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ANL-CANDID,

A Two-dimensional, Diffusion-theory Code Based on CANDID2D

by

G. K. Leaf, A. S. Kennedy, and G. C. Jensen

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Applied Mathematics Division

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A Two-dimensional, Diffusion-theory Code Based on CANDID2D

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ABSTRACT

ANL-CANDID is an extension and modification of the two-dimensional diffusion-theory code CANDID2D developed by Computer Applications Incorporated[1] for use on the Control Data Corporation 3600 computer. The code, as delivered, was capable of performing a reactivity calculation as well as geometry, composition, and buckling searches. These calculations were limited to rz geometry. In addition, the code could perform an up-scattering calculation. The present code is the result of extending and modifying the C.A.I. code. The extensions include the capability of performing calculations in xy and $r\theta$ geometry, including the full periodic case. Adjoint and source calculations were added with an acceleration procedure for the source calculation. In addition, an α calculation was added. The use of two-term Chebyshev extrapolation was retained; however, the strategy for employing it was changed. In addition, the strategy employed in the search procedure was completely changed. Mesh refinement and restart capability have been provided.

I. FINITE-DIFFERENCE EQUATIONS

A. Derivation of Equations for $r\theta$ Geometry

We shall begin our discussion by deriving the finite-difference equations for $r\theta$ geometry. The derivation is based on the usual first-order approximation and is consistent with the derivation for rz geometry.[1] In the absence of external sources, the system of multigroup diffusion equations can be written in the form

$$-\mathrm{div}(D_g \nabla \phi_g) + (\sigma_R^g + D_g B^2)\phi_g = \sum_{g' \neq g} \sigma^{g'g}\phi_{g'} + \frac{1}{k}\sum_{g'=1}^{G} \chi^{g'g}(\nu\sigma_f)_{g'}\phi_{g'}, \quad g = 1, 2, \ldots, G, \tag{1.1}$$

with external boundary conditions having the form

$$A_g \nabla \phi_g \cdot \bar{n} + B_g \phi_g = C_g, \tag{1.2}$$

where B denotes the transverse buckling, and $\bar{n}$ is the unit normal for the exterior surface of the reactor. The reactor configuration is assumed to be composed of regions such that the macroscopic cross sections are constant within each region.

The object of the continuous problem described above is to find the unique positive flux $\{\phi_g\}_{g=1}^{G}$ and the corresponding positive number k for which the system 1.1 has a solution subject to the conditions 1.2. In practice, we replace the continuous system by a finite-difference approximation and solve the resulting system. To this end, let the reactor domain be defined by $R_L \le R \le R_R$, $\Theta_B \le \Theta \le \Theta_T$. In addition, we lay down a mesh $R_L = R_0 < R_1 < \dots < R_I = R_R$, and $\Theta_B = \Theta_0 < \Theta_1 < \dots < \Theta_J = \Theta_T$. Here we include the possibility of $\Theta_B = 0$, $\Theta_T = 2\pi$, which is the full periodic case. The mesh is assumed to be laid down in such a manner that region boundaries occur only along mesh lines. Consider an interior cell centered at (r_i, θ_j), as shown in Fig. 1. Integrate each member of the system 1.1 over this cell, apply Green's Theorem to the divergence term, and make the approximation

$$\int_{\theta_{j-1}}^{\theta_j} \int_{R_{i-1}}^{R_i} \phi_g(r,\theta)\, r\, dr\, d\theta \cong \phi_g(r_i,\theta_j)\, V_{ij} = \phi_{ijg} V_{ij}, \tag{1.3}$$

where

$$V_{ij} = (\Delta\theta_j/2)(R_i^2 - R_{i-1}^2)$$

is the volume of the cell and

$$\Delta\theta_j = \Theta_j - \Theta_{j-1}.$$

Having done this, we obtain the system

$$-\int D_g \frac{\partial \phi_g}{\partial n}\, d\Omega + \left(\sigma_R^g + D_g B^2\right) V_{ij}\phi_{ijg} = \sum_{g' \neq g} \sigma^{g'g} V_{ij}\phi_{ijg} + \frac{1}{k}\sum_{g'=1}^{G} \chi^{g'g} (\nu\sigma_f)_{g'}\, \phi_{ijg'}. \tag{1.4}$$

The surface integral extends over the four surfaces of the (i,j)th cell. Along the surfaces extending from points 1 to 2 and 3 to 4 in Fig. 1, we have $\partial\phi/\partial n = \partial\phi/\partial r$. Region boundaries may lie along any of these surfaces, so that ordinary interpolation will not suffice for even a first-order approximation. However, if we impose the conditions that the flux and current are continuous across the region boundaries and if we neglect the dependence of $\partial\phi/\partial r$ on θ, we can approximate two of the surface integrals as follows:[3]

$$\left.\begin{aligned} &\text{a.} \quad \int_1^2 D\frac{\partial\phi}{\partial r}\,d\Omega \cong \left(\frac{\hat{D}}{\ell}\right)_E (\phi_E - \phi_0)\, R_i \Delta\theta_j, \\ &\text{b.} \quad \int_3^4 D\frac{\partial\phi}{\partial r}\,d\Omega \cong \left(\frac{\hat{D}}{\ell}\right)_W (\phi_W - \phi_0)\, R_{i-1} \Delta\theta_j. \end{aligned}\right\} \qquad (1.5)$$

Here we have dropped the group index, and we are using the subscripts 0, E, and W for the subscripts (i,j), (i+1,j) and (i-1,j), respectively. The linkage coefficients are defined by

$$\left.\begin{aligned} &\text{a.} \quad \left(\frac{\ell}{\hat{D}}\right)_E = \frac{\frac{1}{2}\Delta R_i}{D_0} + \frac{\frac{1}{2}\Delta R_{i+1}}{D_E}, \\ &\text{b.} \quad \left(\frac{\ell}{\hat{D}}\right)_W = \frac{\frac{1}{2}\Delta R_{i-1}}{D_W} + \frac{\frac{1}{2}\Delta R_i}{D_0}, \end{aligned}\right\} \qquad (1.6)$$

where D_0, D_E, and D_W denote the values of the diffusion lengths in the respective cells.

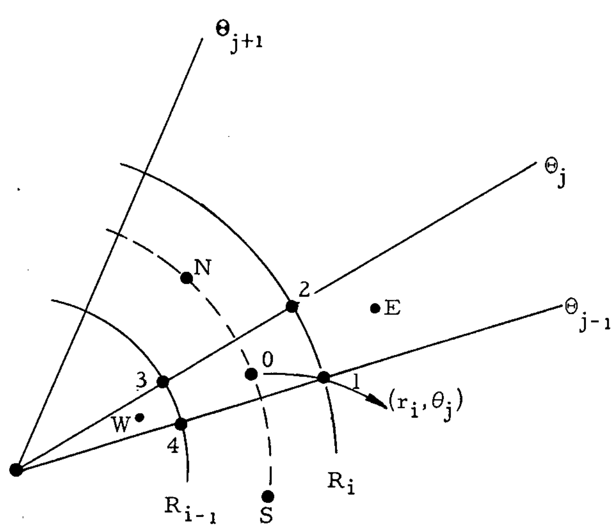

Fig. 1 Interior Cell, Centered at (r_i, θ_j)

For the remaining two surfaces, $\partial\phi/\partial n = (1/r)(\partial\phi/\partial\theta)$, and an approximation is sought for this tangential derivative along the two surfaces. Consider the surface extending from points 2 to 3, as shown in Fig. 2. To approximate the tangential derivative at the region boundary, we first approximate the derivative of ϕ in the direction of the chord joining the points 0 and N. This is done just as before, where now

$$\left(\frac{\ell}{\hat{D}}\right)_N = \frac{\ell_N}{D_N} + \frac{\delta_0}{D_0}. \qquad (1.7)$$

This approximation $(\hat{D}/\ell)_N\,(\phi_N - \phi_0)$, is then projected in the direction of the tangential derivative and the resulting component,

$$\left(\frac{\hat{D}}{\ell}\right)_N (\phi_N - \phi_0) \cos \frac{\Delta\theta_{j+1} - \Delta\theta_j}{2},$$

is taken as the approximation to the tangential derivative. Thus,

$$\int_2^3 D \frac{\partial\phi}{\partial n}\, d\Omega \cong \left(\frac{\hat{D}}{\ell}\right)_N (\phi_N - \phi_0)\, \Delta R_i \cos \frac{\Delta\theta_{j+1} - \Delta\theta_j}{2}. \tag{1.8}$$

If we set $\delta_U = \delta_0 + \ell_N$, then

$$\delta_U = (R_i + R_{i-1}) \sin \frac{\Delta\theta_j + \Delta\theta_{j+1}}{4}, \tag{1.9}$$

and

$$\ell_N = \frac{\delta_U \omega_U}{1 + \omega_U}, \qquad \delta_0 = \frac{\delta_U}{1 + \omega_U}, \tag{1.10}$$

where

$$\omega_U = \frac{\sin \frac{1}{2} \Delta\theta_{j+1}}{\sin \frac{1}{2} \Delta\theta_j}.$$

The surface integral over the surface from 3 to 4 is handled in an analogous manner. Having finished the case of interior mesh cells, we must now consider the case when one or more of the surfaces of the cell are part of the exterior boundary when a boundary condition of the form $A\, \partial\phi/\partial n + B\phi = C$ is imposed. If, for example, the surface from 1 to 2 is an exterior surface, we obtain in the usual fashion[3]

$$\int_1^2 D \frac{\partial\phi}{\partial n}\, d\Omega \cong \frac{D_0(C - B\phi_0)}{A + \frac{1}{2}\Delta R_i B} R_i \Delta\theta_j, \tag{1.11}$$

with an analogous expression for the integral from 3 to 4. If, for example, the surface from 2 to 3 is a part of the exterior surface, then $\Delta\theta_{j+1} = 0$; therefore, $\ell_N = 0$, $\delta_U = \delta_0$, and $\omega_U = 0$. Thus,

$$\int_2^3 D \frac{\partial\phi}{\partial n}\, d\Omega \cong \frac{D_0(C - B\phi_0)\, \Delta R_i}{A + \delta_0 B} \cos \frac{1}{2} \Delta\theta_j, \tag{1.12}$$

where

$$\delta_0 = (R_i + R_{i-1}) \sin \tfrac{1}{4} \Delta\theta_j.$$

Note that if an inhomogeneous boundary condition ($C \not\equiv 0$) is present, then a source term is present and the relevant calculation is a source calculation.

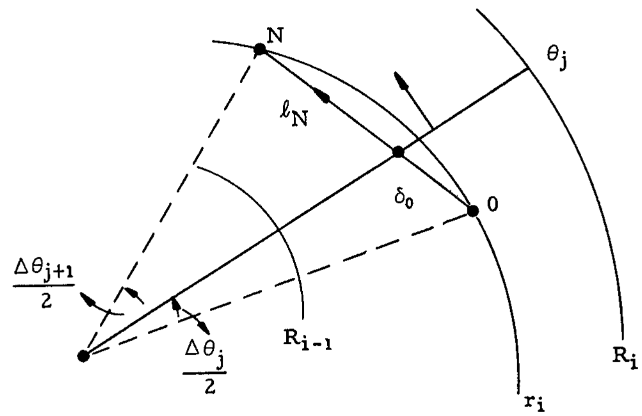

Fig. 2
Detail of Interface between Two Interior Cells

Having approximated the four surface integrals for the case of both interior and boundary points, we can make the following definitions for an interior cell:

$$\left.\begin{aligned}
a_{ij} &= \left(\frac{\hat{D}}{\ell}\right)_E R_i \Delta\theta_j, \\
b_{ij} &= \left(\frac{\hat{D}}{\ell}\right)_N \Delta R_i \cos \frac{\Delta\theta_{j+1} - \Delta\theta_j}{2}, \\
c_{ij} &= a_{i-1,j}, \\
\text{and} \\
d_{ij} &= b_{i,j-1}.
\end{aligned}\right\} \qquad (1.13)$$

At the boundary cells, we make the following definitions:

$$\left.\begin{aligned}
a_{I,j} &= \frac{DBR_I \Delta\theta_j}{A + \frac{1}{2}\Delta R_I B}, \qquad 1 \le j \le J; \\
b_{iJ} &= \frac{DB\Delta R_i}{A + \delta_0 B} \cos \frac{1}{2}\Delta\theta_J, \qquad 1 \le i \le I; \\
c_{1,j} &= \frac{DBR_0 \Delta\theta_j}{A + \frac{1}{2}\Delta R_1 B}, \qquad 1 \le j \le J; \\
\text{and} \\
d_{i,1} &= \frac{DB\Delta R_i}{A + \ell_0 B} \cos \frac{1}{2}\Delta\theta_1, \qquad 1 \le i \le I.
\end{aligned}\right\} \qquad (1.14)$$

In the full periodic case, $\theta_0 = 0$ and $\theta_J = 2\pi$; i.e., the top and bottom boundaries coincide. Thus, in this case we have

$$d_{i1} \equiv b_{iJ}, \qquad 1 \le i \le I. \tag{1.15}$$

Here we have dropped the group and region index on the quantities D, A, and B. Finally, if we set

$$e_{ijg} = a_{ijg} + b_{ijg} + e_{ijg} + d_{ijg} + \left(\sigma_R^g + D_g B^2\right) V_{ij},$$

the finite-difference system 1.4 takes the form

$$-(a_{ijg}\phi_{i+1,j,g} + b_{ijg}\phi_{i,j+1,g} + c_{ijg}\phi_{i-1,j,g} + d_{ijg}\phi_{i,j-1,g})$$

$$+ e_{ijg}\phi_{ijg} = \sum_{g' \neq g} \sigma^{g'g} V_{ij}\phi_{ijg} + \frac{1}{k}\sum_{g'=1}^{G} \chi^{g'g}(\nu\sigma_f)_{g'} V_{ij}\phi_{ijg}. \tag{1.16}$$

Here, since we have assumed that $C \equiv 0$, the calculation is a reactivity calculation rather than a source calculation. The case of a source calculation will be discussed in Section IV.

B. Finite-difference Equations XY Geometry

For completeness, we shall exhibit the expressions for the finite-difference coefficients for XY geometry. Let the reactor domain be defined by

$$X_L \le x \le X_R, \; Y_B \le y \le Y_T.$$

Again we construct a mesh

$$X_L = X_0 < X_1 < \ldots < X_I = X_R, \; Y_B = Y_0 < Y_1 < \ldots < Y_J = Y_T$$

in such a way that region boundaries lie along mesh lines. Letting

$$\Delta X_i = X_i - X_{i-1} \text{ and } \Delta Y_j = Y_j - Y_{j-1},$$

we set

$$\left.\begin{aligned} a_{ijg} &= \frac{2D_{ijg}D_{i+1,j,g}\Delta Y_j}{\Delta X_i D_{i+1,j,g} + \Delta X_{i+1} D_{i,j,g}}, \\ b_{ijg} &= \frac{2D_{ijg}D_{i,j+1,g}\Delta X_i}{\Delta Y_j D_{i,j+1,g} + \Delta Y_{j+1} D_{ijg}}, \\ c_{ijg} &= a_{i-1,j,g}, \text{ and } d_{ijg} = b_{i,j-1,g} \end{aligned}\right\} \tag{1.17}$$

at interior mesh cells. At the boundaries, we set

$$\left.\begin{aligned}
a_{Ijg} &= \frac{D_{Ijg}B_{Ijg}\Delta Y_j}{A_{Ijg} + \frac{1}{2}\Delta X_I B_{Ijg}}, && 1 \le j \le J;\\[2ex]
b_{iJg} &= \frac{D_{iJg}B_{iJg}\Delta X_i}{A_{iJg} + \frac{1}{2}\Delta Y_J B_{iJg}}, && 1 \le i \le I;\\[2ex]
c_{1jg} &= \frac{D_{1jg}B_{1jg}\Delta Y_j}{A_{1jg} + \frac{1}{2}\Delta X_1 B_{1jg}}, && 1 \le j \le J;\\[2ex]
&\text{and}\\[2ex]
d_{i1g} &= \frac{D_{i1g}B_{i1g}\Delta X_i}{A_{i1g} + \frac{1}{2}\Delta Y_1 B_{i1g}}, && 1 \le i \le I;
\end{aligned}\right\} \qquad (1.18)$$

where the boundary constants A_{ijg} and B_{ijg} are permitted to vary by region and group. The form of the resulting finite-difference equation is the same as that in $r\theta$ or rz geometry.

II. ADJOINT CALCULATION

The differential operator associated with the partial-differential system 1.1 and 1.2, when viewed as an operator in the space L^2 over the reactor, has an adjoint operator in the same space. If the boundary conditions 1.2 are homogeneous, then the domain of the adjoint operator coincides with that of the real operator. Thus the functions that lie in the domain of the adjoint operator satisfy the same boundary conditions as the functions that lie in the domain of the real operator. Hence, the adjoint operator is, in this case, just the formal adjoint operator. Consequently the finite-difference approximation to the adjoint can be found by forming the transpose of the real finite-difference equations. Before displaying the transposed system, we shall put the finite-difference equations in the form of a matrix equation. The ordering of the space will be that of channel ordering,[3] which is just a permutation of the usual group ordering. The ordering is defined in the following way: For each i, $1 \le i \le I$, the set of points $I_i = \{(i,j,g): 1 \le j \le J, 1 \le g \le G\}$ is called a channel. The points within a channel are ordered first with respect to the energy groups; then within each energy group they are ordered with respect to the points in the channel. Thus the flux vector ϕ is partitioned in the following manner:

$$\left.\begin{aligned} \phi &= (\phi_1, \phi_2, \ldots, \phi_I)', && \\ \phi_i &= (\phi_{i1}, \phi_{i2}, \ldots, \phi_{iG})', && 1 \le i \le I; \\ \phi_{ig} &= (\phi_{ig1}, \phi_{ig2}, \ldots, \phi_{igJ})', && 1 \le i \le I, \quad 1 \le g \le G; \end{aligned}\right\} \tag{2.1}$$

where the prime denotes the transpose, since all vectors in this discussion are column vectors. Relative to this ordering of the flux space, we shall define the following matrices:

$$J_{ig} = \begin{bmatrix} e_{ig1} & -b_{ig1} & & & \\ -b_{ig1} & e_{ig2} & -b_{ig2} & & \\ & \ddots & \ddots & \ddots & \\ & & & & -b_{igJ-1} \\ & & & -b_{igJ-1} & e_{igJ} \end{bmatrix}; \; 1 \le g \le G, \; 1 \le i \le I; \tag{2.2}$$

(In the full periodic case, J_{ig} has the element $-b_{igJ}$ appearing in the extreme upper right- and lower left-hand corners.)

$$\left.\begin{aligned}
K_{ig} &= \operatorname{diag}\left[a_{ig1}, a_{ig2}, \ldots, a_{igJ}\right]; \\
B_i^{g'g} &= \operatorname{diag}\left[V_{i1}\sigma_{i1}^{g'g}, V_{i2}\sigma_{i2}^{g'g}, \ldots, V_{iJ}\sigma_{iJ}^{g'g}\right]; \\
F_i^{g'g} &= \operatorname{diag}\left[V_{i1}\sigma_{i1}^{g'g}(\nu\sigma_f)_{i1}^{g'}, \ldots, V_{iJ}\sigma_{iJ}^{g'g}(\nu\sigma_f)_{iJ}^{g'}\right].
\end{aligned}\right\} \qquad (2.3)$$

Then, collecting the above matrices, we define

$$\left.\begin{aligned}
&\text{a.}\quad J_i = \begin{bmatrix} J_{i1} & -B_i^{21} & \cdots & -B_i^{G1} \\ B_i^{12} & J_{i2} & & \vdots \\ \vdots & & \ddots & \vdots \\ -B_i^{1G} & \cdots & & J_{iG} \end{bmatrix}, \\
&\text{b.}\quad K_i = \operatorname{diag}\left[K_{i1}, K_{i2}, \ldots, K_{iG}\right], \\
&\text{and} \\
&\text{c.}\quad F_i = \begin{bmatrix} F_i^{11} & F_i^{21} & \cdots & F_i^{G1} \\ F^{12} & F_i^{22} & \cdots & \vdots \\ \vdots & & & \vdots \\ F_i^{1G} & \cdots & \cdots & F_i^{GG} \end{bmatrix}.
\end{aligned}\right\} \qquad (2.4)$$

Finally, we define the following matrices:

$$\left.\begin{aligned}
&\text{a.}\quad M = \begin{bmatrix} J_1 & -K_1 & & \\ -K_1 & J_2 & -K_2 & \\ & \ddots & \ddots & -K_{I-1} \\ & & K_{I-1} & J_I \end{bmatrix}; \\
&\text{b.}\quad F = \operatorname{diag}\left[F_1, F_2, \ldots, F_I\right].
\end{aligned}\right\} \qquad (2.5)$$

In terms of the matrices M and F, the finite-difference system 1.16 can be put in the following form:

$$M\phi = \frac{1}{k} F\phi. \tag{2.6}$$

As we have noted (see p. 14), the assumption of homogeneous boundary conditions enables us to approximate the continuous adjoint by simply solving the adjoint equations of Eq. 2.6. Thus we define ϕ^* by the following equation:

$$M^*\phi^* = \frac{1}{k} F^*\phi^*, \tag{2.7}$$

where the * denotes the operation of taking the transpose. Forming the transpose of M involves taking the transpose of each of its blocks, and, in particular, would involve the transpose of the matrice J_i. In the great majority of cases, J_i is block lower triangular, and the iterative algorithms are designed to exploit this fact. However, J_i^* will then be block upper triangular, which is undesirable if we wish to use exactly the same algorithms in both cases. To circumvent this difficulty, we form the adjoint matrices and then invert or reverse the order of the energy groups. Hence we define the following matrices:

$$\left.\begin{aligned}
&\text{a.} \quad \overline{J}_{ig} = J_{i,G-g+1}; \\
&\text{b.} \quad \overline{K}_{ig} = K_{i,G-g+1}; \\
&\text{c.} \quad \overline{B}_i^{gg'} = B_i^{G-g'+1,G-g+1}; \\
&\text{d.} \quad \overline{F}_i^{gg'} = F_i^{G-g'+1,G-g+1}.
\end{aligned}\right\} \tag{2.8}$$

Then with $\overline{J}_i$, $\overline{F}_i$, $\overline{K}_i$, $\overline{M}$, and $\overline{F}$ defined in terms of these matrices as before, we can solve the equation

$$\overline{M}\psi = \frac{1}{k} \overline{F}\psi, \tag{2.9}$$

which has the same form as the real equation.

