -1.657437         8.387798    .281718    -.377544     .704653          .1500   5.47667
 15   3.360    .428525  -1.919730         9.033014    .326101    -.416182     .900740          .2000   5.89761
 16   3.600    .487937  -2.192655         9.678229    .371312    -.452172    1.125731          .2500   6.25406
 17   3.840    .547419  -2.472339        10.323444    .416578    -.484719    1.379910          .3000   6.57064
 18   4.080    .605897  -2.754576        10.968659    .461078    -.513158    1.663049          .3500   6.85475
 19   4.320    .662284  -3.035033        11.613875    .503988    -.536995    1.974386          .4000   7.11837
 20   4.560    .715547  -3.309498        12.259090    .544520    -.555951    2.312643          .4500   7.35698
 21   4.800    .764773  -3.574142        12.904305    .581981    -.569973    2.676061          .5000   7.58370
 22   5.040    .809231  -3.825766        13.549521    .615812    -.579236    3.062478         1.0000   9.32624
 23   5.280    .848422  -4.062005        14.194736    .645637    -.584114    3.469431         1.5000  10.60390
 24   5.520    .882112  -4.281438        14.839951    .671274    -.585132    3.894276         2.0000  11.66424
 25   5.760    .910327  -4.483614        15.485166    .692745    -.582909    4.334319         2.5000  12.59637
 26   6.000    .933335  -4.668974        16.130382    .710253    -.578094    4.786937         3.0000  13.44735
 27   6.240    .951591  -4.838696        16.775597    .724146    -.571311    5.249686         3.5000  14.24189
 28   6.480    .965682  -4.994486        17.420812    .734869    -.563117    5.720375         4.0000  14.99658
 29   6.720    .976260  -5.138351        18.066027    .742919    -.553973    6.197121         4.5000  15.72297
 30   6.960    .983980  -5.272392        18.711243    .748794    -.544239    6.678359         5.0000  16.42880
 31   7.200    .989458  -5.398630        19.356458    .752962    -.534176    7.162837         6.0000  17.79998
 32   7.440    .993237  -5.518885        20.001673    .755838    -.523958    7.649587         7.0000  19.13993
 33   7.680    .995772  -5.634705        20.646888    .757767    -.513693    8.137888         8.0000  20.46483
 34   7.920    .997424  -5.747348        21.292104    .759024    -.503440    8.627216         9.0000  21.78303
 35   8.160    .998471  -5.857784        21.937319    .759821    -.493223    9.117207        10.0000  23.09854
 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
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X(J) =     5.62500  DELSTR =    9.838104
                                                                                                        INTERPOLATED
  K   ETA        U          V              Y          UST         VST        PSI               PSI         Y          Y
  1   0.000   0.000000   0.000000       0.000000   0.000000    0.000000    0.000000          0.0000     2.20776
  2    .240   -.004568   -.010363        .653332   -.003467    -.004031    -.001133           .0050     2.65103
  3    .480   -.002668   -.041690       1.306663   -.002025    -.015576    -.002927           .0100     2.88515
  4    .720    .005643   -.094475       1.959995    .004283    -.033875    -.002189           .0150     3.09704
  5    .960    .020272   -.169218       2.613327    .015387    -.058185     .004236           .0200     3.28198
  6   1.200    .041054   -.266394       3.266658    .031162    -.087792     .019443           .0250     3.41598
  7   1.440    .067791   -.386439       3.919990    .051458    -.122008     .046432           .0300     3.54377
  8   1.680    .100229   -.529657       4.573322    .076080    -.160158     .088094           .0350     3.66534
  9   1.920    .138049   -.696110       5.226653    .104787    -.201548     .147177           .0400     3.78071
 10   2.160    .180861   -.885497       5.879985    .137285    -.245450     .226254           .0450     3.88987
 11   2.400    .228198  -1.097052       6.533317    .173217    -.291077     .327684           .0500     3.98218
 12   2.640    .279505  -1.329455       7.186648    .212162    -.337578     .453574           .1000     4.71634
 13   2.880    .334126  -1.580770       7.839980    .253622    -.384041     .605730           .1500     5.25215
 14   3.120    .391301  -1.848412       8.493312    .297022    -.429516     .785607           .2000     5.67706
 15   3.360    .450162  -2.129165       9.146644    .341701    -.473042     .994256           .2500     6.04309
 16   3.600    .509741  -2.419242       9.799975    .386925    -.513691    1.232273           .3000     6.36624
 17   3.840    .568992  -2.714405      10.453307    .431900    -.550621    1.499755           .3500     6.65658
 18   4.080    .626831  -3.010147      11.106639    .475804    -.583129    1.796271           .4000     6.92110