We obtain the adjoint flux ϕ^* by setting

$$\phi^*_{i,g,j} = \psi_{i,G-g+1,j}. \tag{2.10}$$

III. SEARCH STRATEGY AND α-CALCULATIONS

Consider a critical system; at time $t = 0$, let the system be modified in some manner. Suppose that this modification or change is a constant in time; then if the matrices M and F reflect the conditions of the modified system, the flux $\Phi(x,t)$ can be described by the equation

$$V^{-1}\frac{\partial \Phi}{\partial t} = (F - M)\,\Phi, \tag{3.1}$$

where V is a diagonal matrix whose elements are the speeds associated with the energy groups. After a sufficient length of time, the flux can be reasonably described by a solution of Eq. 3.1 separable in time. Letting $\Phi(x,t) = \phi(x)e^{\alpha t}$ in 3.1 leads to

$$(M + \alpha V^{-1})\,\phi = F\phi. \tag{3.2}$$

Note that since αV^{-1} is a diagonal matrix, its effect is to change the diagonal elements of M from e_{igj} to $e_{igj} + \alpha v_g^{-1} V_{ij}$. Thus the form of Eqs. 3.2 is identical to that of Eq. 2.6 with $k = 1$. Thus if we call the result of solving 2.6 a k-calculation, we see that a means for solving 3.2 can be based on a series of k-calculations. Thus, for each given α, we solve the system

$$(M + \alpha V^{-1})\,\phi(\alpha) = \frac{1}{k(\alpha)}\,F\phi(\alpha). \tag{3.3}$$

Then we search for that value of α for which $k(\alpha) = 1$. Thus we see that an α-calculation is just a particular type of criticality search.

To discuss the strategy employed in a search calculation, we shall have to describe briefly the method used in solving Eq. 2.6. Now recall that

$$e_{igj} = a_{igj} + b_{igj} + c_{igj} + d_{igj} + V_{ij}\left[\left(\sigma_R^g\right)_{ij} + D_{ijg}B^2\right],$$

where for each (i,j), we have

$$\sigma_R^g = \sigma_c^g + \sigma_f^g + \sum_{g' \neq g} \sigma^{gg'}.$$

Thus,

$$e_{igj} > b_{igj} + d_{ijg} = b_{igj} + b_{igj-1};$$

hence, J_{ig}^{-1} exists and is positive. Moreover,

$$e_{igj} > V_{ij} \sum_{g' \neq g} \sigma_{ij}^{gg'};$$

hence, J_i^{-1} exists and is nonnegative. As a consequence, the matrix $M^{-1}F$ exists and is nonnegative. The problem posed by Eq. 2.6 can be viewed in the following manner: Find the largest positive eigenvalue and the corresponding positive eigenvector of the matrix $M^{-1}F$. The method used to find these quantities is that of power iterations.[4] The method consists of the following iterations: Starting with any nonnegative vector $\phi^{(0)}$ and any positive number $k^{(0)}$, the sequences $\psi^{(n)}$ and $k^{(n)}$ are generated as follows:

$$\psi^{(n)} = \frac{1}{k^{(n)}} (M^{-1}F)\, \psi^{(n-1)}, \qquad k^{(n)} = k^{(n-1)} \frac{\left(\psi^{(n)},\psi^{(n)}\right)}{\left(\psi^{(n)},\psi^{(n-1)}\right)}, \tag{3.4}$$

where

$$(\psi,\phi) = \sum_{ijg} \psi_{igj}\phi_{igj}.$$

Then, if the matrix $M^{-1}F$ is nonnegative and irreducible, it is well known[4] that the sequence $k^{(n)}$ will tend to the unique largest positive eigenvalue of the matrix, and the sequence $\psi^{(n)}$ will tend to the corresponding positive eigenvector. In the above situation, we see that the generation of $\psi^{(n)}$ from $\psi^{(n-1)}$ involves the solution of the equation

$$M\psi^{(n)} = \frac{1}{k^{(n-1)}} F\psi^{(n-1)}. \tag{3.5}$$

In general, the matrix M is far too large to be held in fast core; however, it is block tridiagonal with nonpositive off-diagonal blocks and nonsingular diagonal blocks, which are diagonally dominant and have nonnegative inverses. Thus, a Gauss-Seidel iterative procedure will converge to a solution of Eq. 3.5. Referring to Eq. 2.5a, we define

$$\left.\begin{aligned} &\text{a. } D = \operatorname{diag}[J_1, J_2, \ldots, J_I]; \\ &\text{b. } L = \begin{bmatrix} O & & & O \\ K_1 & O & & \\ & K_2 & O & \\ & & \ddots & \ddots \\ O & & K_{I-1} & O \end{bmatrix}, \quad U = \begin{bmatrix} O & K_1 & & O \\ & O & K_2 & \\ & & \ddots & \ddots \\ & & & K_{I-1} \\ O & & & O \end{bmatrix}. \end{aligned}\right\} \tag{3.6}$$

Then $M = D - L - U$, and a Gauss-Seidel iteration relative to this splitting is defined by the following procedure:

$$(D - L)\, X_n^{(\ell)} = UX_n^{(\ell-1)} + \frac{1}{k^{(n-1)}} F\psi^{(n-1)}, \qquad \ell = 1, 2, \ldots, \tag{3.7}$$

with $X_n^{(0)} = \psi^{(n-1)}$. The sequence $X_n^{(\ell)}$ will then converge to the solution $\psi^{(n)}$ of Eq. 3.5. Moreover, if there is no up-scattering, the matrices J_i can be inverted directly since they are then block lower triangular, with tridiagonal matrices forming the diagonal blocks. If up-scattering is present, the matrices J_i satisfy the necessary criteria so that a Gauss-Seidel iterative procedure can be applied to these matrices.

The present code does not go beyond the first iterate in the iterative procedure defined by Eq. 3.7. Thus, $\psi^{(n+1)}$ is defined to be equal to $\chi_n^{(1)}$; hence, the iterative procedure used in this code is as follows: Starting with any positive number $k^{(0)}$ and any nonnegative vector $\phi^{(0)}$, a sequence of numbers $k^{(n)}$ and vectors $\phi^{(n)}$ is generated by

$$(D - L)\, \phi^{(n)} = U\phi^{(n-1)} + \frac{1}{k^{(n-1)}} F\phi^{(n-1)}, \; k^{(n)} = k^{(n-1)} \frac{\left(\phi^{(n)}, \phi^{(n)}\right)}{\left(\phi^{(n)}, \phi^{(n-1)}\right)} . \tag{3.8}$$

Thus we see that the actual iterative procedure used in this code is a non-stationary, nonhomogeneous power iteration, where the product

$$\prod_{\ell=1}^{n} S_\ell$$

replaces

$$\frac{1}{\prod_{\ell=1}^{n} k^{(\ell)}} (M^{-1}F).$$

Here S_ℓ denotes the nonnegative matrix $(D - L)^{-1} [U + (1/k)(\ell)\, F]$.

Before we discuss the effect of the above iterative procedure on the search strategy, we shall display the above iterations in more detail. Thus, using the definitions of D, L, and U, we have the sweep through the channels.

$$J_i\phi_i^{(n)} = K_{i-1}\phi_{i-1}^{(n)} + K_i\phi_{i+1}^{(n-1)} + \frac{1}{k^{(n)}} F_i\phi_i^{(n-1)} \text{ for } i = 1, 2, \ldots, I \tag{3.9}$$

with $K_0 = K_I = 0$.

If up-scattering is present, the matrices J_i will not be block lower triangular; thus, the vector $\phi_i^{(n)}$ will be found iteratively. Within a given channel, we have the following iterative scheme:

$$J_{ig}Y_{ig}^{(m)} = \sum_{g'<g} B_i^{g'g}Y_{ig'}^{(m)} + \sum_{g>g'} B_i^{g'g}Y_{ig'}^{(m-1)} + K_{i-1,g}\phi_{i-1,g}^{(n)}$$

$$+ K_{ig}\phi_{i+1,g}^{(n-1)} + \frac{1}{k^{(n)}} \sum_{g'=1}^{G} F_i^{g'g}\phi_{ig'}^{(n-1)} \text{ for } g = 1, 2, \ldots, G. \tag{3.10}$$

Here we take $Y_{ig}^{(0)} = \phi_{ig}^{(n-1)}$, and upon achieving convergence, we set $\phi_{ig}^{(n)} = Y_{ig}^{(m)}$ for $g = 1, 2, \ldots, G$, and then move on to the next channel. If no up-scattering is present, we obtain $\phi_{ig}^{(n)}$ exactly in one sweep through the groups. Except for the full periodic case, the vectors $Y_{ig}^{(m)}$ are found by a direct inversion procedure based on the factorization of a tridiagonal matrix into the product of a lower bidiagonal and an upper bidiagonal matrix.[1,5] This technique is sometimes known as Choleski's method.[5] In the full periodic case, the solution is found by means of an iterative technique, which will be discussed in Section VI.

Having thus displayed the iteration procedure at various stages of detail, we shall consider the question of how a search is carried out. In a search, we seek the value of a parameter such that the resulting system has a k_{eff} equal to a prescribed value. Thus, we seek that value X_0 such that $k(X_0) = k_0$ where k_0 is given. This is accomplished by means of linear interpolation; hence, given

$$\left(X^{(s)}, k\left(X^{(s)}\right)\right) \text{ and } \left(X^{(s-1)}, k\left(X^{(s-1)}\right)\right),$$

a straight line is passed through these points, and $X^{(s+1)}$ is taken to be the abscissa of the intersection of this straight line with the line $k = k_0$. The major problem is that an estimate for $k(X)$ is expensive in machine time; moreover, the cost is higher than usual in this code for the following reason. Experience has shown that generally the rate of convergence of a power iteration procedure based on Eq. 3.4 is relatively fast ($r \cong 0.9$) for the flux and even faster for the sequence $k^{(n)}$. (In this context, by a rate of convergence r, we mean that the error eventually behaves like r^n, where n is the iteration count.) Since the matrix M is so large, we cannot perform an iterative procedure based on Eq. 3.4. On the other hand, we could base a practical iterative procedure on Eq. 3.5 in conjunction with Eq. 3.6. Then the same rate of convergence would apply to Eq. 3.5; however, the rate of convergence of Eq. 3.7 would be very much slower. Since the determination of the sequence $k^{(n)}$ is based on Eq. 3.5, we would expect the rate of convergence of $k^{(n)}$ to be comparable to a procedure based on Eq. 3.4, provided a sufficient number of iterations are performed in Eq. 3.7. However, since the flux is determined by Eq. 3.7, we would expect its rate of convergence to be slow. Thus, insofar as rates are concerned, we would expect the sequence $k^{(n)}$ to converge more rapidly than the fluxes. The present code uses only one iteration of Eq. 3.7 per iteration of Eq. 3.5, thereby creating the iterative procedure, Eq. 3.8. In this procedure, the rate for the sequence $k^{(n)}$ is now comparable to that for the flux estimates, hence converging at a rate of 0.99 or greater for the average-sized problem (Appendix A, Sample Problem 1). This situation, namely the slow convergence of the estimates $k^{(n)}$, causes an extreme amount of difficulty in the search procedure by compounding or accentuating the following dilemma: On the one hand, for a given $X^{(i)}$, a sufficiently accurate estimate $k^{(n)}\left(X^{(i)}\right)$ must be found for $k\left(X^{(i)}\right)$ to ensure that the sequence $X^{(i)}$ will converge to X_0. On the other hand, because of the curvature of $k(X)$, an accurate determination of $k\left(X^{(i)}\right)$ does not lead to a comparably accurate estimate $X^{(i+1)}$ of X_0 when $X^{(i)}$ is not near X_0. Taking these considerations into account, we have developed a search procedure based on the following observations:

1. Each $k^{(n)}(X)$ is very costly; its value in time corresponds to a complete sweep of the mesh for all groups.

2. The sequence $k^{(n)}(X)$ is slowly converging, its rate being of the same order as the flux.

3. The sequence $k^{(n)}(X)$ changes slowly as a function of X. Thus, if $k^{(n)}(X)$ is an acceptable estimate for a given X and if X' is the next estimate for X_0, then $k^{(1)}(X')$ is close to $k^{(n)}(X)$.

4. After a sufficient number of iterations, the sequence $k^{(n)}(X)$ converges to $k(X)$ in a geometric fashion.

With these observations in mind, the following strategy is employed: Suppose that we are beginning the iterations needed to approximate $k_i = k\left(X^{(i)}\right)$ corresponding to a control value $X^{(i)}$. Here $X^{(i)}$ may be an initial guess or the result of interpolation. The code then generates successive estimates $k_i^{(1)}$, $k_i^{(2)}$, ..., $k_i^{(n)}$ for k_i. Because of observations 2, 3, and 4, no change is contemplated until at least 15 iterations have been completed and a minimal level of convergence has been achieved. We then determine whether the sequence $k_i^{(n)}$ is heading towards the desired value k_0. If the sequence is heading away from k_0, we stop the iteration as soon as the following criterion is satisfied:

$$|k_i^{(n)} - k_i| < 0.2\,|k_i^{(n)} - k_0|. \tag{3.11}$$

Of course we do not know k_i; therefore $|k_i^{(n)} - k_i|$ must be estimated. Based on the assumption that the convergence of $k_i^{(n)}$ is geometric, this difference is approximated by

$$|k_i^{(n)} - k_i| \cong \frac{r_i^{(n)}}{1 - r_i^{(n)}} |\Delta k_i^{(n)}|, \tag{3.12}$$

where

$$r_i^{(n)} = \frac{|\Delta k_i^{(n)}|}{|\Delta k_i^{(n-1)}|}$$

and

$$\Delta k_i^{(n)} = k_i^{(n)} - k_i^{(n-1)}.$$

The test defined by 3.11 in conjunction with the approximation 3.12 is made only after at least three successive unextrapolated iterations have occurred. This restriction is necessary because extrapolation destroys the geometric character of the convergence. The case in which the sequence $k_i^{(n)}$ is heading towards k_0 is somewhat more complicated. In this case, an effort is made as soon as possible to determine whether the iterates $k_i^{(n)}$ will pass through the desired value k_0. Again this determination is made under the assumption that the sequence $k_i^{(n)}$ is converging geometrically; thus, the same restriction with regard to flux extrapolation is in effect. If the estimate $\overline{k}_i^{(n)}$ for k_i lies on the other side of k_0 or is close to k_0 (that is, $|k_0 - \overline{k}_i^{(n)}| < (10)\epsilon_c$), then the code continues to iterate without making a control change. On the other hand, if the estimate $\overline{k}_i^{(n)}$ lies on the same side of k_0 as $k_i^{(n)}$ and is not close to k_0, then the test defined by 3.11 and 3.12 is applied. If the test is satisfied, a control change is made using the estimate $\overline{k}_i^{(n)}$ for k_i. If the test is not satisfied, then the code continues to iterate (see Appendix A, Sample Problem 3).

Having discussed the decision-making process involved in seeking a value of the control parameter (X) such that $k(X) = k_0$, we turn next to the logical control of the search process. Of course, what we ultimately seek as the result of a criticality search is not the required order of X but the value of some reactor parameter(s) such that k (parameter(s)) = k_0; i.e., we must have parameter(s) = F(X). The functional relationship used in the program is

$$P_n^{(s)} = P_n^{(0)}(1 + X^{(s)}\delta P_n),$$

where

X^s is the value of the control parameter for the sth pass,

$P_n^{(0)}$ are the initial values of the reactor parameter(s),

$P_n^{(s)}$ are the values of the reactor parameter(s) for the sth pass,

and

δP_n are the parameter(s) modifier(s).

The code currently allows the following four choices of the parameter(s) P_n (i.e., four different types of criticality searches are possible):

1. <u>Composition Search</u>

$$P_n = VF_{m,c},$$

where $VF_{m,c}$ are the volume fractions for materials m in composition c.

2. <u>Dimension Search</u>

$$P_n = \Delta X_i \text{ and/or } \Delta Y_j,$$

where $\Delta X_i(\Delta Y_j)$ are the mesh increments (i.e., interval lengths) in the X(Y) direction.

3. <u>Buckling (B^2) Search</u>

$$P_n = B_r^2,$$

where B_r^2 is the transverse buckling for region r.

4. <u>α Calculation</u>

$$P_n = \alpha,$$

where α is the asymptotic inverse reactor time period.

The logical control of the criticality search is essentially as given in the CANDID2D document,[1] but is duplicated here for completeness.

A first guess, X_A, and either a second guess, X_B, or an estimate of dk/dX, (KDOT), and k_0 are required input. If KDOT is given, then X_B is computed from the following equation:

$$X_B = X_A + \left(k_0 - k\left(X_A\right)\right)/KDOT.$$

Once $k(X_A)$ and $k(X_B)$ are computed, linear extrapolation is done until k_0 is bracketed. A maximum number of extrapolations to bracket k_0 is provided in the input. Once k_0 has been bracketed, the values of $k(X)$ and X that best bracket k_0 are stored in X_L, k_L, X_R, and k_R such that $k_L < k_0 < k_R$.

For the purpose of the following discussion on bracketing k, let us assume that $\underline{X} < X_A < X_B < \overline{X}$. If an extrapolation results in $X < \underline{X}$, then a midpoint is attempted for X from $X = (\underline{X} + X_A)/2$. If a later extrapolation has the same result, $X < \underline{X}$, then the bound itself is used; i.e., $X = \underline{X}$.

A third failure at the same bound will be a terminal error. The above discussion follows through in a similar manner if $X_B < X_A$ and/or the failure is at the other bound, $\overline{X}$.

X_1, k_1, X_2, and k_2 are the interpolation parameters and are chosen in the following manner: Once k_0 has been bracketed, set X_1 and X_2 equal to X_L and X_R, and interpolate for X from the following equation:

$$X = X_1 + \frac{k_0 - k(X_1)}{k(X_2) - k(X_1)} (X_2 - X_1);$$

then $k(X)$ is computed, and the bounds are updated as follows:

If $k(X) < k_0$, then $X_L = X$ and $k_L = k(X)$;

or

if $k(X) > k_0$, then $X_R = X$ and $k_R = k(X)$.

The closest two values of X are used for the next interpolation:

If $|X - X_1| < |X - X_2|$, then $X_2 = X$ and $k_2 = k(X)$;

or

if $|X - X_2| < |X - X_1|$, then $X_1 = X$ and $k_1 = k(X)$.

Now interpolate for a new value of X. If X does not fall in range of the best known bounds,

$X < X_L$ and X_R,

or

$$X > X_L \text{ and } X_R,$$

then the bounds are used:

$$X_1 = X_L, \ k_1 = k_L,$$

or

$$X_2 = X_R, \ k_2 = k_R;$$

this will yield a valid X.

This procedure is continued until either the convergence criterion is met or a specifiable number of interpolations is exceeded.

IV. SOURCE CALCULATION

A source calculation can arise in two ways. Either a fixed source is prescribed, or an inhomogeneous boundary condition is present. In either event, the basic assumption of a source calculation is that the reactor system in the absence of the fixed source is subcritical. In terms of the matrices introduced in Section II, a source problem can be written in the form

$$(M - F)\,\phi = f, \tag{4.1}$$

where f is a prescribed nonnegative source. The assumption of subcriticality ensures that the matrix M - F is not singular. In addition, it ensures that the solution ϕ is nonnegative when f is nonnegative. This last statement is by virtue of the fact that $\phi = (1 - M^{-1}F)^{-1} M^{-1}f$, and by the hypothesis that the spectral radius of $M^{-1}F$ is less than one. Thus $(1 - M^{-1}F)^{-1} \geq 0$.