 19   4.320    .682187  -3.301923      11.759970    .517822    -.610699    2.120855           .4500     7.16951
 20   4.560    .734065  -3.585423      12.413302    .557202    -.633039    2.472028           .5000     7.39578
 21   4.800    .781617  -3.856840      13.066634    .593296    -.650096    2.847857          1.0000     9.16321
 22   5.040    .824191  -4.113121      13.719965    .625613    -.662054    3.246032          1.5000    10.45387
 23   5.280    .861386  -4.352143      14.373297    .653846    -.669302    3.663988          2.0000    11.52226
 24   5.520    .893062  -4.572809      15.026629    .677890    -.672383    4.099020          2.5000    12.46315
 25   5.760    .919337  -4.775025      15.679960    .697834    -.671936    4.548422          3.0000    13.31983
 26   6.000    .940553  -4.959595      16.333292    .713938    -.668634    5.009600          3.5000    14.11995
 27   6.240    .957219  -5.128023      16.986624    .726589    -.663123    5.480171          4.0000    14.87973
 28   6.480    .969951  -5.282290      17.639955    .736254    -.655984    5.958032          4.5000    15.61036
 29   6.720    .979409  -5.424611      18.293287    .743433    -.647704    6.441395          5.0000    16.31982
 30   6.960    .986240  -5.557226      18.946619    .748618    -.638668    6.928797          6.0000    17.69690
 31   7.200    .991035  -5.682233      19.599950    .752258    -.629162    7.419081          7.0000    19.04167
 32   7.440    .994308  -5.801484      20.253282    .754742    -.619386    7.911367          8.0000    20.37068
 33   7.680    .996478  -5.916521      20.906614    .756389    -.609472    8.405002          9.0000    21.69258
 34   7.920    .997877  -6.028578      21.559945    .757451    -.599497    8.899522         10.0000    23.01157
 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
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X(J) =     5.75000  DELSTR =    9.702114
                                                                                                     INTERPOLATED
  K   ETA        U          V              Y          UST         VST         PSI             PSI          Y          Y
  1   0.000   0.000000   0.000000       0.000000   0.000000    0.000000    0.000000         0.0000     1.78402
  2    .240   -.002434   -.012697        .661366   -.001843    -.004725    -.000610          .0050     2.16539
  3    .480    .001548   -.050612       1.322731    .001172    -.018216    -.000831          .0100     2.49318
  4    .720    .011898   -.113451       1.984097    .009009    -.039442     .002535          .0150     2.73326
  5    .960    .028517   -.200986       2.645463    .021593    -.067413     .012655          .0200     2.91145
  6   1.200    .051254   -.313086       3.306829    .038809    -.101209     .032629          .0250     3.07736
  7   1.440    .079907   -.449713       3.968194    .060505    -.139985     .065470          .0300     3.23098
  8   1.680    .114208   -.610768       4.629560    .086478    -.182937     .114075          .0350     3.36037
  9   1.920    .153817   -.795958       5.290926    .116469    -.229272     .181186          .0400     3.47032
 10   2.160    .198308  -1.004653       5.952292    .150158    -.278174     .269355          .0450     3.57627
 11   2.400    .247172  -1.235752       6.613657    .187157    -.328782     .380899          .0500     3.67820
 12   2.640    .299802  -1.487585       7.275023    .227008    -.380177     .517856          .1000     4.45380
 13   2.880    .355491  -1.757843       7.936389    .269175    -.431387     .681936          .1500     5.00058
 14   3.120    .413425  -2.043557       8.597755    .313043    -.481399     .874465          .2000     5.44232
 15   3.360    .472690  -2.341121       9.259120    .357918    -.529202    1.096341          .2500     5.81759
 16   3.600    .532278  -2.646385       9.920486    .403038    -.573826    1.347975          .3000     6.14497
 17   3.840    .591125  -2.954798      10.581852    .447596    -.614397    1.629265          .3500     6.44148
 18   4.080    .648143  -3.261618      11.243217    .490770    -.650198    1.939567          .4000     6.71187
 19   4.320    .702288  -3.562172      11.904583    .531768    -.680708    2.277703          .4500     6.95978
 20   4.560    .752614  -3.852139      12.565949    .569874    -.705647    2.641997          .5000     7.19443
 21   4.800    .798342  -4.127827      13.227315    .604499    -.724983    3.030342         1.0000     8.98095
 22   5.040    .838914  -4.386414      13.888680    .635221    -.738928    3.440296         1.5000    10.28523
 23   5.280    .874027  -4.626097      14.550046    .661807    -.747899    3.869201         2.0000    11.36478
 24   5.520    .903638  -4.846150      15.211412    .684229    -.752472    4.314313         2.5000    12.31287
 25   5.760    .927956  -5.046870      15.872778    .702642    -.753313    4.772927         3.0000    13.17686