The method used to solve Eq. 4.1 takes advantage of the existing method for solving the homogeneous problem. Hence, in terms of the matrices introduced in Section III, the iterative procedure employed in the absence of up-scattering can be written in the form

$$(D - L)\,\phi^{(n)} = (U + F)\,\phi^{(n-1)} + f. \tag{4.2}$$

As far as the mechanics are concerned, this procedure differs from the k_{eff} case only to the extent that the eigenvalue estimates $k^{(n)}$ are not used in the fission source. Recalling the structure of D - L from Section III for no up-scattering, we see that $(D - L)^{-1}$ exists and is nonnegative. Furthermore, U + F is a nonnegative matrix; thus, the splitting M - F = (D - L) - (U + F) is a regular splitting.[3] As a consequence, the spectral radius of $(D - L)^{-1}(U + F)$ is less than one; thus, 4.2 is a convergent iterative procedure.

When up-scattering is present, we shall assume that a fixed number of up-scattering iterations are performed. From Eq. 3.10, we recall that within each channel i, $1 \leq i \leq I$, the up-scattering iterations have the following form:

$$J_{ig} Y_{ig}^{(m)} = \sum_{g'<g} B_i^{g'g} Y_{ig'}^{(m)} + \sum_{g'>g} B_i^{g'g} Y_{ig'}^{(m-1)} + K_{i-1,g}\phi_{i-1,g}^{(n)}$$
$$+ K_{ig}\phi_{i+1,g}^{(n-1)} + \sum_{g'=1}^{G} F_i^{g'g}\phi_{ig'}^{(n-1)} + f_{ig}, \qquad g = 1, 2, \ldots, G. \tag{4.3}$$

Here,

$$Y_{ig}^{(0)} \equiv \phi_{ig}^{(n-1)},$$

and at the end of ℓ iterations we set

$$\phi_{ig}^{(n)} \equiv Y_{ig}^{(\ell)}.$$

Referring to the definition of J_i in Eq. 2.4a, we form the block decomposition $J_i = D_i - L_i - U_i$, where

$$D_i = \mathrm{diag}[J_{i1}, J_{i2}, \ldots, J_{iG}],$$

and L_i and U_i are the remaining block lower and upper triangular matrices, respectively. In terms of this decomposition, the up-scattering iterations take the form

$$(D_i - L_i)\, Y_i^{(m)} = U_i Y_i^{(m-1)} + K_{i-1}\phi_{i-1}^{(n)} + K_i\phi_{i+1}^{(n-1)} + F_i\phi_i^{(n-1)} + f_i. \tag{4.4}$$

If we set $R_i = (D_i - L_i)^{-1}\, U_i$, and recall that $Y_i^{(0)} \equiv \phi_i^{(n-1)}$ and $\phi_i^{(n)} \equiv Y_i^{(\ell)}$, then $\phi_i^{(n)}$ has the following form:

$$\phi_i^{(n)} = R_i^{\ell}\phi_i^{(n-1)} + (I - R_i^{\ell})J_i^{-1}\left\{K_{i-1}\phi_{i-1}^{(n)} + K_i\phi_{i+1}^{(n-1)} + F_i\phi_i^{(n-1)} + f_i\right\}. \tag{4.5}$$

We can write this iterative procedure in a manner analogous to Eq. 4.2 if we define the following matrices. Let $\hat{M}$ and $\hat{N}$ be defined by

$$\hat{M} = \begin{bmatrix} I & & & & \bigcirc \\ -(I - R_2^{\ell})\, J_2^{-1}K_1 & I & & & \\ & & \ddots & & \\ & -(I - R_3^{\ell})\, J_3^{-1}K_2 & & I & \\ \bigcirc & & \ddots & -(I - R_I^{\ell})\, J_I^{-1}K_{I-1} & I \end{bmatrix} \tag{4.6}$$

and

$$\hat{N} = \begin{bmatrix} R_1^{\ell} + (I - R_1^{\ell})\, J_1^{-1}F_1 & (I - R_1^{\ell})\, J_1^{-1}K_1 & & \bigcirc \\ & R_2^{\ell} + (I - R_2^{\ell})\, J_2^{-1}F_2 & (I - R_2^{\ell})\, J_2^{-1}K_2 & \\ & & \ddots & \\ \bigcirc & & & R_I^{\ell} + (I - R_I^{\ell})\, J_I^{-1} + F_I \end{bmatrix}. \tag{4.7}$$

With these matrices defined, the iterative procedure 4.5 can be written in the form

$$\hat{M}\phi^{(n)} = \hat{N}\phi^{(n-1)} + g, \tag{4.8}$$

where

$$g_i = \left(I - R_i^{\ell}\right) J_i^{-1} f_i \text{ for } i = 1, 2, \ldots, I.$$

At this point we can make several observations:

1. For each channel i, the matrix $\left(I - R_i^{\ell}\right) J_i^{-1}$ is nonnegative and nonsingular.
2. The iterative procedure 4.8 is convergent.
3. The solution thus obtained satisfies Eq. 4.1.

Starting with the first observation, recall that $R_i = (D_i - L_i)^{-1} U_i$ is the block Gauss-Seidel iteration matrix associated with the matrix J_i. The matrix J_i has on its block diagonal nonsingular matrices which have positive inverses. Moreover, the block off-diagonal matrices are nonpositive; thus, R_i is nonnegative and has a spectral radius less than one. For the same reasons, J_i^{-1} and $(D_i - L_i)^{-1}$ are nonnegative. As a consequence, we see that $J_i^{-1} \geq R_i J_i^{-1}$ since

$$(I - R_i)\, J_i^{-1} = (I - R_i)(I - R_i)^{-1}(D_i - L_i)^{-1} = (D_i - L_i)^{-1} \geq 0. \tag{4.9}$$

From this it follows that $\left(I - R_i^{\ell}\right) J_i^{-1} \geq 0$ for any $\ell \geq 1$. Since the spectral radius of R_i is less than one, the same is true of R_i^{ℓ}; thus, $\left(I - R_i^{\ell}\right)^{-1}$ exists and is nonnegative. Hence, $\left(I - R_i^{\ell}\right) J_i^{-1}$ is not singular.

Addressing ourselves to the second observation, we see from the first observation that $\hat{M}^{-1}$ exists and is nonnegative; moreover $\hat{N}$ is also nonnegative. Thus the matrices $\hat{M}$ and $\hat{N}$ used in 4.8 form a regular splitting[3] of the matrix $\hat{M} - \hat{N}$; consequently, the process is convergent.

Concerning the third observation, suppose that ψ satisfies

$$(\hat{M} - \hat{N})\, \psi = g. \tag{4.10}$$

Now $\hat{M} - \hat{N} = SJ^{-1}(M - N)$, where

$$\left.\begin{aligned} J &= \mathrm{diag}[J_1, J_2, \ldots, J_I] \\ &\text{and} \\ S &= \mathrm{diag}\left[\left(I - R_1^{\ell}\right), \ldots, \left(I - R_I^{\ell}\right)\right]. \end{aligned}\right\} \tag{4.11}$$

From the first observation, the matrix SJ^{-1} is not singular; moreover, $g = SJ^{-1}f$. Hence, ψ satisfies Eq. 4.1; therefore $\psi = \phi$, where ϕ satisfies the equation

$$(M - F)\,\phi = f. \tag{4.12}$$

Based on the above observations, we can draw the following conclusion: When up-scattering is present, the solution does not depend on the number of up-scattering iterations performed. The use of up-scattering iterations would then rest on the possibility that they will improve the rate of convergence or at least the asymptotic rate. The possibility of improvement rests heavily on the behavior of $\hat{N}$ defined in 4.7 as a function of the number of up-scattering iterations, ℓ. However, although the asymptotic rate of the process defined by Eq. 4.8 does increase with increasing ℓ, it is still not sufficient to offset the consequent increase in computation time.

V. ACCELERATION

In this section we shall describe the acceleration scheme that was implemented for source calculations. The scheme used was two-term Chebyshev extrapolation applied to the iterative scheme 4.2 (or 4.8 for up-scattering). This scheme was chosen because a two-term Chebyshev procedure is used to accelerate the k_{eff} calculation. Thus a minimum amount of effort was involved in adapting this procedure to a source calculation.

Recall from Section IV that the iterative procedure used to solve a source problem can be written in the form

$$\phi^{(n+1)} = R\phi^{(n)} + b. \tag{5.1}$$

Here $R = (D - L)^{-1}(U + F)$ and $b = (D - L)^{-1} f$, if no up-scattering is present. If up-scattering is present and we assume that a fixed number of up-scattering iterations are performed, then $R = \hat{M}^{-1}\hat{N}$ and $b = \hat{M}^{-1}f$, where $\hat{M}$ and $\hat{N}$ are defined by Eqs. 4.6 and 4.7. Neither the matrix R nor its associated Jacobi matrix is symmetric; thus, to justify the use of Chebyshev extrapolation, we shall have to assume that the matrix R has real eigenvalues. The two-term Chebyshev extrapolation[4] can be described briefly as follows: Let ϕ be the solution of Eq. 5.1, and let $e^{(n)} = \phi - \phi^{(n)}$. It then follows that

$$e^{(p)} = Re^{(p-1)} = R^p e^{(0)}. \tag{5.2}$$

If we assume for simplicity that the eigenvalues λ_q of R are simple with $1 > \lambda_1 > \lambda_2 > \dots \geq 0$, then $e^{(p)}$ can be expressed in the form

$$e^{(p)} = e_1\lambda_1^p u_1 + c_2\lambda_2^p u_2 + \dots . \tag{5.3}$$

If, on the other hand, we had used

$$\prod_{j=1}^{p} \frac{R - \alpha_j}{1 - \alpha_j} = \frac{R - \alpha_p}{1 - \alpha_p} \cdot \frac{R - \alpha_{p-1}}{1 - \alpha_{p-1}} \cdot \frac{R - \alpha_1}{1 - \alpha_1}$$

in place of R^p on $e^{(0)}$, we would have obtained

$$e^{(p)} = c_1 \prod_{j=1}^{p} \frac{\lambda_1 - \alpha_j}{1 - \alpha_j} u_1 + c_2 \prod_{j=1}^{p} \frac{\lambda_2 - \alpha_j}{1 - \alpha_j} u_2 + \dots . \tag{5.4}$$

Here we can see the possibility of making $e^{(p)}$ as defined by Eq. 5.4 smaller than $e^{(p)}$ as defined by Eq. 5.3. For if we set

$$Q_p(\lambda;\lambda_1) = \prod_{j=1}^{p} \frac{\lambda - \alpha_j}{1 - \alpha_j}, \tag{5.5}$$

and then choose $Q_p(\lambda; \lambda_1)$ to be the minimal polynomial in the supremum norm of degree p over the interval $[0, \lambda_1]$, then $e^{(p)}$ as defined by Eq. 5.4 will be smaller than $e^{(p)}$ as defined by Eq. 5.3. The solution to the above minimization problem is given by

$$Q_p(\lambda; \lambda_1) = \frac{C_p\left(\frac{2\lambda}{\lambda_1} - 1\right)}{C_p\left(\frac{2}{\lambda_1} - 1\right)}, \tag{5.6}$$

where $C_p(x)$ is the Chebyshev polynomial of degree p normalized to be 1 at $x = 1$.. The roots of the polynomial in Eq. 5.6 are then given by

$$\alpha_j^{(p)} = \frac{\lambda_1}{2}\left[1 + \cos\left\{(2(p-j)+1)\frac{\pi}{2p}\right\}\right] \quad \text{for } j = 1, 2, \ldots, p. \tag{5.7}$$

Since the matrix polynomial $Q_p(R; \lambda_1)$ is expressed in its factorial form, we accomplish the extrapolation by applying one factor at a time. Suppose that starting with a flux $\phi^{(n)}$ and an estimate $\overline{\lambda}_1$ for λ_1, we decide to perform an extrapolation cycle of order p. The roots $\left\{\alpha_j^{(p)}\right\}_{j=1}^{p}$ are then computed from Eq. 5.7 by using $\overline{\lambda}_1$ in place of λ_1. For use in the actual application, we define the numbers $\beta_j^{(p)} = \left(1 - \alpha_j^{(p)}\right)^{-1}$. Then we generate in succession

$$\left.\begin{aligned}
\phi^{(n+1)} &= R\phi^{(n)} + b;\\
\hat{\phi}^{(n+1)} &= \frac{1}{1-\alpha_1^{(p)}}\left(\phi^{(n+1)} - \alpha_1^{(p)}\phi^{(n)}\right) = \beta_1^{(p)}\phi^{(n+1)} + \left(1 - \beta_1^{(p)}\right)\phi^{(n)};\\
\phi^{(n+2)} &= R\hat{\phi}^{(n+1)} + b;\\
\hat{\phi}^{(n+2)} &= \frac{1}{1-\alpha_2^{(p)}}\left(\phi^{(n+2)} - \alpha_2^{(p)}\hat{\phi}^{(n+1)}\right) = \beta_2^{(p)}\phi^{(n+2)} + \left(1 - \beta_2^{(p)}\right)\hat{\phi}^{(n+1)};\\
&\;\;\vdots\\
\hat{\phi}^{(n+p)} &= \frac{1}{1-\alpha_p^{(p)}}\left(\phi^{(n+p)} - \alpha_p^{(p)}\hat{\phi}^{(n+p-1)}\right) = \beta_p^{(p)}\phi^{(n+p)} + \left(1 - \beta_p^{(p)}\right)\hat{\phi}^{(n+p-1)}.
\end{aligned}\right\} \tag{5.8}$$

With the generation of $\hat{\phi}^{(n+p)}$ we have completed an extrapolation cycle of order p. The error vector, $\hat{e}^{(n+p)} = \phi - \hat{\phi}^{(n+p)}$, then satisfies

$$\hat{e}^{(n+p)} = Q_p(R; \overline{\lambda}_1)\, e^{(n)}. \tag{5.9}$$

As is well known,[3,4] the effectiveness of this extrapolation is sensitive to the accuracy of the estimate $\overline{\lambda}_1$ for λ_1. In this code, the initial estimate for λ_1 is found from the fact that, for sufficiently large n,

$$\frac{||\phi^{(n+1)} - \phi^{(n)}||_2}{||\phi^{(n)} - \phi^{(n-1)}||_2} \cong \lambda_1, \tag{5.10}$$

where

$$||\phi||_2 = \left(\sum_{ijg} \phi_{ijg}^2\right)^{1/2}.$$

Subsequent estimates are made using an up-dating procedure introduced by Varga.[3] This up-dating procedure is used in the following way: Suppose an extrapolation cycle of order p was begun with the nth iteration, so that $\hat{\phi}^{(n+p)}$ is the result of this cycle. An unextrapolated pass is then made generating $\phi^{(n+p+1)}$, and the following quantity is formed:

$$E_{n,p} = \frac{||\phi^{(n+p+1)} - \hat{\phi}^{(n+p)}||_2}{||\phi^{(n+1)} - \phi^{(n)}||_2}. \tag{5.11}$$

It can be shown[3] that

$$E_{n,p} \cong |Q_p(\lambda_1; \overline{\lambda}_1)|. \tag{5.12}$$

Now

$$|Q_p(\lambda; \overline{\lambda}_1)| \leq Q_p(\overline{\lambda}_1; \overline{\lambda}_1) = \frac{1}{C_p\left(\frac{2}{\overline{\lambda}_1} - 1\right)} \qquad \text{for } 0 \leq \lambda \leq \lambda_1, \tag{5.13}$$

and

$$Q_p(\lambda; \overline{\lambda}_1) \geq Q_p(\lambda_1; \overline{\lambda}_1) \qquad \text{for } \overline{\lambda}_1 \leq \lambda \leq 1. \tag{5.14}$$

Hence, using Eq. 5.12, if

$$E_{n,p} \leq \frac{1}{C_p\left(\frac{2}{\overline{\lambda}_1} - 1\right)}, \tag{5.15}$$

then we can conclude that $\lambda_1 \leq \overline{\lambda}_1$ and also that the extrapolation was as effective as we can expect since $1/[C_p(2/\overline{\lambda}_1 - 1)]$ is the maximum of the modulus of $Q_p(\lambda; \lambda_1)$ in the interval $[0, \overline{\lambda}_1]$. On the other hand, if

$$E_{n,p} > \frac{1}{C_p\left(\frac{2}{\bar{\lambda}_1} - 1\right)}, \tag{5.16}$$

then, using Eq. 5.14, we can conclude that $\bar{\lambda}_1 < \lambda_1$. In this case, the estimate for $\bar{\lambda}_1$ will need to be moved up. Since $\bar{\lambda}_1 < \lambda_1$, we know that $Q_p(\lambda_1; \bar{\lambda}_1)$ is positive; thus, using Eq. 5.12, we define the new estimate $\bar{\lambda}_1'$ as that value of λ for which

$$E_{n,p} = Q_p(\bar{\lambda}_1'; \bar{\lambda}_1). \tag{5.17}$$

This yields a new estimate $\bar{\lambda}_1'$ for which $\bar{\lambda}_1 < \bar{\lambda}_1' < 1$.

A source calculation then proceeds in the following manner: Starting with an initial guess for the flux, we perform 15 unextrapolated iterations, at which point we make an initial estimate $\bar{\lambda}_1$ for λ_1 using Eq. 5.10. If this estimate, which is also a measure of the rate of convergence, is greater than 0.75 and less than 0.995, then we perform an extrapolation cycle of order 6. If the estimate is greater than 0.995 but not greater than 0.999, the order is limited to 5. On the other hand, if the estimate exceeds 0.999, then this value is used in place of the estimate. On the other hand, if the estimate is less than 0.75, then the unextrapolated iterations are continued until the estimates exceed 0.75 or convergence is attained. At the end of an extrapolation cycle, we make a test according to inequality 5.15 as to whether the cycle was effective. If it was not, we make a new estimate according to Eq. 5.17. Three unextrapolated iterations are then performed before entering the next extrapolated cycle. Generally speaking then, the pattern is extrapolated cycles of length p, interspersed with three unextrapolated iterations. Of course, there are exceptions to this general pattern. For example, if the rate of convergence (as estimated by Eq. 5.10) drops below 0.75 or rises above one during unextrapolated iterations, then these unextrapolated iterations are continued.

The problem is continued until the following criteria are satisfied:

$$\|\phi^{(n)}\|_2^{-1}\|\phi^{(n)} - \phi^{(n-1)}\|_2 \le \epsilon_\phi \tag{5.18}$$

and

$$\bar{k}(n) - \underline{k}(n) \le \epsilon_k, \tag{5.19}$$

where

$$\bar{k}(n) = \max_{ijg} \frac{\phi_{ijg}^{(n)}}{\phi_{ijg}^{(n-1)}}, \quad \underline{k}(n) = \min_{ijg} \frac{\phi_{ijg}^{(n)}}{\phi_{ijg}^{(n-1)}}, \tag{5.20}$$

and the extrema are taken over the set of points (i, j, g) for which $\phi_{ijg}^{(n-1)} \geq \underline{\epsilon_\phi}$ (see Appendix A, Sample Problem 4). Also note the following fact: If any component of the flux should become negative during, or at the conclusion of, an extrapolation cycle, this component is set equal to zero. The intuitive justification of this is as follows: The external source is nonnegative; thus it might be expected to be strongly biased in the direction of the dominant eigenvector of R, which is positive. Thus the desired solution is positive and thereby biased in the direction of the dominant eigenvector. Thus, if a component becomes negative in the course of extrapolation, it indicates a buildup of a lower harmonic. This means the approximation is heading away from the solution and will have to pass through zero on its way toward the solution. Thus, setting the negative component equal to zero can do no harm and indeed prevents the difficulty that arises when any component of the flux goes negative.

Many of the procedures used to accelerate a source calculation have been incorporated into the k_{eff} acceleration procedures. To describe these procedures, as well as others that were developed, we shall describe the acceleration procedure in some detail. For simplicity in description, we shall assume that no up-scattering is present and that the problem is not a full periodic problem.