 26   6.000    .947389  -5.229423      16.534143    .717357    -.751118    5.242496         3.5000    13.98216
 27   6.240    .962494  -5.395629      17.195509    .728795    -.746557    5.720714         4.0000    14.74638
 28   6.480    .973912  -5.547709      17.856875    .737440    -.740228    6.205573         4.5000    15.48103
 29   6.720    .982301  -5.688046      18.518241    .743792    -.732636    6.695391         5.0000    16.19408
 30   6.960    .988293  -5.818972      19.179606    .748329    -.724183    7.188810         6.0000    17.57728
 31   7.200    .992453  -5.942625      19.840972    .751479    -.715171    7.684770         7.0000    18.92693
 32   7.440    .995259  -6.060843      20.502338    .753604    -.705815    8.182475         8.0000    20.26004
 33   7.680    .997099  -6.175139      21.163703    .754997    -.696261    8.681344         9.0000    21.58559
 34   7.920    .998271  -6.286693      21.825069    .755885    -.686601    9.180966        10.0000    22.90800
 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
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X(J) =     5.87500  DELSTR =     9.552461
                                                                                                    INTERPOLATED
 K    ETA        U          V              Y          UST        VST        PSI              PSI         Y            Y
 1   0.000    0.000000   0.000000       0.000000   0.000000   0.000000   0.000000          0.0000     0.00000
 2    .240     .000079   -.015362        .669310    .000060   -.005505    .000020           .0050     1.71337
 3    .480     .006439   -.060675       1.338621    .004864   -.021142    .001668           .0100     2.10795
 4    .720     .019044   -.134494       2.007931    .014386   -.045500    .008110           .0150     2.35502
 5    .960     .037806   -.235619       2.677241    .028558   -.077270    .022481           .0200     2.57667
 6   1.200     .062595   -.363169       3.346552    .047284   -.115287    .047862           .0250     2.75200
 7   1.440     .093219   -.516507       4.015862    .070417   -.158513    .087252           .0300     2.89496
 8   1.680     .129405   -.695075       4.685173    .097752   -.206005    .143531           .0350     3.03068
 9   1.920     .170794   -.898208       5.354483    .129017   -.256864    .219420           .0400     3.15916
10   2.160     .216929  -1.124949       6.023793    .163868   -.310199    .317436           .0450     3.28040
11   2.400     .267258  -1.373878       6.693104    .201886   -.365085    .439837           .0500     3.38712
12   2.640     .321125  -1.642998       7.362414    .242577   -.420549    .588579           .1000     4.18038
13   2.880     .377770  -1.929659       8.031724    .285366   -.475570    .765258           .1500     4.74737
14   3.120     .436327  -2.230543       8.701035    .329600   -.529098    .971060           .2000     5.19576
15   3.360     .495837  -2.541714       9.370345    .374553   -.580088   1.206708           .2500     5.57603
16   3.600     .555261  -2.858725      10.039656    .419443   -.627552   1.472423           .3000     5.91340
17   3.840     .613520  -3.176794      10.708966    .463451   -.670614   1.767888           .3500     6.21231
18   4.080     .669537  -3.491042      11.378276    .505766   -.708564   2.092242           .4000     6.48701
19   4.320     .722298  -3.796767      12.047587    .545621   -.740907   2.444094           .4500     6.74191
20   4.560     .770918  -4.089744      12.716897    .582349   -.767398   2.821575           .5000     6.97548
21   4.800     .814700  -4.366496      13.386207    .615422   -.788048   3.222415          1.0000     8.78707
22   5.040     .853180  -4.624510      14.055518    .644490   -.803113   3.644051          1.5000    10.10453
23   5.280     .886158  -4.862360      14.724828    .669401   -.813053   4.083751          2.0000    11.19304
24   5.520     .913689  -5.079725      15.394138    .690198   -.818479   4.538748          2.5000    12.14910
25   5.760     .936063  -5.277293      16.063449    .707099   -.820085   5.006361          3.0000    13.01880
26   6.000     .953753  -5.456574      16.732759    .720462   -.818586   5.484102          3.5000    13.82988
27   6.240     .967355  -5.619658      17.402070    .730737   -.814665   5.969753          4.0000    14.59905
28   6.480     .977522  -5.768954      18.071380    .738417   -.808928   6.461413          4.5000    15.33783
29   6.720     .984908  -5.906953      18.740690    .743997   -.801885   6.957511          5.0000    16.05444
30   6.960     .990124  -6.036024      19.410001    .747936   -.793940   7.456794          6.0000    17.44342
31   7.200     .993702  -6.158287      20.079311    .750640   -.785401   7.958300          7.0000    18.79776
32   7.440     .996088  -6.275534      20.748621    .752442   -.776485   8.461314          8.0000    20.13485