Recall from Section III that a k_{eff} calculation involves finding the largest positive eigenvalue and corresponding eigenvector of a nonnegative matrix. We saw from Eq. 3.8 that this code solves the problem by relying entirely on power iterations (disregarding up-scattering and periodic iterations). Thus, from Eq. 3.8, the basic iterative procedure is given by

$$\phi^{(n)} = (D - L)^{-1}\left[U + \frac{1}{k^{(n-1)}}F\right]\phi^{(n-1)}, \qquad k^{(n)} = k^{(n-1)}\frac{\left(\phi^{(n)}, \phi^{(n)}\right)}{\left(\phi^{(n)}, \phi^{(n-1)}\right)}. \tag{5.21}$$

If we set $S(k) = (D - L)^{-1}[U + (1/k)F]$ with $S_{n-1} = S\left(k^{(n-1)}\right)$ we can write Eq. 5.21 in the form

$$\phi^{(n)} = S_n\phi^{(n-1)} = \prod_{m=1}^{n} S_m\phi^{(0)}, \qquad k^{(n)} = k^{(n-1)}\frac{\left(\phi^{(n)}, \phi^{(n)}\right)}{\left(\phi^{(n)}, \phi^{(n-1)}\right)}. \tag{5.22}$$

It is not hard to see that if k is the dominant eigenvalue and ϕ the corresponding eigenvector which satisfy

$$M\phi = \frac{1}{k}F\phi, \tag{5.23}$$

then

$$S(k)\,\phi = \phi. \tag{5.24}$$

Moreover, 1 is the dominant eigenvalue of the nonnegative matrix S(k). Thus if we know that the sequence $k^{(n)}$ as generated in Eq. 5.22 converges to k, it follows that the sequence $\phi^{(n)}$ will converge to ϕ. However, the coupling between $k^{(n)}$ and $\phi^{(n)}$ is so complex that it is difficult to show that the procedure defined by Eq. 5.22 will converge.

Let us assume that the process defined by Eq. 5.22 is convergent. The application of Chebyshev acceleration to power iteration is predicated on two basic assumptions:

1. The eigenvalues of the matrix are real.

2. The eigenvalue estimates are converging at a faster rate than the eigenvector iterates. Moreover, the extrapolation is not applied until the eigenvalue iterates have almost converged.

Suppose both assumptions are satisfied; so that $k^{(n)} \cong k$. Then the process becomes an iterative process with a fixed matrix, S = S(k). Thus,

$$\phi^{(\ell+1)} = S\phi^{(\ell)} \quad \text{for } \ell \geq n, \tag{5.25}$$

where S has its dominant eigenvalue equal to one. Let $\bar{\sigma}$ be an estimate for the second largest eigenvalue σ of S, whose eigenvalues lie in the interval [0, 1]. Then a Chebyshev extrapolation cycle of order p applied to the process Eq. 5.25, beginning with ℓ = n, would yield

$$\hat{\phi}^{(n+p)} = Q_p(S;\bar{\sigma})\,\phi^{(n)}, \tag{5.26}$$

where

$$Q_p(x;\bar{\sigma}) = \frac{C_p\left(\frac{2x}{\bar{\sigma}} - 1\right)}{C_p\left(\frac{2}{\bar{\sigma}} - 1\right)}. \tag{5.27}$$

The function $C_p(x)$ is, as before, the Chebyshev polynomial of degree p normalized to be 1 at x = 1. If we expand $\phi^{(n)}$ in terms of the eigenvectors of S, we see that the $\hat{\phi}^{(n+p)}$ has the form

$$\hat{\phi}^{(n+p)} = a_1Q_p(1;\bar{\sigma})\,u_1 + a_2Q_p(\sigma_1;\bar{\sigma})\,u_2 + \ldots, \tag{5.28}$$

where $\phi^{(n)} = c_1u_1 + c_2u_2 + \ldots$ and $1 > \sigma_1 \geq \sigma_2 \geq \ldots \geq 0$ are the eigenvalues of S. Now $Q_p(1;\bar{\sigma}) \equiv 1$ and $Q_p(x;\bar{\sigma})$ is minimal over $[0,\bar{\sigma}]$. Therefore we have performed an effective extrapolation depending on where our estimate $\bar{\sigma}$ is relative to σ_1.

We have described the standard technique for applying Chebyshev extrapolation to eigenvalue problems. Accounts may be found in Refs. 3 and 6. Note that here the dominant eigenvector estimates play the same role that the error vectors did in the source calculation. Based on the above analysis, we could use the up-dating method for finding new estimates for σ_1.

When the two-term Chebyshev extrapolation is applied to a k_{eff} problem, the results are disappointing (see Appendix A, Sample Problems 1 and 2). This is in contrast to the source-calculation case (see Appendix A, Sample Problems 4 and 5). There the results are quite good; for example, the extrapolation cycles make their theoretical error-reduction criterion $(E_{n,p} \leq C_p(2/\overline{\lambda} - 1)^{-1})$ more often than not. On the other hand, for a k_{eff} calculation, an extrapolation cycle will almost never make its theoretical criterion, frequently does little better than the same number of power iterations would have done, and occasionally even causes apparent divergence. Of course, we can always recover from this latter contingency by performing power iterations.

We shall explain why extrapolations in the k_{eff} case behave as they do. We shall also describe what remedial steps were taken in the use of extrapolation to minimize the effects described above.

The problem in the k_{eff} case is that assumption 2 is not satisfied. That assumption 1 is essentially satisfied is shown by the following empirical evidence: If $k = 1$, then the matrix $S(k)$ is essentially the same as the matrix R which appeared in the source calculation. In fact, $S(k) = R + (1/k - 1)(D - L)^{-1} F$. The source extrapolations were very effective, indicating that R had essentially real eigenvalues. Thus we would expect that at least for k near one, $S(k)$ would also have essentially real eigenvalues. This argument is somewhat weak since $S(k)$ can be viewed as a perturbation of R by a nonsymmetric matrix.

On the other hand, the evidence that assumption 2 is not satisfied is overwhelming. In almost every case, the rate of convergence of the eigenvalue iterates $k^{(n)}$ is of the same order as the eigenvalue iterates. Thus, it is not feasible to wait until the sequence $k^{(n)}$ has converged before extrapolating. Let us consider the effect of performing an extrapolation cycle before the eigenvalue iterates have converged. Two effects are present. First, the estimate $k^{(n)}$ for k is not accurate, and second, the iterates $k^{(n)}$ are changing during the extrapolation cycle. Consider the first effect. Assume that we have an estimate $\mu = k^{(n)}$ and an estimate $\overline{\sigma}$ for the dominance ratio of $S(\mu) = S\left(k^{(n)}\right)$; i.e., if $\lambda_1(\mu) > \lambda_2(\mu) \geq \ldots$ are the eigenvalues of $S(\mu)$, then we have an estimate for $\lambda_2(\mu)/\lambda_1(\mu)$. Note that since $\mu \neq k$, $\lambda_1(\mu) \neq 1 = \lambda_1(k)$. Let $\phi^{(n)}$ be considered in terms of the eigenvectors of $S/(\mu)$; i.e.,

$$\phi(n) = c_1 u_1 + c_2 u_2 + \ldots, \qquad u_i = u_i(\mu). \tag{5.29}$$

Then, as a result of an extrapolation cycle, we obtain

$$\hat{\phi}^{(n+p)} = c_1 Q_p(\lambda_1(\mu); \bar{\sigma})\, u_1 + c_2 Q_p(\lambda_2(\mu); \bar{\sigma})\, u_2 + \ldots \; . \tag{5.30}$$

Figure 3 is a graph of $Q_p(x; \bar{\sigma})$.

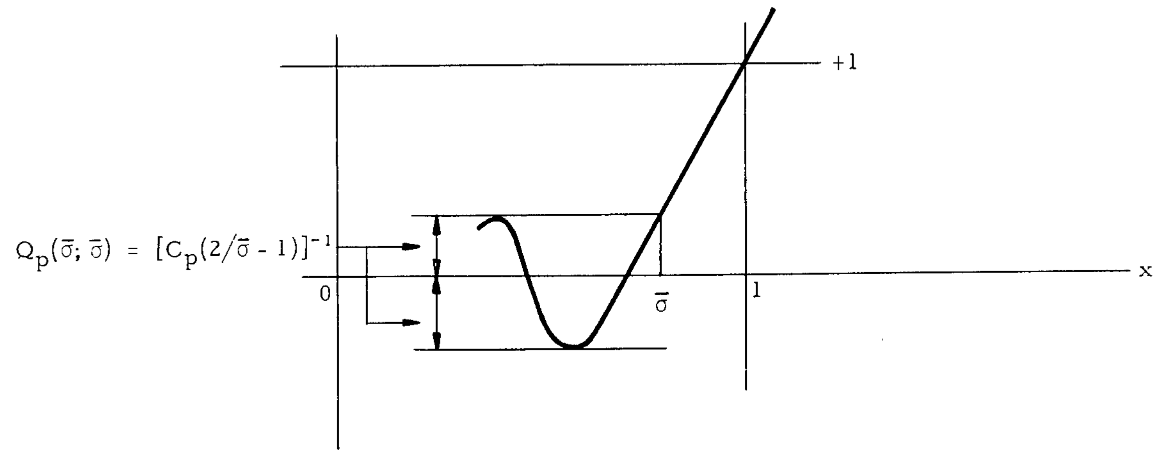

Fig. 3. Graph of $Q_p(x; \bar{\sigma})$

Now $\lambda_1(\mu) \neq 1$, and since μ is in general not even close to k, we see that $\lambda_1(\mu)$ need not be less than one; or if it is less than one, it need not be greater than $\bar{\sigma}$. Thus we see that the "reduction factor"

$$\left| \frac{Q_p(\lambda_2(\mu); \bar{\sigma})}{Q_p(\lambda_1(\mu); \bar{\sigma})} \right| \tag{5.31}$$

need not be less than the theoretical reduction factor $[C_p(2/\bar{\sigma} - 1)]^{-1}$ regardless of how well the dominance ratio $\bar{\sigma}$ is estimated. Indeed we can see that for $\lambda_1(\mu) < \bar{\sigma}$, the reduction factor can be greater than one. Thus, we can begin to see why the extrapolations are so ineffective, and how the higher harmonics can be built up during a cycle when $\lambda_1(\mu) < \bar{\sigma}$.

The problem of a changing estimate $k^{(n)}$ during the extrapolation cycle adds an additional degree of complexity by preventing us from applying a Chebyshev polynomial.

Having examined the causes for the ineffectiveness of the extrapolation procedure, we find that two courses of action are open. First, change the basic iterative structure. Second, modify the technique of applying the extrapolation procedure. The first course of action requires scrapping the computational portion of the code and starting from the beginning. This is being done. As far as this code is concerned, the procedures for applying the extrapolation have been modified to at least prevent disaster.

The following procedure is available, on option, to help prevent the occurrence of $\lambda_1(\mu) < \bar{\sigma}$. The code has a built-in sequence of numbers 0.8, 0.85, 0.9, 0.925, 0.95, 0.96, ..., 0.99, 0.991, ..., 0.995. The user specifies one of these numbers, say $\bar{\sigma}_0$. Then in the first extrapolation cycle, the code will not use any estimate for $\bar{\sigma}$ that exceeds $\bar{\sigma}_0$. If $\bar{\sigma}_1$ is the next larger number in the above sequence, then on the second extrapolation cycle the code will not use any estimate $\bar{\sigma}$ which exceeds $\bar{\sigma}_1$. This process is continued until 0.995 is reached. The above procedure then has the effect of restricting the growth of $\bar{\sigma}$ as the iterations proceed.

In this connection, a second technique is available for avoiding the situation $\lambda_1(\mu) > \bar{\sigma}$. This involves running a coarse-mesh problem and then refining the mesh and using the results from the coarse problem.

The up-dating method for finding estimates for the dominance ratio σ is used only when the sequence $k^{(n)}$ has essentially converged. As we have noted before, this seldom occurs before the flux has converged. The reason the up-dating method is not used before this point is that it forces the estimates for σ to be large very early in the iteration process. Most of the estimates for σ are made by means of

$$\bar{\sigma}_n = \frac{\|\phi^{(n)} - \phi^{(n-1)}\|_2}{\|\phi^{(n-1)} - \phi^{(n-2)}\|_2} \doteq \sigma. \tag{5.32}$$

This monitoring is performed during the three- to four-power iterations that follow each Chebyshev extrapolation cycle.

VI. SOLUTION OF THE FULL PERIODIC PROBLEM

The full periodic case arises in $r\theta$ geometry when the reactor domain is annular. Thus the flux must satisfy $\phi_g(r, 0) \equiv \phi_g(r, 2\pi)$. This condition leads to the following form for the matrices J_{ig}:

$$J_{ig} = \begin{bmatrix} e_{ig1} & -b_{ig1} & & -b_{igJ} \\ -b_{ig1} & e_{ig2} & -b_{iJ2} & \\ & & & \\ & & & -b_{ig,J-1} \\ -b_{igJ} & & -b_{ig,J-1} & e_{ig,J} \end{bmatrix}. \tag{6.1}$$

We recall from Eq. 3.10 that for each channel i and group g we seek the solution of the equation

$$J_{ig}Y_{ig} = f_{ig}, \tag{6.2}$$

where f_{ig} denotes the entire right-hand side of Eq. 3.10. In the nonfull periodic case, $b_{igJ} = 0$, and the Choleski algorithm is used. Because of memory limitations and programming difficulties, Eq. 6.2 is solved iteratively.

To effectively describe the iterative scheme used to solve Eq. 6.2 in the full periodic case, we shall briefly describe the Choleski algorithm as used in this code. In the remainder of this section, we shall drop the subscripts i and g. The basic idea of the method is to factor the matrix into the product of a lower triangular matrix and an upper triangular matrix (Gauss elimination). Thus, starting with a system $Ax = g$, where A is a tridiagonal matrix, we obtain the pair of equations

$$\left.\begin{aligned} L\omega &= g; \\ Ux &= \omega. \end{aligned}\right\} \tag{6.3}$$

Here L is lower triangular, and U is upper triangular and has the form

$$U = \begin{bmatrix} 1 & -\gamma_1 & & & \bigcirc \\ & 1 & -\gamma_2 & & \\ & & 1 & -\gamma_3 & \\ \bigcirc & & & & -\gamma_{p-1} \\ & & & & 1 \end{bmatrix}. \tag{6.4}$$

A forward sweep yields the sequences $\{\gamma_j\}$ and $\{\omega_j\}$; the backward sweep yields the solution $\{x_j\}$. Thus if

$$A = \begin{bmatrix} e_1 & -b_1 & & & \\ -b_1 & e_2 & -b_2 & & \\ & & & & \\ & & & & \\ & & & -b_{p-1} & e_p \end{bmatrix}, \tag{6.5}$$

then

$$\left.\begin{aligned} \gamma_1 &= \frac{b_1}{e_1}, \qquad \omega_1 = g_1/e_1; \\ \gamma_j &= \frac{b_j}{e_j - b_{j-1}\gamma_{j-1}}, \qquad \text{for } j = 2, 3, \ldots, p-1; \\ \omega_j &= \frac{g_j + b_{j-1}\omega_{j-1}}{e_j - b_{j-1}\gamma_{j-1}}, \qquad \text{for } j = 2, 3, \ldots, p. \end{aligned}\right\} \tag{6.6}$$

The backward sweep that generates the solution is then given by

$$\left.\begin{aligned} x_p &= \omega_p; \\ x_j &= \omega_j + \gamma_j x_{j+1}, \qquad \text{for } j = p-1, p-2, \ldots, 1. \end{aligned}\right\} \tag{6.7}$$

Note that the sequence $\{\omega_j\}$ depends on the vector g, whereas the sequence $\{\gamma_j\}$ depends only on the matrix elements; thus the sequence $\{\gamma_j\}$ is calculated only once and then stored.

We shall now consider the iterative method used to solve the periodic problem,

$$Jy = f, \tag{6.8}$$

where J (without the ig subscripts) is defined by 6.1. Let the matrix A be the result of setting $b_J = 0$ in the matrix J. Then we rewrite 6.8 in the following form:

$$Ay = \begin{bmatrix} f_1 + b_J y_J \\ f_2 \\ \cdot \\ \cdot \\ \cdot \\ f_{J-1} \\ f_J + b_J y_1 \end{bmatrix}. \tag{6.9}$$

Let $y^{(0)}$ be an initial guess. Then we will generate $y^{(1)}$ from

$$Ay^{(1)} \quad \begin{bmatrix} f_1 + b_J y_J^{(0)} \\ f_2 \\ \cdot \\ \cdot \\ \cdot \\ f_J + b_J y_1^{(0)} \end{bmatrix}. \tag{6.10}$$

Since A is tridiagonal, we can use Choleski's algorithm to generate $y^{(1)}$. Thus we form

$$\gamma_1 = b_1/e_1, \qquad \gamma_j = \frac{b_j}{e_j - b_{j-1}\gamma_{j-1}}, \qquad \text{for } j = 2, 3, \ldots, J-1,$$

and

$$\left.\begin{aligned} &\omega_1^{(1)} = \frac{f_1 + b_J y_J^{(0)}}{e_1}; \qquad \omega_j^{(1)} = \frac{f_j + b_{j-1}\omega_{j-1}^{(1)}}{e_j - b_{j-1}\gamma_{j-1}}, \qquad j = 2, 3, \ldots, J-1, \\ &\text{with} \\ &\omega_J^{(1)} = \frac{f_J + b_J y_1^{(0)} + b_{J-1}\omega_{J-1}^{(1)}}{e_J - b_{J-1}\gamma_{J-1}}. \end{aligned}\right\} \tag{6.11}$$

With the sequence $\left\{\omega_j^{(1)}\right\}$ thus generated on the forward sweep, we generate the sequence $\left\{\hat{y}_j^{(1)}\right\}$ on the backward sweep:

$$\left.\begin{aligned}
\hat{y}_J^{(1)} &= \omega_J^{(1)};\\
\hat{y}_{J-1}^{(1)} &= \omega_{J-1}^{(1)} + \gamma_{J-1}\hat{y}_J^{(1)};\\
&\;\;\vdots\\
\hat{y}_2^{(1)} &= \omega_2^{(1)} + \gamma_2\hat{y}_3^{(1)};\\
\hat{y}_1^{(1)} &= \omega_1^{(1)} + \gamma_1\hat{y}_2^{(1)}.
\end{aligned}\right\} \qquad (6.12)$$

At this point, we shall modify the definition of the sequence $\left\{\hat{y}_j^{(1)}\right\}$. We define the sequence $\left\{y_j^{(1)}\right\}$ by

$$y_j^{(1)} = \hat{y}_j^{(1)} \text{ for } j = 2, 3, \ldots, J,$$

and

$$y_1^{(1)} = \frac{f_1}{e_1} + \frac{b_J}{e_1} y_J^{(1)} + \gamma_1 y_2^{(1)} = \omega_1^{(1)} + \gamma_1 y_2^{(1)} + \frac{b_J}{e_1}\left(y_J^{(1)} - y_J^{(0)}\right).$$

Thus the modification consists of requiring $y_1^{(1)}$ to satisfy the first equation of the system 6.9 with the latest estimate available for y_J.

With $\left\{y^{(1)}\right\}$ thus generated, the process is repeated, thereby generating $y^{(2)}, \ldots, y^{(\ell)}$. The iteration is complete when the last equation in the system 6.9 is satisfied to a sufficient degree of accuracy. Hence we terminate the iteration when

$$\left|-b_J y_1^{(\ell)} - b_{J-1} y_{J-1}^{(\ell)} + e_J y_J^{(\ell)} - f_J\right| < \epsilon_{\phi_{I,I}}. \qquad (6.13)$$

The code actually stores $\left\{\gamma_j\right\}$ rather than $\left\{e_j\right\}$; however, the code does form γ_J, defined by

$$\gamma_J = \frac{1}{e_J - b_{J-1}\gamma_{J-1}}. \qquad (6.14)$$

From this, e_J can be found and used in Eq. 6.13. Note that this error criterion is on one component of the residual and thus has nothing to do with the rate of convergence of the iterative process.

The periodic iterations differ fundamentally from up-scattering iterations in the following sense. We saw in Section IV that for a source calculation (and the same thing is true for a k_{eff} calculation) it does not matter how many up-scattering iterations are performed per sweep through the channels. The iterative process will still converge to the same solution although the rate of convergence will be affected (see Appendix A, Sample Problems 8 and 9). The situation with regard to periodic iterations is entirely different. Within each channel and for each group, we must find the solution, or at least an approximation to the solution, of the system 6.2. However, this solution is the solution to a periodic system. The iterates $y^{(1)}, y^{(2)}, \ldots, y^{(\ell)}$ we generate to approximate the periodic solution are themselves solutions of a nonperiodic system. Moreover, the higher levels of iterations (up-scattering or outer) will not modify the lack of periodicity. Thus the periodicity of the solution to the source problem or k_{eff} problem is determined by the systems 6.2. From these we must obtain essentially periodic solutions (see Appendix A, Sample Problems 6 and 7).

VII. INPUT DATA PREPARATION

In general, ANL-CANDID conforms to the Argonne Standard Reactor Code input as specified in ANL-7194.[7] A type 100000 identification card is followed by a set of CANDID code-dependent cards (Type 1).

A. Type 1 Cards

These cards contain data peculiar to ANL-CANDID: user options, problem constants, convergence criteria, criticality search specifications, and buckling and volume source data. All data values listed below take the default options noted, unless specifically input otherwise. The card type is punched beginning in column 1. CANDID reads the cards into one of three arrays (entitled INTERFCE, IOPTIONS, and B) depending on column 2.