33   7.680     .997634  -6.389206      21.417932    .753610   -.767343   8.965322          9.0000    21.46394
34   7.920     .998607  -6.500413      22.087242    .754344   -.758072   9.469967         10.0000    22.78966
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
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X(J) =     6.00000  DELSTR =   9.392881
                                                                                         INTERPOLATED
 K    ETA        U           V              Y          UST         VST         PSI              PSI         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   7.44C    .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
                                                                                                     INTERPOLATED
  K    ETA        U           V                   Y          UST         VST          PSI                  PSI        Y            Y
  1   0.000    0.000000    0.000000           0.000000    0.000000    0.000000    0.000000            0.0000    0.00000
  2    .240     .006257    -.019955            .684888     .004706    -.006704     .001612             .0050    1.08258
  3    .480     .018184    -.077891           1.369776     .013676    -.025615     .007907             .0100    1.48658
  4    .720     .035805    -.170201           2.054663     .026930    -.054682     .021812             .0150    1.74592
  5    .960     .059134    -.293857           2.739551     .044476    -.092051     .046265             .0200    1.97756
  6   1.200     .088132    -.446474           3.424439     .066286    -.136106     .084194             .0250    2.15478
  7   1.440     .122668    -.626214           4.109327     .092262    -.185452     .138488             .0300    2.30525
  8   1.680     .162498    -.831594           4.794215     .122219    -.238882     .211936             .0350    2.44775
  9   1.920     .207247   -1.061226           5.479103     .155876    -.295315     .307168             .0400    2.58227
 10   2.160     .256408   -1.313550           6.163990     .192851    -.353733     .426587             .0450    2.70881
 11   2.400     .309348   -1.586601           6.848878     .232668    -.413129     .572303             .0500    2.81454
 12   2.640     .365313   -1.877847           7.533766     .274761    -.472476     .746069             .1000    3.63948
 13   2.880     .423440   -2.184113           8.218654     .318480    -.530718     .949221             .1500    4.22569
 14   3.120     .482771   -2.501580           8.903542     .363104    -.586795    1.182625             .2000    4.69220
 15   3.360     .542269   -2.825872           9.588430     .407854    -.639676    1.446635             .2500    5.08273
 16   3.600     .600850   -3.152216          10.273317     .451914    -.688415    1.741057             .3000    5.43184
 17   3.840     .657431   -3.475662          10.958205     .494470    -.732207    2.065141             .3500    5.73756
 18   4.080     .710978   -3.791363          11.643093     .534744    -.770441    2.417589             .4000    6.02114
 19   4.320     .760574   -4.094872          12.327981     .572046    -.802741    2.796602             .4500    6.28084
 20   4.560     .805476   -4.382432          13.012869     .605818    -.828991    3.199955             .5000    6.52165
 21   4.800     .845165   -4.651215          13.697757     .635669    -.849328    3.625094            1.0000    8.37400
 22   5.040     .879378   -4.899480          14.382644     .661402    -.864119    4.069268            1.5000    9.71700
 23   5.280     .908113   -5.126620          15.067532     .683014    -.873913    4.529655            2.0000   10.82478
 24   5.520     .931609   -5.333099          15.752420     .700686    -.879379    5.003495            2.5000   11.79542
 25   5.760     .950298   -5.520279          16.437308     .714742    -.881238    5.488199            3.0000   12.67762
 26   6.000     .964754   -5.690189          17.122196     .725615    -.880207    5.981441            3.5000   13.49921
 27   6.240     .975623   -5.845256          17.807083     .733790    -.876946    6.481205            4.0000   14.27740
 28   6.480     .983563   -5.988050          18.491971     .739762    -.872031    6.985814            4.5000   15.02399
 29   6.720     .989200   -6.121066          19.176859     .744002    -.865935    7.493920            5.0000   15.74742
 30   6.960     .993087   -6.246564          19.861747     .746925    -.859028    8.004478            6.0000   17.14775
 31   7.200     .995691   -6.366483          20.546635     .748884    -.851584    8.516709            7.0000   18.51114
 32   7.440     .997385   -6.482400          21.231523     .750158    -.843799    9.030047            8.0000   19.85575