1. Type 11 cards for user Options. A blank means the option will not be exercised; any nonblank character causes execution of the option. Standard problems have nonblank columns 8 and 10.

INTERFCE Subscript	Columns	Contents
	1-2	Must contain 11.
	3-6	Undefined.
1	7	Process all input cards, but do not execute the problem (input check only).
2	8	Print all fluxes (normally selected).
3	9	On-line output (for programmer use only).
4	10	Print interface fluxes and currents (normally selected).
5	11	Execute slower critical search procedure (i.e., run each intermediate k calculation to full, specified convergence). This option is normally blank, implying the program will decide when a control change is to be made.
6	12	Do not use Chebyshev acceleration during a k calculation. This option is normally blank, implying Chebyshev acceleration is to be used to allow acceleration to speed convergence.
7	13	Print modified cross sections with every control change during a composition search. Normally selected if a composition search.
8	14	Must be blank.

INTERFCE Subscript	Columns	Contents
9	15	Fission fraction (χ) vector is the same for all materials in cross-section set and does not need homogenization into a (space-consuming) matrix for every composition, normally selected, if possible, to conserve storage.
10	16	Perturbation problem is to be executed.
11	17	Two-tape perturbation (real flux on logical unit 49, adjoint flux and original cross sections on logical unit 48). Otherwise, the perturbation program will expect one flux tape consisting of real and adjoint flux and original cross sections.

2. Type 12 cards for Integer data. Integers must be right adjusted and fully contained within their six-column fields.

IOPTIONS Subscript	Columns	Contents
121 card	1-3	Must contain 121.
	4-6	Undefined.
1	7-12	Number of energy groups in cross-section set.
2	13-18	Number of energy groups in problem.
3	19-24	Number of regions in problem.
4	25-30	Maximum number of outer iterations desired. Normally set to 10000 since program will stop on time limit.
5	31-36	Maximum number of up-scattering iterations (for up-scattering problems only). Enter 1 if not up-scattering problem.†
6	37-42	Maximum number of fixed fission source iterations (generally not used).
7	43-48	Maximum number of extrapolations on k_{eff} during a search problem (4 assumed).

†If up-scattering iterations are performed, the convergence rate of the problem is increased. However, experience has indicated that the increase is not sufficient to offset the cost in time for performing the iterations. Thus, it is recommended that up-scattering problems be tried without using up-scattering iterations first, and these iterations only resorted to if unusual convergence difficulties arise.

IOPTIONS Subscript	Columns	Contents
8	49-54	Maximum number of interpolations on k_{eff} during a search problem (20 assumed).
9	55-60	Print frequency during a search (i.e., number of control changes in criticality search before indicative printing is performed). Normally enter a 1 to imply printing after each control change.
10	61-66	Number of general interfaces (feature not available).
11	67-72	= 0 if new problem. = 49 if a restart problem. In addition, input final k from previous run on 500000 card.
122 card	1-3	Must contain 122.
	4-6	Undefined.
12	7-12	X direction mesh-refinement factor (relative to mesh of input flux guess or restart flux) (1 assumed).
13	13-18	Y direction mesh-refinement factor (1 assumed).
14	19-24	Perturbation-point output key: 61 for printer; 62 for card punch; 0 if point perturbation output not desired; another value (1-49) if output is desired on user logical unit (0 assumed).
15	25-30	Maximum number of periodic iterations when doing an $r\theta$ full-circle problem. Normally set to 2.

3. Type 13 cards for Decimal data. All numbers must have decimal points.

B Subscript	Columns	Contents
131 card	1-3	Must contain 131.
	3-6	Undefined.
1	7-18	Desired final value of k_{eff} when doing a critical search (1.0 assumed).
2	19-30	Upper bound on search-control parameter (X) (0.0 assumed).

B Subscript	Columns	Contents
3	31-42	Second guess (X_2) of search-control parameter (0.0 assumed). (First guess on Type 500000 card.)
4	43-54	Lower bound on search-control parameter (0.0 assumed).
5	55-66	Estimate of dk/dx (used to calculate X_2 if nonzero). Normally used, if k(X) is approximately known, to eliminate the second control pass required to compute dk/dx. Estimate may also be available from previous restart runs.
132 card	1-3	Must contain 132.
	3-6	Undefined.
6	7-18	Flux-convergence criterion on outer bounds $(\bar{k}, \underline{k})$ of k (0.001 assumed).
7	19-30	Not used.
8	31-42	Smallest flux used in computing monitor information (10^{-6} assumed).
9	43-54	Agreement required in neutron balance equation (0.001 assumed).
10	55-66	Estimate of initial k_{eff} in critical search problem (1.0 assumed).
133 card	1-3	Must contain 133.
	3-6	Undefined.
11	7-18	Extrapolation parameter for fixed fission source iteration (1.0 assumed). Normally not used.
12	19-30	Up-scatter iteration convergence criterion (0.001 assumed). Normally not used. (See footnote on p. 45.)
13	31-42	Flux convergence criterion on sum of flux differences† (0.001 assumed).

For a k-calculation, three convergence criteria are required on the outer iterations:

1. Outer bounds of k: $\underline{k} \le k^{(n)} \le \bar{k}$ (132 card)
2. Sum of flux differences: $\left[\sum_{ijg}\left(\phi_{ijg}^{(n)} - \phi_{ijg}^{(n-1)}\right)^2\right]^{1/2}$ (133 card)
3. k_{eff} differences: $k^{(n)} - k^{(n-1)}$ (Type 500000 card)

We recommend that these all have the same order of magnitude, ranging from 10^{-4} to 10^{-7}, with a "normal" value of 10^{-5}. That is, a convergence of 10^{-4} may be desired for some purposes, but does not generally yield sufficient accuracy. A convergence of 10^{-7} yields sufficient accuracy, but at a large cost in computer time. Hence, this convergence is not generally used unless the results are to be input to the perturbation code where small perturbations are to be made.

B Subscript	Columns	Contents
14	43-54	Not used.
15	55-66	Asymptotic inverse reactor time period (α).
	1-3	Must contain 134.
	3-6	Undefined.
16	7-18	Initial estimate of outer iteration convergence rate used in computing Chebyshev extrapolation coefficients (0.995 assumed). Normally set to 0.995. (See page 37.)
17	19-30	Periodic iterations convergence criterion ($r\theta$ full circle). Normally set to 0.0001.
18	31-36	Interval shift factor for Chebyshev acceleration (0.0 is assumed, implying no shift). Normally set to 0.0.

4. Type 14 and 15 cards for Buckling and Volume Source (decimal) data. Data can be input as one constant, as varying with energy only or with region only, or as varying both with energy and region number.

Columns	Contents
1-2	Must contain 14 for Buckling data and 15 for Volume Source data.
3-6	Region number, given only when data are to be distributed into regions.
7-18 19-30 31-42 43-54 55-66	Buckling or Volume Source data, as named in columns 1-2, given on as many cards as necessary to cover all energy groups for this region, before beginning next region.
67-69	Energy-group number of first group on this card, given only when data are to be distributed by energy groups.

The remaining cards in the input deck are standard, except as noted below.

B. Type 2XXXXX Cards

The Type 210000 cards for geometry specification must be consistent with mesh of the input flux guess. If a problem is being restarted using an old flux tape, the number of mesh points and the region structure given on the Type 2 cards must correspond to the tape structure. Mesh "multiplying" in

X or Y directions is accomplished by setting the values of the X and Y mesh-refinement factors (IOPTIONS (12) and (13) on the 122 card). The factor input is the number of mesh points to be made from each input mesh point. The problem is then run using the new, "full" mesh. Subsequent restart problems to be run using the new mesh will require a new set of Type 2 cards consistent with this mesh (and the removal of mesh-multiplying factors IOPTIONS (12) and (13)). That is, mesh refinement is used only once for each desired mesh size without redefining the mesh in the Type 2 cards.

The Type 220000 cards for the ratio-method geometry specification is not implemented.

C. Type 3XXXXX Cards

Column 60 is ignored; i.e., general boundary conditions are not implemented.

On the remaining Type 3XXXXX cards the only restriction on card ordering is that the sides be input one at a time, until all regions and groups on a side are covered, with any ordering of data within a side allowed.

D. Type 4XXXXX Cards

Both Type 400000 and 410000 cards must always be present. That is, direct isotope-to-composition homogenization is not implemented.

E. Type 5XXXXX Cards

On the Type 500000 card, the value for δ (columns 13-24) is used as the convergence criterion on differences between k values; for generation n, the criterion is satisfied if $|k^{(n)} - k^{(n-1)}| < \delta$ (see footnote on p. 47). The initial guess supplied in columns 46-57 is used as an initial value for k in a flux calculation, or for μ in a source calculation (blank or 0 signals the default option of 1.0). The k corresponding to a restart flux must be used for a restart problem. If the problem is a criticality search, the initial guess, i.e., the control parameter (X_1), is placed in this field, and the initial k is put on the 132 card. The remaining Type 5XXXXX cards are implemented as specified. All cards with region numbers must have them in increasing order. Energy-dependent buckling modifiers can be input using the concentration change format, with columns 2-6 containing a region number, if desired, and columns 19-24, 37-42, and 55-60 containing group numbers corresponding to modifiers in columns 7-18, 25-36, and 43-54.

F. Type 6XXXXX Cards

On the Type 600000 card CANDID requires the initial guess to be a flux guess and not a source; therefore column 7 must be nonblank. Spectrum averaging is not performed. External source must be read from Type 15 cards.

G. Type 7XXXXX Cards

These cards are as specified in ANL-7194. In addition to the normal use of cross-section set modification,† these cards are used to input cross sections for use in perturbation calculations.[8]

†ANL-CANDID expects microscopic cross-section data on a magnetic tape prepared by the XLIBIT Code.[9] An XLIBIT cross-section set must be available on tape for each problem even if all cross-section data are to be input via the 700000 cards.

VIII. EXECUTION CARD DECK ARRANGEMENTS

A. Normal Execution

The control cards and deck structure necessary to execute a normal ANL-CANDID run are ($^7_9$ punches are assumed in column 1):

```
JOB, User Identification
MOUNT XLIBIT Cross-section Tape on LUN 44
MOUNT CANDID AOV Tape on LUN 47 (AOV means absolute overlay)
SCRATCH TAPES on LUN 42, 43, 45, 55 (SYSTEM scratch unit)
EQUIP,44=(XLIBIT Cross-section tape name, Version) RO, SV
EQUIP,3=45 (Equivalent reference saves one scratch tape)
EQUIP,47=(CANDID AOV tape name, Version), RO, SV
LOAD MAIN, 47, Time estimate, Print estimate
Data
END OF PROBLEM (column 3)
```

B. Program Compilation

The volume of source program cards (some 20000) in ANL-CANDID prohibits the handling of source decks directly. Thus, the cards are put on tape along with SCOPE cards denoting the end of overlays. The following SCOPE control cards (in addition to special mounting instructions) will compile the source code from LUN 10 (unlabeled) and prepare the binary load and go (LGO) tape on LUN 11. Note that CANDID is compiled as a one-bank code.

```
MOUNT TAPE (ANL-CANDID source tape reference number) ON
  LUN 10
EQUIP,10=SV,**
EQUIP,11=(CANDID LGO tape name,Version), SV
FILE,11
MAIN,47
FILE END                  Main Control Section
FTN,L,X=11,I=10,R,*.
COMPASS,L,X=11,I=10
FILE,11
OVERLAY,47,1
FILE END                  Overlay 1:  Processes card Types 1 and 2.
FTN,L,X=11,I=10,R,*.
FILE,11
OVERLAY,47,2
FILE END                  Overlay 2:  Processes card Types 3-5.
FTN,L,X=11,I=10,R,*.
```

FILE,11 OVERLAY,47,3 FILE END FTN,L,X=11,I=10,R,*.	Overlay 3: Creates pseudo cross-section library tape from XLIBIT tape.
FILE,11 OVERLAY,47,4 FILE END FTN,L,X=11,I=10,R,*.	Overlay 4: Processes card Type 7 if they exist.
FILE,11 OVERLAY,47,5 FILE END FTN,L,X=11,I=10,R,*.	Overlay 5: Performs search and k calculations.
FILE,11 OVERLAY,47,6 FILE END FTN,L,X=11,I=10,R,*.	Overlay 6: Output edit.
FILE,11 OVERLAY,47,7 FILE END FTN,L,X=11,I=10,R,*.	Overlay 7: Perturbation.

C. Program Modification Using LGOEDIT

Additions, corrections, or deletions to the load-and-go tape are made using the program LGOEDIT (see Appendix B). The card deck structure listed below will accomplish the following (assuming the existence of an old load-and-go tape):

1. Compile the indicated source programs and place them, together with the associated LGOEDIT control cards (REP,DEL,INS), on the merge tape (LUN 45).

2. Select the first program name (NAME1) from the control card on the merge tape, and search the old LGO tape (LUN13) until NAME1 is found. Preceding subroutines are simply copied from LUN13 onto the new LGO tape (LUN11). The instruction on the control card is executed as described in Appendix B, and LGOEDIT proceeds to the next subroutine on the merge tape. Note that LGOEDIT does not space the old LGO tape, indicating that the ordering on the old LGO tape must be preserved on the merge tape.

```
MOUNT TAPE (Old LGO tape) on LUN13
EQUIP,13 = (Old LGO tape name, Version), RO,SV
EQUIP,11 = (New LGO tape name, Version), SV
FILE, 45
REP NAME 1
FILE END
FTN,L,X=45,*.
```

Source for Subroutine NAME1
SCOPE

```
FILE,45
DEL NAME2
FILE END
FILE,45
INS NAME3
FILE END
FTN,L,X=45,*.
```

Source for Subroutine NAME3
SCOPE

Binary Deck for LGOEDIT
RUN
11 | 13 | 45 (Tape numbers as input to LGOEDIT columns 1-6)

D. Modification Followed by Execution

The normal execution structure (A) may be merged with the program modification procedure (C) to produce a run in which modification is followed by execution. The structure is as follows:

Normal control cards (A)
Modification structure (C)

LOAD, 11 (Prepares AOV Tape on LUN 47)
RUN
Problem Data

E. Restart

A restart feature is provided for the following reasons:

1. Machine failure usually in the form of tape parity error.

2. Time estimate exceeded.

CANDID checks internally for an error condition, and when one is encountered, the current flux vector is written, as indicated in Fig. 4, onto a flux save tape (LUN 48). Normal termination will also result in the flux being written on LUN 48. Thus, to save the flux, the user must insert the following control card:

EQUIP,48=(Flux save tape name, Version), SV.

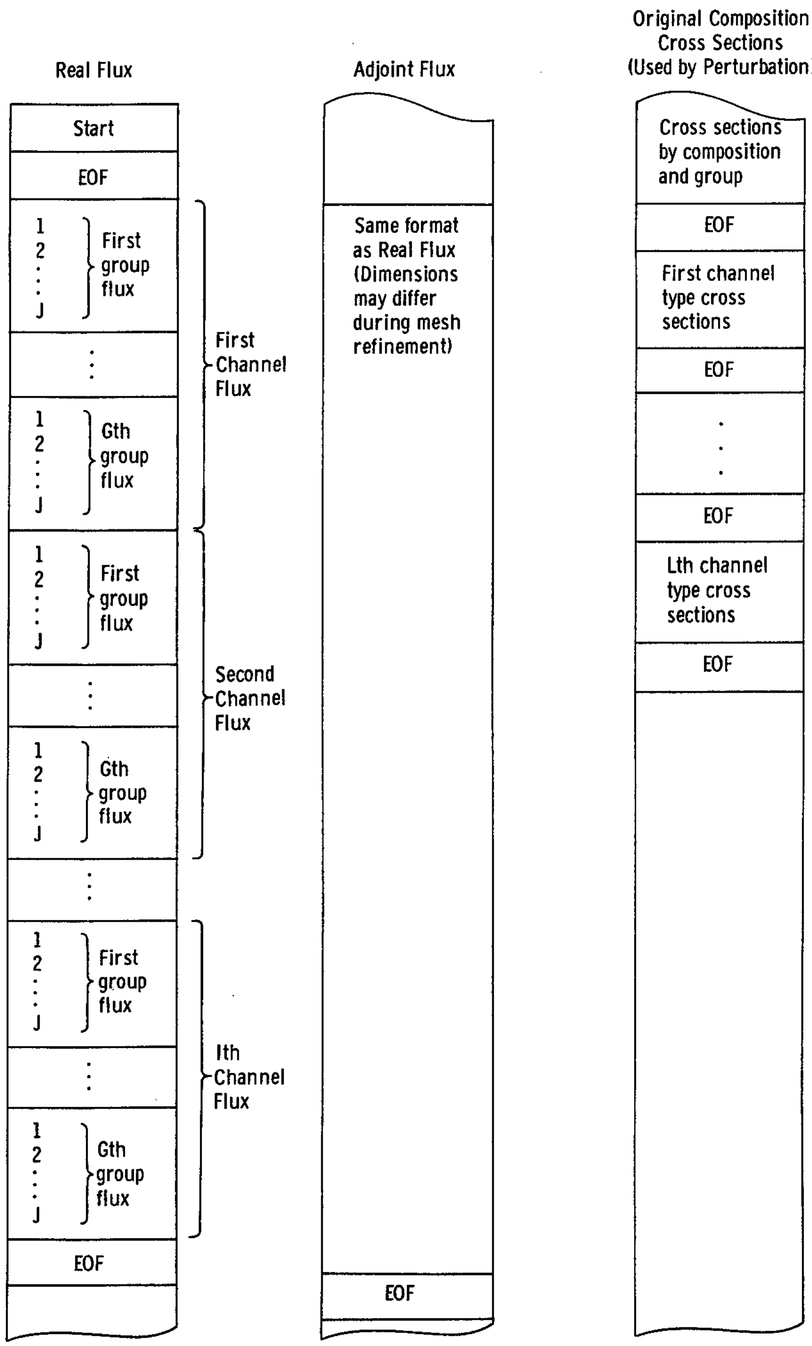

Fig. 4. Restart Tape Format

To restart the problem from this point, the user must remount the tape on the restart unit (LUN49) by inserting the following SCOPE cards:

Mount tape (Old Flux tape Identification) on LUN 49
EQUIP,49=(Old Flux Tape Name, Version), RO,SV

The original input-data deck is used with the exceptions (1) the number 49 must be punched on the 12 card (see Section VII), and (2) the

$k_{eff}^{(n)}$, where n is the last iteration of the previous run, must be punched on the 500000 card (or on the 132 card if a search problem). Normal execution will then proceed with the flux guess taken from LUN 49 instead of the standard input unit. The new flux may again be saved on LUN 48. (See Section IX.)

F. Back-to-back Runs

The stacking of runs back-to-back is provided, but is not usually done except when perturbation problems are run.[8] The reason for this is that two-dimensional problems of any size require so much machine time that they are run in stages. (See Section IX.)

A complete exit to the SCOPE System is made following each End of Problem card. Thus, the program must be reloaded for each problem. This is done to allow for any available mounting or dismounting type instructions to be recognized between problems. Thus, in stacking problems, the deck structure is:

Normal execution control cards (A)
Program modification structure, if any (C)
LOAD, RUN
OR
LOADMAIN,47
Data Problem 1
END OF PROBLEM
Tape-handling instructions (i.e., unloading old flux tape, mounting new flux tapes for next problem, etc.)
LOADMAIN,47
Data Problem 2
END OF PROBLEM
.
.
.
Tape-handling instructions
LOADMAIN,47
Data Problem n
END OF PROBLEM
End of File

G. Sample Deck Structure

A sample deck structure including program modification, restart, and back-to-back problems might appear as follows:

JOB, User Identification

```
MOUNT OLD LGO Tape ON LUN11
MOUNT XLIBIT Cross-section Tape on LUN 44
MOUNT Old Flux Tape for Problem 11 on LUN 49
SCRATCH Tapes on LUN's 42,43,45,55
EQUIP,11=(NEW CANDID LGO,L),SV
EQUIP,13=(OLD CANDID LGO,),SV
EQUIP,3=45
EQUIP,44=(XLIBIT Cross-section Tape Name,Version),SV
EQUIP,47=(CANDID AOV,2),SV
EQUIP,48=(NEWFLUX1,1),SV
EQUIP,49=(OLDFLUX1,1),SV
FILE,45
REP    NAME1
FILE END
FTN,L,X=45,*.

                       Source deck for Subroutine NAME1
                       SCOPE
                       Binary deck for LGOEDIT

RUN
131145                   (LGOEDIT input card)
End of File
Release, 13              (Special ANL Control Card which unloads 13)
Load, 11
Release, 11
RUN

                       CANDID Data Deck for Problem 1

End of Problem
End of File
Release, 48
Release, 49
Mount old flux tape for Problem 2 on LUN 49
EQUIP,48=(NEWFLUX2,1) ,SV
EQUIP,49=(OLDFLUX2,1) ,SV
LOADMAIN,47

                       CANDID Data Deck for Problem 2

End of Problem
End of File
```

IX. NORMAL EXECUTION PROCEDURES

A two-dimensional diffusion problem is usually run in stages (a sequence of computer runs) for two reasons:

1. The probability of error in problem input data (even if it gets by the input processor, which checks for consistency only) is significant. Thus, we would like to be assured that the problem is proceeding in the "right" direction before spending a significant amount of computer time.