 33   7.680     .998456   -6.595540          21.916410     .750963    -.835806    9.544097            9.0000   21.19146
 34   7.920     .999113   -6.706815          22.601298     .751457    -.827692   10.058591           10.0000   22.52332
 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
```

```
X(J) =      6.25000  DELSTR =      9.064248
                                                                                                       INTERPOLATED
 K    ETA         U            V              Y           UST         VST          PSI            PSI        Y           Y
 1   0.000    0.000000    0.000000       0.000000    0.000000    0.000000     0.000000         0.0000    0.00000
 2    .240     .009684    -.021614        .692502     .007270    -.007052      .002517          .0050     .90856
 3    .480     .024631    -.084121       1.385004     .018490    -.026919      .011436          .0100    1.28914
 4    .720     .044913    -.183146       2.077506     .033716    -.057360      .029513          .0150    1.53791
 5    .960     .070598    -.314981       2.770008     .052997    -.096352      .059537          .0200    1.73889
 6   1.200     .101701    -.476647       3.462510     .076346    -.142123      .104322          .0250    1.92402
 7   1.440     .138137    -.665802       4.155012     .103698    -.193147      .166663          .0300    2.09020
 8   1.680     .179688    -.880539       4.847514     .134890    -.248107      .249274          .0350    2.21775
 9   1.920     .225981   -1.119118       5.540017     .169641    -.305840      .354718          .0400    2.34021
10   2.160     .276490   -1.379679       6.232519     .207558    -.365268      .485324          .0450    2.45759
11   2.400     .330547   -1.659992       6.925021     .248138    -.425351      .643109          .0500    2.56989
12   2.640     .387353   -1.957292       7.617523     .290782    -.485043      .829711          .1000    3.40279
13   2.880     .446000   -2.268187       8.310025     .334807    -.543292     1.046322          .1500    3.98423
14   3.120     .505485   -2.588679       9.002527     .379462    -.599051     1.293638          .2000    4.45032
15   3.360     .564743   -2.914263       9.695029     .423947    -.651322     1.571820          .2500    4.85269
16   3.600     .622679   -3.240104      10.387531     .467439    -.699206     1.880463          .3000    5.19553
17   3.840     .678218   -3.561284      11.080033     .509131    -.741957     2.218601          .3500    5.51158
18   4.080     .730362   -3.873087      11.772535     .548275    -.779038     2.584729          .4000    5.79235
19   4.320     .778252   -4.171299      12.465037     .584226    -.810150     2.976858          .4500    6.05588
20   4.560     .821226   -4.452486      13.157539     .616486    -.835256     3.392606          .5000    6.30106
21   4.800     .858858   -4.714206      13.850041     .644736    -.854562     3.829305         1.0000    8.16868
22   5.040     .890984   -4.955132      14.542543     .668852    -.868493     4.284136         1.5000    9.52245
23   5.280     .917694   -5.175055      15.235046     .688904    -.877634     4.754260         2.0000   10.63815
24   5.520     .939308   -5.374783      15.927548     .705128    -.882672     5.236945         2.5000   11.61622
25   5.760     .956317   -5.555947      16.620050     .717897    -.884327     5.729669         3.0000   12.50444
26   6.000     .969330   -5.720747      17.312552     .727666    -.883301     6.230197         3.5000   13.33035
27   6.240     .979004   -5.871684      18.005054     .734928    -.880226     6.736622         4.0000   14.11253
28   6.480     .985993   -6.011318      18.697556     .740174    -.875648     7.247377         4.5000   14.86272
29   6.720     .990896   -6.142070      19.390058     .743855    -.870005     7.761224         5.0000   15.58935
30   6.960     .994238   -6.266085      20.082560     .746364    -.863637     8.277214         6.0000   16.99506
31   7.200     .996449   -6.385168      20.775062     .748024    -.856794     8.794647         7.0000   18.36267
32   7.440     .997871   -6.500758      21.467564     .749091    -.849651     9.313025         8.0000   19.71076
33   7.680     .998758   -6.613957      22.160066     .749757    -.842326     9.832003         9.0000   21.04949
34   7.920     .999296   -6.725573      22.852568     .750161    -.834896    10.351351        10.0000   22.38411
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
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```
X(J) =      6.37500  DELSTR =    8.900685
                                                                                                         INTERPOLATED
 K    ETA        U          V             Y          UST        VST         PSI                 PSI         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
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