2. Even when we are assured that the problem is progressing smoothly, it is worthwhile to continue in stages of less than 60 min of computing time to measure convergence rates, progress, etc.

The stages mentioned above are of two types:

1. Mesh size: i.e., starting with a coarse mesh, running the coarse-mesh problem, and refining the mesh using the coarse-mesh flux as an input flux guess for the refined problem.

2. Computer time: i.e., putting a time limit on execution of something less than 60 min, coming off the computer to measure progress, and restarting and continuing the problem from that point.

Experience has shown that a 20-group, 40 x 40 mesh may take 3 to 4 hr of computing time (depending on accuracy requirements and the rate of convergence of the problem). Hence, it is wise not to be hasty in expending this amount of time only to find (possibly because of an error or incorrect assumptions) that the results are not what was expected. The problems are generally run as follows:

1. The mesh is reduced or "coarsened" to a problem that will run in 20 or 30 min (e.g., 10 x 10 x number of groups); the results are expected for "ballpark" accuracy. Experience indicates that this result is certainly within 10% of the final answer and may be as good as 1%. Errors in configuration should show up at this time. At the end of the job, the flux tape is saved as indicated under Execution Card Deck Arrangements, Section VIII.

2. After step 1 is completed and the refined problem is to be attempted, the mesh-refinement feature is used. This amounts to placing a multiplication factor (integer) for the X and/or Y direction on the 122 card (see Section VII). For example, a 2 placed in the field for the X direction will double the mesh along this axis. (The coarse problem must be planned so that an integral multiple of the coarse mesh will give the final desired mesh.) CANDID now automatically spreads the coarse mesh to adjacent points in the fine mesh, as indicated in Figs. 5 and 6. The resulting flux guess is then used to start the problem. Refinement can take place as often as desired along either axis.

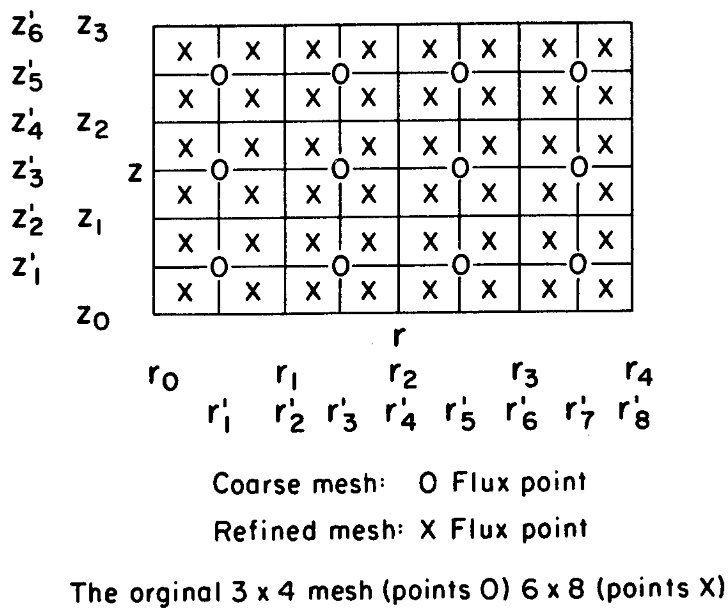

Fig. 5. Mesh Refinement*(Doubling in r and z directions)

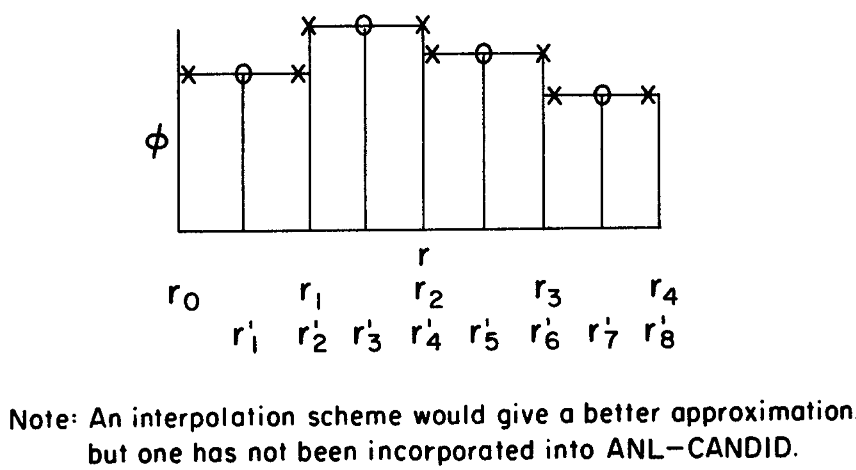

Fig. 6. Typical Flux Shape for Starting the Refined Problem*

*Unprimed mesh lines denote coarse mesh.
Primed mesh lines denote refined mesh.

X. COMPUTING REQUIREMENTS AND EXECUTION TIME

A. Machine: CDC 3600 with one-bank 32K fast memory.

B. Operating System: SCOPE

C. Tape Units: Normal Execution: Four scratch tapes, cross-section tape, AOV tape.

Program Modification: Four scratch tapes, cross-section tape, old LGO tape, new LGO tape, AOV tape.

Restart: Four scratch tapes, cross-section tape, AOV tape, old flux tape, new flux tape.

D. Execution Time: Execution time depends on the convergence criterion and the problem convergence rate. Typically, a 40 x 40 mesh, 20-group problem will run 3-4 hr. A 10 x 10 mesh, 20-group problem will run 20-30 min.

XI. RESTRICTIONS AND LIMITATIONS

1. Roughly, the largest problem that can be handled is 20 groups by 40-45 points in a channel (i.e., Y or Z or θ direction). Any number of points can be handled in the R direction if one has enough money.

2. The number of compositions cannot exceed the number of materials in the cross-section library. "Dummy" isotopes should be inserted in the cross-section set if this situation arises.

3. Composition cross sections cannot be directly homogenized from isotopes. The material level cross sections must be inserted even though they may be decimals (i.e., volume fractions are 1.0).

4. A source guess cannot be input. Only a flux guess is allowed.

5. The distributed source for a source calculation must be input by region and group on the Type 15 cards. CANDID will not accept an external source input via the 610000 cards.

6. Generally, the output is erroneous for adjoint calculations, but the flux printout is correct.

XII. SUMMARY OF REQUIREMENTS

Execution of ANL-CANDID requires familiarity with the following documents, in addition to ANL-7305:

1. Code independent input and cross-section library tape preparation are described in the following documents:

   M. Butler and H. Greenspan, General Input Specifications for ANL Reactor Programs, ANL-7194 (April 1966).

   S. D. Sparck, XLIBIT: An ANL Cross-section Library Code, ANL-7112 (Feb 1966).

2. To make modifications and/or additions to the CANDID load-and-go tape, the use of LGOEDIT is helpful:

   LGOEDIT2, reproduced as Appendix B by permission of the authors.

3. For perturbation calculations, the following publication is required:

   G. K. Leaf and A. S. Kennedy, PERC, A Two-dimensional Perturbation Code Based on Diffusion Theory, ANL-7304 (May 1967).

4. Finally, if available, the Control Data Corporation documentation of CANDID2D may be helpful:

   CANDID2D, A Two-dimensional Neutron Diffusion Program, Control Data Corporation (1966).

The following items are necessary to run ANL-CANDID:

1. Source (BCD FORTRAN Card images) tape.
2. Load-and-go tape prepared by compiling source tape.
3. Absolute overlay tape prepared from the load-and-go tape.
4. XLIBIT generated cross-section library tape.
5. Proper SCOPE control cards.
6. Input deck which conforms to ANL-7305 and ANL-7194.
7. Lots of luck!!

APPENDIX A

Sample Problems

The sample problems in this appendix reinforce the conclusions drawn in the body of the report. Hence only relevant parts of each output listing are included. For completeness, sample problem 1 is listed in its entirety.

For reference, the tests for convergence are listed below:

1. Sum of flux differences $= \left[\sum_{i,j,g}\left(\phi_{ijg}^{(n)} - \phi_{ijg}^{(n-1)}\right)^2\right]^{1/2}$,

where

(i,j) are the point indices,

g is the group index,

and

n is the outer iteration index.

2. Bounds of $k_{eff} = \overline{k} - \underline{k}$,

where

$$\overline{k} = \max_{ijg}\left\{\frac{\phi_{ijg}^{(n)}}{\phi_{ijg}^{(n-1)}}\right\}$$

and

$$\underline{k} = \min_{ijg}\left\{\frac{\phi_{ijg}^{(n)}}{\phi_{ijg}^{(n-1)}}\right\}.$$

3. k_{eff} difference $= \left|k_{eff}^{(n)} - k_{eff}^{(n-1)}\right|$.

4. Criticality search $= \left|k_{eff}^{(n)} - k_{desired}\right|$.

5. Up-scattering $= \dfrac{\sum_{jg} \left| \phi_{jg}^{(m)} - \phi_{jg}^{(m-1)} \right|}{\sum_{jg} \left| \phi_{jg}^{(1)} - \phi_{jg}^{(0)} \right|}$

6. Periodic $= \left| -b_J y_1^{(\ell)} - b_{J-1} y_{J-1}^{(\ell)} + e_J y_J^{(\ell)} - f_j \right|$.

1. Sample Problem 1

a. Description

(1) Problem Type

Real k_{eff} calculation without Chebyshev acceleration.

(2) Configuration

(a) Geometry

rz

(b) Region Definition

The reactor consists of three regions as follows:

Region No. 1: Core region composed of uranium (U^{235} and U^{238}), stainless steel, molybdenum, zirconium, iron, nickel, chromium, and sodium.

Region No. 2: Control- and safety-rod region composed of uranium (U^{235} and U^{238}), molybdenum, niobium, iron, nickel, chromium, and sodium.

Region No. 3: Radial-blanket region composed of uranium (U^{235} and U^{238}), plutonium (Pu^{239}), iron, nickel, chromium, and sodium.

(c) Mesh Definition

r direction: 27 points

z direction: 20 points

(d) Boundary Conditions

Left: $\phi' = 0.$

Right: $\phi = 0.$

Bottom: $\phi' = 0.$

Top: $\phi = 0.$

(e) Number of Energy Groups: 2

(3) Convergence Criteria

k_{eff} difference $= 10^{-5}.$

k_{eff} bounds $= 10^{-5}.$

Sum of flux difference $= 10^{-5}.$

b. Output Listing

```
PROB. NO.   2.00000+080  2DCANDID  K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH          PAGE NO.    1

                    CODE DEPENDENT DATA OR INPUT IF DIFFERENT THAN ZERO.


                              BUCKLING DATA HAVE NOT BEEN INPUT.


                           VOLUME SOURCE DATA HAVE NOT BEEN INPUT.


              ALL FLUX VALUES WILL BE PRINTED.
              CHEBYCHEV ACCELERATION WILL NOT BE USED.


              ENERGY GROUPS IN CROSS SECTION DATA.......................            2
              ENERGY GROUPS TO USE IN PROBLEM...........................            2
              NUMBER OF REGIONS.........................................            3
              MAXIMUM NUMBER OF OUTER ITERATIONS........................        10000
              MAXIMUM NUMBER OF INNER ITERATIONS / CHANNEL CALC.........            4
              MAXIMUM NUMBER OF EXTRAPOLATIONS ON K-EFFECTIVE...........            4
              MAXIMUM NUMBER OF INTERPOLATIONS ON K-EFFECTIVE...........           20
              PRINT FREQUENCY FOR CRITICALITY SEARCH....................            1
              PRINT FREQUENCY ON FISSION SOURCE K.......................           49


              DESIRED K-EFFECTIVE.......................................   1.0250+000
              UPPER BOUND ON SEARCH PARAMETER...........................   1.0000+001
              SECOND GUESS ON SEARCH PARAMETER..........................   1.5000+000
              LOWER BOUND ON SEARCH PARAMETER...........................  -1.0000+001
              CONVERGENCE CRITERION ON OUTER BOUNDS OF K................   1.0000-005
              CONVERGENCE CRITERION FOR SOURCES.........................   1.0000-003
              SMALLEST FLUX VALUE USED IN COMPUTING K-EFFECTIVE.........   1.0000-006
              AGREEMENT REQUIRED IN NEUTRON BALANCE.....................   1.0000-003
              FIRST GUESS AT K-EFFECTIVE................................   1.0000+000
              CONVERGENCE CRITERION ON FLUX PER INNER ITERATION.........   1.0000-003
              CONVERGENCE CRITERION FOR SUM OF FLUX DIFFERENCES.........   1.0000-005
```

PROB. NO. 2.00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 2

REACTOR GEOMETRY

GEOMETRY TYPE	LEFT BOUND	RIGHT BOUND	BOTTOM BOUND	TOP BOUND
RZ WITHOUT INVERSION	0.0000+000	7.8100+001	0.0000+000	6.0000+001

REGION BOUNDARIES

REGION NO.	LEFT BDRY.	RIGHT BDRY.	BOTTOM BDRY.	TOP BDRY.
1	0.0000+000	2.3168+001	0.0000+000	6.0000+001
2	2.3168+001	2.5902+001	0.0000+000	6.0000+001
3	2.5902+001	7.8100+001	0.0000+000	6.0000+001

PROB. NO. 2.00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 3

MESH DEFINITION

INCREMENT METHOD - X(R) DIRECTION

X(R)	INCREMENTS	X(R)	INCREMENTS	X(R)	INCREMENTS	X(R)	INCREMENTS	X(R)
0.0000+000	12	2.3168+001	3	2.5902+001	12	7.8100+001		

IMAX = 27

X(R) PLUS DELTA X(R) FROM LEFT TO RIGHT OF REACTOR

MESH NO.	1	2	3	4	5	6	7	8	9	10
ABSCISSA	1.9307+000	3.8613+000	5.7920+000	7.7227+000	9.6533+000	1.1584+001	1.3515+001	1.5445+001	1.7376+001	1.9307+001
MESH NO.	11	12	13	14	15	16	17	18	19	20
ABSCISSA	2.1237+001	2.3168+001	2.4079+001	2.4991+001	2.5902+001	3.0252+001	3.4602+001	3.8951+001	4.3801+001	4.7651+001
MESH NO.	21	22	23	24	25	26	27			
ABSCISSA	5.2001+001	5.6351+001	6.0701+001	6.5050+001	6.9400+001	7.3750+001	7.8100+001			

MESH DEFINITION

INCREMENT METHOD = Y(Z) DIRECTION

Y(Z)	INCREMENTS	Y(Z)	INCREMENTS	Y(Z)	INCREMENTS	Y(Z)	INCREMENTS	Y(Z)
0,0000*000	20	6,0000*001						

JMAX = 20

Y(Z) PLUS DELTA Y(Z) FROM BOTTOM TO TOP OF REACTOR

Y(Z) MESH NO,	1	2	3	4	5	6	7	8	9	10
ORDINATE	3,0000*000	6,0000*000	9,0000*000	1,2000*001	1,5000*001	1,8000*001	2,1000*001	2,4000*001	2,7000*001	3,0000*001

Y(Z) MESH NO,	11	12	13	14	15	16	17	18	19	20
ORDINATE	3,3000*001	3,6000*001	3,9000*001	4,2000*001	4,5000*001	4,8000*001	5,1000*001	5,4000*001	5,7000*001	6,0000*001

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 5

REGION MAP
(REGION NUMBER BY MESH POINT)
R MESH POINTS

Z MESH POINTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Z MESH POINTS
20*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	20
19*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	19
18*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	18
17*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	17
16*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	16
15*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	15
14*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	14
13*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	13
12*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	12
11*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	11
10*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	10
9*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	9
8*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	8
7*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	7
6*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	6
5*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	5
4*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	4
3*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	3
2*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	2
1*	1	1	1	1	1	1	1	1	1	1	1	1*	2	2	2*	3	3	3	3	3	3	3	3	3	3*	1
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	

R MESH POINTS

```
PROB, NO,   2,00000+000  2DCANDID  K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH          PAGE NO,    6
  Z                                      REGION MAP                                                      Z
 MESH                          (REGION NUMBER BY MESH POINT)                                            MESH
POINTS                                   R MESH POINTS                                                 POINTS
            26   27
          *********
       20*   3   3* 20
         *        *
       19*   3   3* 19
         *        *
       18*   3   3* 18
         *        *
       17*   3   3* 17
         *        *
       16*   3   3* 16
         *        *
       15*   3   3* 15
         *        *
       14*   3   3* 14
         *        *
       13*   3   3* 13
         *        *
       12*   3   3* 12
         *        *
       11*   3   3* 11
         *        *
       10*   3   3* 10
         *        *
        9*   3   3*  9
         *        *
        8*   3   3*  8
         *        *
        7*   3   3*  7
         *        *
        6*   3   3*  6
         *        *
        5*   3   3*  5
         *        *
        4*   3   3*  4
         *        *
        3*   3   3*  3
         *        *
        2*   3   3*  2
         *        *
        1*   3   3*  1
          *********
            26   27
                                         R MESH POINTS
```

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 7

BOUNDARY CONDITION DATA

LEFT FACE OR AXIS	RIGHT OR OUTER FACE	BOTTOM FACE	TOP FACE
DER, FLUX = 0,0	FLUX = 0,0	FLUX = 0,0	FLUX = 0,0

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 8

MATERIAL ASSIGNMENT DATA

THE CROSS SECTION SET IS IDENTIFIED AS 224

MATERIAL MAKEUP

MATERIAL NUMBER	ISOTOPE ID	NUMBER DENSITY	ISOTOPE ID	NUMBER DENSITY	ISOTOPE ID	NUMBER DENSITY	ISOTOPE ID	NUMBER DENSITY
1	R 1N15	1,189800-002	R 1N16	1,505600-003	R 1N17	3,398200-003	R 1N27	8,326500-004
	R 1N31	6,816000-004	R 1N34	1,078600-002	R 1N69	6,881800-003	R 1N71	6,455000-003
2	R 2N15	1,271000-002	R 2N16	1,609000-003	R 2N17	3,630000-003	R 2N27	5,702000-004
	R 2N31	4,667000-004	R 2N34	1,279000-002	R 2N69	4,712000-003	R 2N71	4,420000-003
3	R 3N15	1,196000-002	R 3N16	1,514000-003	R 3N17	3,417000-003	R 3N34	4,323000-003
	R 3N55	3,600000-005	R 3N69	2,872000-002	R 3N71	6,500000-005		

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 9

COMPOSITION MAKEUP

COMPOSITION NUMBER	MATERIAL NUMBER/ID	VOLUME FRACTION	MATERIAL NUMBER/ID	VOLUME FRACTION	MATERIAL NUMBER/ID	VOLUME FRACTION	MATERIAL NUMBER/ID	VOLUME FRACTION
1	1	1,000000+000						
2	2	1,000000+000						
3	3	1,000000+000						

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 10

COMPOSITION ASSIGNMENT BY REGION NUMBER

REGION NO,	1	2	3
COMPOSITION NO,	1	2	3

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 11

PROBLEM TYPE

K CALCULATION

FLUX CONVERGENCE CRITERION (DELTA),,, 1,0000-005

```
        THE FLUX VALUES WHICH WERE INPUT ARE GIVEN BELOW

            REGION      FLUX      FLUX      FLUX      FLUX      FLUX     ENERGY     CARD
             NO,        VALUE     VALUE     VALUE     VALUE     VALUE    GROUP      NO,

                1    1,0
                2    0,5
                3    0,1
        49

LUN 49 REAL FLUX HAS    27 CHANNELS

LUN 49 ADJ  FLUX HAS    27 CHANNELS
I=    1 G=1 J=1 FLUX=  5,1743382=003
I=    2 G=1 J=1 FLUX=  5,1410156=003
I=    3 G=1 J=1 FLUX=  5,0747050=003
I=    4 G=1 J=1 FLUX=  4,9759841=003
I=    5 G=1 J=1 FLUX=  4,8457066=003
I=    6 G=1 J=1 FLUX=  4,6849863=003
I=    7 G=1 J=1 FLUX=  4,4951762=003
I=    8 G=1 J=1 FLUX=  4,2778406=003
I=    9 G=1 J=1 FLUX=  4,0347197=003
I=   10 G=1 J=1 FLUX=  3,7676868=003
I=   11 G=1 J=1 FLUX=  3,4786942=003
I=   12 G=1 J=1 FLUX=  3,1697071=003
I=   13 G=1 J=1 FLUX=  2,9361318=003
I=   14 G=1 J=1 FLUX=  2,7987402=003
I=   15 G=1 J=1 FLUX=  2,6636819=003
I=   16 G=1 J=1 FLUX=  2,0239205=003
I=   17 G=1 J=1 FLUX=  1,3057572=003
I=   18 G=1 J=1 FLUX=  8,4912379=004
I=   19 G=1 J=1 FLUX=  5,5344858=004
I=   20 G=1 J=1 FLUX=  3,6483342=004
I=   21 G=1 J=1 FLUX=  2,4010752=004
I=   22 G=1 J=1 FLUX=  1,5782459=004
I=   23 G=1 J=1 FLUX=  1,0298924=004
I=   24 G=1 J=1 FLUX=  6,5881873=005
I=   25 G=1 J=1 FLUX=  4,0101116=005
I=   26 G=1 J=1 FLUX=  2,1830450=005
I=   27 G=1 J=1 FLUX=  6,5412713=006

 CANDID2D HAS COPIED FLUX FROM LUN    49 ONTO LUN    3

 IMAXIN=   27 JMAXIN=   20 IMAXOUT=   27 JMAXOUT=   20
```

PROB. NO. 2.00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 13

CONTROL VALUE (X) = 0.000000+000 NXT = 0 NINT = 0

PROB. NO. 2.00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 14

COMPOSITION NUMBER... 1

ENERGY GROUP	DIFFUSION COEFFICIENT	REMOVAL CROSS SECTION	FISSION CROSS SECTION	FISSION REACTION RATE
1	2.0386+000	1.3179-002	9.2113-003	2.3430-002
2	1.0434+000	2.2999-002	1.4607-002	3.5497-002

PROB. NO. 2.00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 15

COMPOSITION NUMBER... 1

FISSION SPECTRUM

ENERGY GROUP	1	2
1	9.9221-001	9.9221-001
2	7.7911-003	7.7911-003

PROB. NO. 2.00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 16

COMPOSITION NUMBER... 1

GROUPS FROM WHICH NEUTRONS ARE SCATTERED.
(SUM DOWN TO OBTAIN TOTAL SCATTERING CROSS-SECTION PER ENERGY GROUP.)

ENERGY GROUP	1	2
1	0.0000+000	0.0000+000
2	1.6242-003	0.0000+000

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 17

COMPOSITION NUMBER... 2

ENERGY GROUP	DIFFUSION COEFFICIENT	REMOVAL CROSS SECTION	FISSION CROSS SECTION	FISSION REACTION RATE
1	2,2481+000	9,7404=003	6,2757=003	1,5882=002
2	1,2077+000	1,6110=002	1,0131=002	2,4619=002

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 18

COMPOSITION NUMBER... 2

ENERGY GROUP	FISSION SPECTRUM	
	1	2
1	9,9221=001	9,9221=001
2	7,7911=003	7,7911=003

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 19

COMPOSITION NUMBER... 2

ENERGY GROUP	GROUPS FROM WHICH NEUTRONS ARE SCATTERED, (SUM DOWN TO OBTAIN TOTAL SCATTERING CROSS=SECTION PER ENERGY GROUP)	
	1	2
1	0,0000+000	0,0000+000
2	1,7281=003	0,0000+000

```
PROB, NO,   2,00000+000  2DCANDID  K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH        PAGE NO,   20
      COMPOSITION NUMBER...   3

   ENERGY          DIFFUSION             REMOVAL            FISSION            FISSION
   GROUP          COEFFICIENT         CROSS SECTION      CROSS SECTION      REACTION RATE

     1            1,2438+000            8,8593-003         1,0741-003         2,9480-003
     2            6,8743-001            1,2880-002         2,1334-004         5,4672-004
```

```
PROB, NO,   2,00000+000  2DCANDID  K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH        PAGE NO,   21
      COMPOSITION NUMBER...   3

   ENERGY                              FISSION SPECTRUM
   GROUP
                   1                 2

     1        9,9221-001        9,9221-001
     2        7,7911-003        7,7911-003
```

```
PROB, NO,   2,00000+000  2DCANDID  K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH        PAGE NO,   22
      COMPOSITION NUMBER...   3

   ENERGY                      GROUPS FROM WHICH NEUTRONS ARE SCATTERED.
   GROUP              ( SUM DOWN TO OBTAIN TOTAL SCATTERING CROSS-SECTION PER ENERGY GROUP)

                   1                 2

     1        0,0000+000        0,0000+000
     2        3,3042-003        0,0000+000
CANDID2D IS PREPARING X SECTIONS AND COEFFICIENTS ON LUN   43
```

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	1,3773697+000	6,1440170-002	3,0971785+000	1,6558092-001	1,0000000+000	1,0000000+000	3,0357383+000
4,622							
2	1,3327728+000	2,3260586-001	1,2291780+000	9,4351252-002	1,0000000+000	1,0000000+000	9,9657212-001
3	1,3007313+000	4,3227500-001	1,1166810+000	6,7356246-002	1,0000000+000	1,0000000+000	8,8440604-001
4	1,2770434+000	5,5538333-001	1,0741421+000	5,4212842-002	1,0000000+000	1,0000000+000	5,1875873-001
5	1,2593540+000	6,3341824-001	1,0527936+000	4,6239459-002	1,0000000+000	1,0000000+000	4,1937532-001
6	1,2460554+000	6,9264789-001	1,0403481+000	4,0566803-002	1,0000000+000	1,0000000+000	3,4770019-001
7	1,2359993+000	7,4214974-001	1,0331508+000	3,6130244-002	1,0000000+000	1,0000000+000	2,9100104-001
8	1,2283286+000	7,8503622-001	1,0317257+000	3,2465991-002	1,0000000+000	1,0000000+000	2,4668948-001
9	1,2223844+000	8,2203109-001	1,0303336+000	2,9337948-002	1,0000000+000	1,0000000+000	2,0830246-001
10	1,2176492+000	8,5360629-001	1,0289328+000	2,6610098-002	1,0000000+000	1,0000000+000	1,7532654-001
11	1,2137044+000	8,8061696-001	1,0275521+000	2,4196198-002	1,0000000+000	1,0000000+000	1,4693513-001
12	1,2101739+000	8,9155540-001	1,0256558+000	2,2037956-002	1,0000000+000	1,0000000+000	1,3410042-001
13	1,2067851+000	8,9699044-001	1,0232507+000	2,0082774-002	1,0000000+000	1,0000000+000	1,2626031-001
14	1,2033687+000	9,0181376-001	1,0205935+000	1,8305807-002	1,0000000+000	1,0000000+000	1,1877973-001
15	1,1998310+000	9,0536106-001	1,0179032+000	1,6696202-002	1,0000000+000	1,0000000+000	1,1254212-001
16	1,1961292+000	9,0817362-001	1,0153233+000	1,5245504-002	1,0000000+000	1,0000000+000	1,0714973-001
17	1,1922539+000	9,1103729-001	1,0129363+000	1,3944112-002	1,0000000+000	1,0000000+000	1,0189903-001
18	1,1882159+000	9,1398080-001	1,0112219+000	1,2780716-002	1,0000000+000	1,0000000+000	9,7241146-002
19	1,1840371+000	9,1700162-001	1,0103946+000	1,1742814-002	1,0000000+000	1,0000000+000	9,3393012-002
20	1,1797445+000	9,2008183-001	1,0096243+000	1,0817486-002	1,0000000+000	1,0000000+000	8,9542457-002
21	1,1753668+000	9,2319734-001	1,0089060+000	9,9920680-003	1,0000000+000	1,0000000+000	8,5708677-002
22	1,1709317+000	9,2632298-001	1,0082355+000	9,2546349-003	1,0000000+000	1,0000000+000	8,1912472-002
23	1,1664648+000	9,2943511-001	1,0076087+000	8,5942781-003	1,0000000+000	1,0000000+000	7,8173582-002
24	1,1619893+000	9,3251286-001	1,0070223+000	8,0012340-003	1,0000000+000	1,0000000+000	7,4509446-002
25	1,1575252+000	9,3553855-001	1,0064733+000	7,4669007-003	1,0000000+000	1,0000000+000	7,0934715-002
26	1,1530900+000	9,3849767-001	1,0059589+000	6,9837874-003	1,0000000+000	1,0000000+000	6,7461198-002
27	1,1486982+000	9,4137871-001	1,0054767+000	6,5454236-003	1,0000000+000	1,0000000+000	6,4098017-002
28	1,1443620+000	9,4417284-001	1,0050247+000	6,1462516-003	1,0000000+000	1,0000000+000	6,0851867-002
29	1,1400913+000	9,4687357-001	1,0046009+000	5,7815136-003	1,0000000+000	1,0000000+000	5,7727310-002
30	1,1358943+000	9,4947642-001	1,0042035+000	5,4471425-003	1,0000000+000	1,0000000+000	5,4727068-002
31	1,1317773+000	9,5197864-001	1,0038309+000	5,1396613-003	1,0000000+000	1,0000000+000	5,1852307-002
32	1,1277452+000	9,5437889-001	1,0034818+000	4,8560939-003	1,0000000+000	1,0000000+000	4,9102893-002
33	1,1238017+000	9,5667701-001	1,0031546+000	4,5938863-003	1,0000000+000	1,0000000+000	4,6477628-002
34	1,1199494+000	9,5838369-001	1,0028483+000	4,3508397-003	1,0000000+000	1,0000000+000	4,4464577-002
35	1,1161901+000	9,5981648-001	1,0025755+000	4,1250534-003	1,0000000+000	1,0000000+000	4,2759043-002
36	1,1125247+000	9,6122207-001	1,0024562+000	3,9148773-003	1,0000000+000	1,0000000+000	4,1234149-002
37	1,1089537+000	9,6260063-001	1,0023239+000	3,7188715-003	1,0000000+000	1,0000000+000	3,9723313-002
38	1,1054770+000	9,6395207-001	1,0021834+000	3,5357738-003	1,0000000+000	1,0000000+000	3,8231327-002
39	1,1020939+000	9,6527616-001	1,0020383+000	3,3644720-003	1,0000000+000	1,0000000+000	3,6762125-002
40	1,0988037+000	9,6657250-001	1,0018914+000	3,2039812-003	1,0000000+000	1,0000000+000	3,5318950-002

41	1,0956051+000	9,6784062-001	1,0017451+000	3,0534252-003	1,0000000+000	1.0000000+000	3.3904478-002
42	1,0924968+000	9,6907998-001	1,0016009+000	2,9120207-003	1,0000000+000	1.0000000+000	3.2520915-002
43	1,0894772+000	9,7029004-001	1,0014601+000	2,7790647-003	1,0000000+000	1.0000000+000	3.1170071-002
44	1,0865445+000	9,7147025-001	1,0013237+000	2,6539235-003	1,0000000+000	1.0000000+000	2.9853422-002
45	1,0836970+000	9,7262008-001	1,0011922+000	2,5360239-003	1,0000000+000	1.0000000+000	2.8572156-002
46	1,0809329+000	9,7373905-001	1,0010663+000	2,4248456-003	1,0000000+000	1.0000000+000	2.7327207-002
47	1,0782500+000	9,7482674-001	1,0009460+000	2,3199147-003	1,0000000+000	1.0000000+000	2.6119288-002
48	1,0756465+000	9,7588280-001	1,0008317+000	2,2207986-003	1,0000000+000	1.0000000+000	2.4948911-002
49	1,0731203+000	9,7690696-001	1,0007234+000	2,1271012-003	1,0000000+000	1.0000000+000	2.3816406-002
50	1,0706695+000	9,7789903-001	1,0006210+000	2,0384590-003	1,0000000+000	1.0000000+000	2.2721943-002
51	1,0682919+000	9,7885892-001	1,0005245+000	1,9545379-003	1,0000000+000	1.0000000+000	2.1665540-002
52	1,0659857+000	9,7978663-001	1,0004337+000	1,8750299-003	1,0000000+000	1.0000000+000	2.0647079-002
53	1,0637488+000	9,8068223-001	1,0003486+000	1,7996509-003	1,0000000+000	1.0000000+000	1.9666319-002
54	1,0615792+000	9,8154591-001	1,0002688+000	1,7281386-003	1,0000000+000	1.0000000+000	1.8722904-002
55	1,0594751+000	9,8237793-001	1,0001943+000	1,6602498-003	1,0000000+000	1.0000000+000	1.7816376-002
56	1,0574344+000	9,8317863-001	1,0001248+000	1,5957595-003	1,0000000+000	1.0000000+000	1.6946185-002
57	1,0554555+000	9,8394842-001	1,0000601+000	1,5344589-003	1,0000000+000	1.0000000+000	1.6111696-002
58	1,0535364+000	9,8468780-001	1,0000000+000	1,4761541-003	1,0000000+000	1.0000000+000	1.5312202-002
59	1,0516753+000	9,8539731-001	9,9994425-001	1,4206649-003	1,0000000+000	1.0000000+000	1.4546931-002
60	1,0498705+000	9,8607758-001	9,9989264-001	1,3678239-003	1,0000000+000	1.0000000+000	1.3815057-002
61	1,0481202+000	9,8672926-001	9,9984497-001	1,3174750-003	1,0000000+000	1.0000000+000	1.3115705-002
62	1,0464230+000	9,8735306-001	9,9980103-001	1,2694728-003	1,0000000+000	1.0000000+000	1.2447963-002
63	1,0447770+000	9,8794972-001	9,9976061-001	1,2236819-003	1,0000000+000	1.0000000+000	1.1810885-002
64	1,0431807+000	9,8852002-001	9,9972352-001	1,1799760-003	1,0000000+000	1.0000000+000	1.1203503-002
65	1,0416326+000	9,8906475-001	9,9968958-001	1,1382372-003	1,0000000+000	1.0000000+000	1.0624831-002
66	1,0401312+000	9,8958472-001	9,9965859-001	1,0983552-003	1,0000000+000	1.0000000+000	1.0073871-002
67	1,0386750+000	9,9008078-001	9,9963040-001	1,0602272-003	1,0000000+000	1.0000000+000	9.5496200-003
68	1,0372627+000	9,9055375-001	9,9960483-001	1,0237568-003	1,0000000+000	1.0000000+000	9.0510741-003
69	1,0358928+000	9,9100448-001	9,9958172-001	9,8885422-004	1,0000000+000	1.0000000+000	8.5772342-003
70	1,0345640+000	9,9143381-001	9,9956092-001	9,5543503-004	1,0000000+000	1.0000000+000	8.1271094-003
71	1,0332751+000	9,9184258-001	9,9954230-001	9,2342035-004	1,0000000+000	1.0000000+000	7.6997213-003
72	1,0320247+000	9,9223160-001	9,9952571-001	8,9273624-004	1,0000000+000	1.0000000+000	7.2941065-003
73	1,0308117+000	9,9260170-001	9,9951102-001	8,6331337-004	1,0000000+000	1.0000000+000	6.9093206-003
74	1,0296349+000	9,9295368-001	9,9949812-001	8,3508673-004	1,0000000+000	1.0000000+000	6.5444392-003
75	1,0284931+000	9,9328832-001	9,9948688-001	8,0799530-004	1,0000000+000	1.0000000+000	6.1985613-003
76	1,0273853+000	9,9360639-001	9,9947720-001	7,8198178-004	1,0000000+000	1.0000000+000	5.8708100-003
77	1,0263103+000	9,9390863-001	9,9946896-001	7,5699235-004	1,0000000+000	1.0000000+000	5.5603341-003
78	1,0252672+000	9,9419577-001	9,9946208-001	7,3297643-004	1,0000000+000	1.0000000+000	5.2663094-003
79	1,0242549+000	9,9446852-001	9,9945646-001	7,0988644-004	1,0000000+000	1.0000000+000	4.9879392-003
80	1,0232724+000	9,9472755-001	9,9945200-001	6,8767760-004	1,0000000+000	1.0000000+000	4.7244552-003
81	1,0223189+000	9,9497352-001	9,9944864-001	6,6630775-004	1,0000000+000	1.0000000+000	4.4751171-003
82	1,0213934+000	9,9520707-001	9,9944628-001	6,4573723-004	1,0000000+000	1.0000000+000	4.2392132-003
83	1,0204949+000	9,9542880-001	9,9944486-001	6,2592860-004	1,0000000+000	1.0000000+000	4.0160604-003
84	1,0196228+000	9,9563930-001	9,9944431-001	6,0684662-004	1,0000000+000	1.0000000+000	3.8050035-003
85	1,0187761+000	9,9583914-001	9,9944455-001	5,8845796-004	1,0000000+000	1.0000000+000	3.6054157-003

86	1,0179540+000	9,9602884-001	9,9944554-001	5,7073122-004	1.0000000+000	1.0000000+000	3.4166972-003
87	1,0171558+000	9,9620892-001	9,9944720-001	5,5363674-004	1.0000000+000	1.0000000+000	3.2382749-003
88	1,0163807+000	9,9637989-001	9,9944949-001	5,3714646-004	1.0000000+000	1.0000000+000	3.0696025-003
89	1,0156280+000	9,9654219-001	9,9945235-001	5,2123390-004	1.0000000+000	1.0000000+000	2.9101588-003
90	1,0148970+000	9,9669630-001	9,9945574-001	5,0587395-004	1.0000000+000	1.0000000+000	2.7594476-003
91	1,0141870+000	9,9684262-001	9,9945962-001	4,9104290-004	1.0000000+000	1.0000000+000	2.6169966-003
92	1,0134974+000	9,9698157-001	9,9946393-001	4,7671823-004	1.0000000+000	1.0000000+000	2.4823568-003
93	1,0128275+000	9,9711353-001	9,9947782-001	4,6287867-004	1.0000000+000	1.0000000+000	2.3642886-003
94	1,0121767+000	9,9723888-001	9,9949263-001	4,4950402-004	1.0000000+000	1.0000000+000	2.2537480-003
95	1,0115445+000	9,9735796-001	9,9950729-001	4,3657510-004	1.0000000+000	1.0000000+000	2.1493314-003
96	1,0109302+000	9,9747110-001	9,9952170-001	4,2407376-004	1.0000000+000	1.0000000+000	2.0506004-003
97	1,0103333+000	9,9757862-001	9,9953566-001	4,1198274-004	1.0000000+000	1.0000000+000	1.9570379-003
98	1,0097533+000	9,9768082-001	9,9954918-001	4,0028562-004	1.0000000+000	1.0000000+000	1.8683597-003
99	1,0091896+000	9,9777797-001	9,9956227-001	3,8896679-004	1.0000000+000	1.0000000+000	1.7842966-003
100	1,0086418+000	9,9787036-001	9,9957495-001	3,7801148-004	1.0000000+000	1.0000000+000	1.7045939-003
101	1,0081094+000	9,9795822-001	9,9958723-001	3,6740556-004	1.0000000+000	1.0000000+000	1.6290108-003
102	1,0075918+000	9,9804181-001	9,9959913-001	3,5713559-004	1.0000000+000	1.0000000+000	1.5573196-003
103	1,0070887+000	9,9812135-001	9,9961066-001	3,4718880-004	1.0000000+000	1.0000000+000	1.4893050-003
104	1,0065996+000	9,9819706-001	9,9962191-001	3,3755298-004	1.0000000+000	1.0000000+000	1.4248492-003
105	1,0061241+000	9,9826913-001	9,9963295-001	3,2821653-004	1.0000000+000	1.0000000+000	1.3638129-003
106	1,0056618+000	9,9833777-001	9,9964363-001	3,1916833-004	1.0000000+000	1.0000000+000	1.3058595-003
107	1,0052122+000	9,9840316-001	9,9965397-001	3,1039784-004	1.0000000+000	1.0000000+000	1.2508187-003
108	1,0047751+000	9,9846546-001	9,9966399-001	3,0189494-004	1.0000000+000	1.0000000+000	1.1985299-003
109	1,0043500+000	9,9852484-001	9,9967368-001	2,9364998-004	1.0000000+000	1.0000000+000	1.1488413-003

```
AN ERROR WAS ENCOUNTERED IN SUBROUTINE  KEFFCALC  AT STATEMENT NUMBER    692
TIME EXCEEDED
I=    1 G=1 J=1 FLUX=  5,2431998-003
I=    2 G=1 J=1 FLUX=  5,2092283-003
I=    3 G=1 J=1 FLUX=  5,1427398-003
I=    4 G=1 J=1 FLUX=  5,0442825-003
I=    5 G=1 J=1 FLUX=  4,9146537-003
I=    6 G=1 J=1 FLUX=  4,7548859-003
I=    7 G=1 J=1 FLUX=  4,5662274-003
I=    8 G=1 J=1 FLUX=  4,3501180-003
I=    9 G=1 J=1 FLUX=  4,1081581-003
I=   10 G=1 J=1 FLUX=  3,8420692-003
I=   11 G=1 J=1 FLUX=  3,5536456-003
I=   12 G=1 J=1 FLUX=  3,2446935-003
I=   13 G=1 J=1 FLUX=  3,0100650-003
I=   14 G=1 J=1 FLUX=  2,8703679-003
I=   15 G=1 J=1 FLUX=  2,7314888-003
I=   16 G=1 J=1 FLUX=  2,0739119-003
I=   17 G=1 J=1 FLUX=  1,3367592-003
```

```
I=    18 G=1  J=1  FLUX=   8.6857698-004
I=    19 G=1  J=1  FLUX=   5.6775897-004
I=    20 G=1  J=1  FLUX=   3.7266853-004
I=    21 G=1  J=1  FLUX=   2.4510971-004
I=    22 G=1  J=1  FLUX=   1.6101682-004
I=    23 G=1  J=1  FLUX=   1.0501365-004
I=    24 G=1  J=1  FLUX=   6.7142307-005
I=    25 G=1  J=1  FLUX=   4.0849703-005
I=    26 G=1  J=1  FLUX=   2.1720506-005
I=    27 G=1  J=1  FLUX=   6.6593465-006

CANDID2D HAS COPIED FLUX FROM LUN    42 ONTO LUN    48

IMAXIN=    27 JMAXIN=    20 IMAXOUT=    27 JMAXOUT=    20
I=     1 G=1  J=1  FLUX=   4.4073824-002
I=     2 G=1  J=1  FLUX=   4.4073824-002
I=     3 G=1  J=1  FLUX=   4.4073824-002
I=     4 G=1  J=1  FLUX=   4.4073824-002
I=     5 G=1  J=1  FLUX=   4.4073824-002
I=     6 G=1  J=1  FLUX=   4.4073824-002
I=     7 G=1  J=1  FLUX=   4.4073824-002
I=     8 G=1  J=1  FLUX=   4.4073824-002
I=     9 G=1  J=1  FLUX=   4.4073824-002
I=    10 G=1  J=1  FLUX=   4.4073824-002
I=    11 G=1  J=1  FLUX=   4.4073824-002
I=    12 G=1  J=1  FLUX=   4.4073824-002
I=    13 G=1  J=1  FLUX=   2.2036912-002
I=    14 G=1  J=1  FLUX=   2.2036912-002
I=    15 G=1  J=1  FLUX=   2.2036912-002
I=    16 G=1  J=1  FLUX=   4.4073824-003
I=    17 G=1  J=1  FLUX=   4.4073824-003
I=    18 G=1  J=1  FLUX=   4.4073824-003
I=    19 G=1  J=1  FLUX=   4.4073824-003
I=    20 G=1  J=1  FLUX=   4.4073824-003
I=    21 G=1  J=1  FLUX=   4.4073824-003
I=    22 G=1  J=1  FLUX=   4.4073824-003
I=    23 G=1  J=1  FLUX=   4.4073824-003
I=    24 G=1  J=1  FLUX=   4.4073824-003
I=    25 G=1  J=1  FLUX=   4.4073824-003
I=    26 G=1  J=1  FLUX=   4.4073824-003
I=    27 G=1  J=1  FLUX=   4.4073824-003

CANDID2D HAS COPIED FLUX FROM LUN    49 ONTO LUN    48

IMAXIN=    27 JMAXIN=    20 IMAXOUT=    27 JMAXOUT=    20
```

PROB. NO. 2.00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 23

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	1.0039366+000	9.9858146-001	9.9968307-001	2.8565415-004	1.0000000+000	1.0000000+000	1.1016096-003
4,612							
2	1.0035344+000	9.9863545-001	9.9969215-001	2.7789779-004	1.0000000+000	1.0000000+000	1.0567008-003
3	1.0031433+000	9.9868697-001	9.9970095-001	2.7037289-004	1.0000000+000	1.0000000+000	1.0139872-003
4	1.0027628+000	9.9873613-001	9.9970948-001	2.6307140-004	1.0000000+000	1.0000000+000	9.7334836-004
5	1.0023927+000	9.9878306-001	9.9971773-001	2.5598558-004	1.0000000+000	1.0000000+000	9.3467149-004
6	1.0020327+000	9.9882788-001	9.9972573-001	2.4910803-004	1.0000000+000	1.0000000+000	8.9784979-004
7	1.0016824+000	9.9887070-001	9.9973348-001	2.4243166-004	1.0000000+000	1.0000000+000	8.6278241-004
8	1.0013415+000	9.9891161-001	9.9974099-001	2.3594967-004	1.0000000+000	1.0000000+000	8.2937469-004
9	1.0010099+000	9.9895072-001	9.9974826-001	2.2965556-004	1.0000000+000	1.0000000+000	7.9753692-004
10	1.0006872+000	9.9898812-001	9.9975531-001	2.2354306-004	1.0000000+000	1.0000000+000	7.6718483-004
11	1.0003731+000	9.9902390-001	9.9976214-001	2.1760616-004	1.0000000+000	1.0000000+000	7.3823900-004
12	1.0000675+000	9.9905814-001	9.9976876-001	2.1183912-004	1.0000000+000	1.0000000+000	7.1062420-004
13	9.9977006-001	9.9909091-001	9.9977518-001	2.0623638-004	1.0000000+000	1.0000000+000	6.8426994-004
14	9.9948056-001	9.9912230-001	9.9978141-001	2.0079263-004	1.0000000+000	1.0000000+000	6.591[illegible]940-004
15	9.9919878-001	9.9915236-001	9.9978744-001	1.9550275-004	1.0000000+000	1.0000000+000	6.35[illegible]7984-004
16	9.9892450-001	9.9918117-001	9.9979329-001	1.9036186-004	1.0000000+000	1.0000000+000	6.1212182-004
17	9.9865751-001	9.9920879-001	9.9979897-001	1.8536520-004	1.0000000+000	1.0000000+000	5.9017957-004
18	9.9839759-001	9.9923528-001	9.9980448-001	1.8050822-004	1.0000000+000	1.0000000+000	5.692[illegible]014-004
19	9.9814455-001	9.9926068-001	9.9980982-001	1.7578655-004	1.0000000+000	1.0000000+000	5.4913403-004
20	9.9789820-001	9.9928507-001	9.9981500-001	1.7119596-004	1.0000000+000	1.0000000+000	5.2993419-004
21	9.9765835-001	9.9930847-001	9.9982003-001	1.6673242-004	1.0000000+000	1.0000000+000	5.1155631-004
22	9.9742481-001	9.9933095-001	9.9982491-001	1.6239202-004	1.0000000+000	1.0000000+000	4.9395871-004
23	9.9719742-001	9.9935254-001	9.9982964-001	1.5817096-004	1.0000000+000	1.0000000+000	4.771[illegible]181-004
24	9.9697599-001	9.9937329-001	9.9983424-001	1.5406561-004	1.0000000+000	1.0000000+000	4.6094853-004
25	9.9676037-001	9.9939324-001	9.9983870-001	1.5007248-004	1.0000000+000	1.0000000+000	4.4546368-004
26	9.9655039-001	9.9941242-001	9.9984305-001	1.4618819-004	1.0000000+000	1.0000000+000	4.3063280-004
27	9.9634589-001	9.9943087-001	9.9984729-001	1.4240947-004	1.0000000+000	1.0000000+000	4.1641318-004
28	9.9614673-001	9.9944863-001	9.9985140-001	1.3873316-004	1.0000000+000	1.0000000+000	4.0276570-004
29	9.9595276-001	9.9946572-001	9.9985538-001	1.3515625-004	1.0000000+000	1.0000000+000	3.8966266-004
30	9.9576384-001	9.9948218-001	9.9985926-001	1.3167578-004	1.0000000+000	1.0000000+000	3.77[illegible]7778-004
31	9.9557983-001	9.9949803-001	9.9986302-001	1.2828892-004	1.0000000+000	1.0000000+000	3.6498615-004
32	9.9540059-001	9.9951331-001	9.9986667-001	1.2499294-004	1.0000000+000	1.0000000+000	3.5336442-004
33	9.9522600-001	9.9952803-001	9.9987022-001	1.2178519-004	1.0000000+000	1.0000000+000	3.4219027-004
34	9.9505593-001	9.9954222-001	9.9987366-001	1.1866310-004	1.0000000+000	1.0000000+000	3.3144273-004
35	9.9489025-001	9.9955591-001	9.9987701-001	1.1562423-004	1.0000000+000	1.0000000+000	3.211[illegible]202-004
36	9.9472885-001	9.9956911-001	9.9988026-001	1.1266615-004	1.0000000+000	1.0000000+000	3.1114910-004
37	9.9457162-001	9.9958186-001	9.9988342-001	1.0978656-004	1.0000000+000	1.0000000+000	3.0156641-004
38	9.9441843-001	9.9959416-001	9.9988649-001	1.0698322-004	1.0000000+000	1.0000000+000	2.9233711-004
39	9.9426919-001	9.9960603-001	9.9988948-001	1.0425397-004	1.0000000+000	1.0000000+000	2.8344512-004
40	9.9412378-001	9.9961750-001	9.9989238-001	1.0159671-004	1.0000000+000	1.0000000+000	2.7487536-004
41	9.9398211-001	9.9962859-001	9.9989520-001	9.9009399-005	1.0000000+000	1.0000000+000	2.6661361-004

42	9.9384407-001	9.9963929-001	9.9989794-001	9.6490079-005	1.0000000+000	1.0000000+000	2.5864624-004
43	9.9370956-001	9.9964965-001	9.9990061-001	9.4036858-005	1.0000000+000	1.0000000+000	2.5096035-004
44	9.9357851-001	9.9965965-001	9.9990320-001	9.1647888-005	1.0000000+000	1.0000000+000	2.4354389-004
45	9.9345080-001	9.9966933-001	9.9990572-001	8.9321368-005	1.0000000+000	1.0000000+000	2.3638514-004
46	9.9332636-001	9.9967869-001	9.9990817-001	8.7055579-005	1.0000000+000	1.0000000+000	2.2947321-004
47	9.9320509-001	9.9968775-001	9.9991055-001	8.4848845-005	1.0000000+000	1.0000000+000	2.2279756-004
48	9.9308692-001	9.9969652-001	9.9991287-001	8.2699522-005	1.0000000+000	1.0000000+000	2.1634848-004
49	9.9297176-001	9.9970501-001	9.9991512-001	8.0606070-005	1.0000000+000	1.0000000+000	2.1011646-004
50	9.9285953-001	9.9971322-001	9.9991732-001	7.8566931-005	1.0000000+000	1.0000000+000	2.04 9252-004
51	9.9275015-001	9.9972118-001	9.9991945-001	7.6580620-005	1.0000000+000	1.0000000+000	1.9826833-004
52	9.9264356-001	9.9972889-001	9.9992153-001	7.4645702-005	1.0000000+000	1.0000000+000	1.9263572-004
53	9.9253968-001	9.9973636-001	9.9992355-001	7.2760775-005	1.0000000+000	1.0000000+000	1.8718702-004
54	9.9243843-001	9.9974360-001	9.9992551-001	7.0924501-005	1.0000000+000	1.0000000+000	1.8191490-004
55	9.9233975-001	9.9975061-001	9.9992743-001	6.9135554-005	1.0000000+000	1.0000000+000	1.7681241-004
56	9.9224357-001	9.9975741-001	9.9992929-001	6.7392677-005	1.0000000+000	1.0000000+000	1.7187303-004
57	9.9214983-001	9.9976401-001	9.9993110-001	6.5694613-005	1.0000000+000	1.0000000+000	1.67 9036-004
58	9.9205846-001	9.9977040-001	9.9993286-001	6.4040168-005	1.0000000+000	1.0000000+000	1.6245837-004
59	9.9196941-001	9.9977661-001	9.9993458-001	6.2428169-005	1.0000000+000	1.0000000+000	1.5797143-004
60	9.9188260-001	9.9978263-001	9.9993625-001	6.0857485-005	1.0000000+000	1.0000000+000	1.5362397-004
61	9.9179799-001	9.9978847-001	9.9993788-001	5.9327018-005	1.0000000+000	1.0000000+000	1.4941093-004
62	9.9171552-001	9.9979413-001	9.9993946-001	5.7835706-005	1.0000000+000	1.0000000+000	1.4532717-004
63	9.9163513-001	9.9979963-001	9.9994100-001	5.6382506-005	1.0000000+000	1.0000000+000	1.4136801-004
64	9.9155676-001	9.9980497-001	9.9994250-001	5.4966402-005	1.0000000+000	1.0000000+000	1.3752893-004
65	9.9148037-001	9.9981016-001	9.9994396-001	5.3586424-005	1.0000000+000	1.0000000+000	1.338 556-004
66	9.9140591-001	9.9981519-001	9.9994539-001	5.2241606-005	1.0000000+000	1.0000000+000	1.3019383-004
67	9.9133332-001	9.9982008-001	9.9994677-001	5.0931056-005	1.0000000+000	1.0000000+000	1.2668975-004
68	9.9126256-001	9.9982483-001	9.9994812-001	4.9653827-005	1.0000000+000	1.0000000+000	1.2328949-004
69	9.9119359-001	9.9982945-001	9.9994944-001	4.8409066-005	1.0000000+000	1.0000000+000	1.1998949-004
70	9.9112634-001	9.9983393-001	9.9995072-001	4.7195933-005	1.0000000+000	1.0000000+000	1.1678621-004
71	9.9106079-001	9.9983829-001	9.9995197-001	4.6013586-005	1.0000000+000	1.0000000+000	1.1367637-004
72	9.9099688-001	9.9984252-001	9.9995318-001	4.4861232-005	1.0000000+000	1.0000000+000	1.1065682-004
73	9.9093458-001	9.9984664-001	9.9995436-001	4.3738082-005	1.0000000+000	1.0000000+000	1.0772454-004
74	9.9087384-001	9.9985064-001	9.9995552-001	4.2643391-005	1.0000000+000	1.0000000+000	1.0487637-004
75	9.9081463-001	9.9985453-001	9.9995664-001	4.1576407-005	1.0000000+000	1.0000000+000	1.021 981-004
76	9.9075690-001	9.9985831-001	9.9995773-001	4.0536414-005	1.0000000+000	1.0000000+000	9.9421930-005
77	9.9070062-001	9.9986199-001	9.9995880-001	3.9522699-005	1.0000000+000	1.0000000+000	9.681 400-005
78	9.9064576-001	9.9986556-001	9.9995983-001	3.8534596-005	1.0000000+000	1.0000000+000	9.4272502-005
79	9.9059226-001	9.9986904-001	9.9996085-001	3.7571443-005	1.0000000+000	1.0000000+000	9.18 5967-005
80	9.9054011-001	9.9987242-001	9.9996183-001	3.6632590-005	1.0000000+000	1.0000000+000	8.94 8510-005
81	9.9048927-001	9.9987571-001	9.9996279-001	3.5717430-005	1.0000000+000	1.0000000+000	8.7077860-005
82	9.9043969-001	9.9987891-001	9.9996373-001	3.4825334-005	1.0000000+000	1.0000000+000	8.4812054-005
83	9.9039136-001	9.9988203-001	9.9996464-001	3.3955707-005	1.0000000+000	1.0000000+000	8.26 8938-005
84	9.9034424-001	9.9988506-001	9.9996553-001	3.3107979-005	1.0000000+000	1.0000000+000	8.0466489-005
85	9.9029829-001	9.9988801-001	9.9996639-001	3.2281594-005	1.0000000+000	1.0000000+000	7.8383004-005
86	9.9025350-001	9.9989088-001	9.9996724-001	3.1475993-005	1.0000000+000	1.0000000+000	7.6356533-005
87	9.9020982-001	9.9989367-001	9.9996806-001	3.0690662-005	1.0000000+000	1.0000000+000	7.4385433-005

88	9.9016724-001	9.9989639-001	9.9996886-001	2.9925065-005	1.0000000+000	1.0000000+000	7.2467883-005
89	9.9012572-001	9.9989904-001	9.9996964-001	2.9178708-005	1.0000000+000	1.0000000+000	7.0602386-005
90	9.9008524-001	9.9990161-001	9.9997040-001	2.8451082-005	1.0000000+000	1.0000000+000	6.8787296-005
91	9.9004577-001	9.9990412-001	9.9997114-001	2.7741745-005	1.0000000+000	1.0000000+000	6.7021218-005
92	9.9000729-001	9.9990656-001	9.9997186-001	2.7050210-005	1.0000000+000	1.0000000+000	[illegible]
93	9.8996976-001	9.9990894-001	9.9997257-001	2.6376005-005	1.0000000+000	1.0000000+000	6.3629952-005
94	9.8993318-001	9.9991125-001	9.9997325-001	2.5718713-005	1.0000000+000	1.0000000+000	[illegible]
95	9.8989750-001	9.9991350-001	9.9997392-001	2.5077898-005	1.0000000+000	1.0000000+000	6.0417689-005
96	9.8986272-001	9.9991570-001	9.9997457-001	2.4453138-005	1.0000000+000	1.0000000+000	5.8875390-005
97	9.8982880-001	9.9991784-001	9.9997521-001	2.3844021-005	1.0000000+000	1.0000000+000	5.7374040-005
98	9.8979573-001	9.9991992-001	9.9997583-001	2.3250165-005	1.0000000+000	1.0000000+000	5.5912475-005
99	9.8976349-001	9.9992194-001	9.9997643-001	2.2671172-005	1.0000000+000	1.0000000+000	5.4489487-005
100	9.8973205-001	9.9992392-001	9.9997702-001	2.2106676-005	1.0000000+000	1.0000000+000	[illegible]
101	9.8970139-001	9.9992584-001	9.9997760-001	2.1556299-005	1.0000000+000	1.0000000+000	5.1754963-005
102	9.8967150-001	9.9992771-001	9.9997815-001	2.1019693-005	1.0000000+000	1.0000000+000	5.0441275-005
103	9.8964235-001	9.9992954-001	9.9997870-001	2.0496491-005	1.0000000+000	1.0000000+000	4.9162045-005
104	9.8961393-001	9.9993132-001	9.9997923-001	1.9986397-005	1.0000000+000	1.0000000+000	4.7916372-005
105	9.8958621-001	9.9993305-001	9.9997975-001	1.9489047-005	1.0000000+000	1.0000000+000	[illegible]
106	9.8955919-001	9.9993473-001	9.9998025-001	1.9004117-005	1.0000000+000	1.0000000+000	4.5521418-005
107	9.8953284-001	9.9993638-001	9.9998075-001	1.8531303-005	1.0000000+000	1.0000000+000	[illegible]
108	9.8950714-001	9.9993798-001	9.9998123-001	1.8070298-005	1.0000000+000	1.0000000+000	4.3249383-005
109	9.8948209-001	9.9993954-001	9.9998169-001	1.7620788-005	1.0000000+000	1.0000000+000	4.2157422-005
110	9.8945766-001	9.9994106-001	9.9998215-001	1.7182516-005	1.0000000+000	1.0000000+000	4.1093779-005
111	9.8943384-001	9.9994254-001	9.9998260-001	1.6755183-005	1.0000000+000	1.0000000+000	4.0057537-005
112	9.8941061-001	9.9994398-001	9.9998303-001	1.6338520-005	1.0000000+000	1.0000000+000	3.9048013-005
113	9.8938796-001	9.9994539-001	9.9998345-001	1.5932238-005	1.0000000+000	1.0000000+000	3.8064565-005

```
AN ERROR WAS ENCOUNTERED IN SUBROUTINE  KEFFCALC  AT STATEMENT NUMBER    692
TIME EXCEEDED
I=    1 G=1 J=1 FLUX=  5.1743382-003
I=    2 G=1 J=1 FLUX=  5.1410156-003
I=    3 G=1 J=1 FLUX=  5.0747050-003
I=    4 G=1 J=1 FLUX=  4.9759841-003
I=    5 G=1 J=1 FLUX=  4.8457066-003
I=    6 G=1 J=1 FLUX=  4.6849863-003
I=    7 G=1 J=1 FLUX=  4.4951762-003
I=    8 G=1 J=1 FLUX=  4.2778406-003
I=    9 G=1 J=1 FLUX=  4.0347197-003
I=   10 G=1 J=1 FLUX=  3.7676868-003
I=   11 G=1 J=1 FLUX=  3.4786942-003
I=   12 G=1 J=1 FLUX=  3.1697071-003
I=   13 G=1 J=1 FLUX=  2.9361318-003
I=   14 G=1 J=1 FLUX=  2.7987402-003
I=   15 G=1 J=1 FLUX=  2.6636819-003
I=   16 G=1 J=1 FLUX=  2.0239205-003
```

```
I=   17 G=1 J=1 FLUX=  1.3057572-003
I=   18 G=1 J=1 FLUX=  8.4912379-004
I=   19 G=1 J=1 FLUX=  5.5544858-004
I=   20 G=1 J=1 FLUX=  3.6483332-004
I=   21 G=1 J=1 FLUX=  2.4010752-004
I=   22 G=1 J=1 FLUX=  1.5782459-004
I=   23 G=1 J=1 FLUX=  1.0298924-004
I=   24 G=1 J=1 FLUX=  6.5881873-005
I=   25 G=1 J=1 FLUX=  4.0101116-005
I=   26 G=1 J=1 FLUX=  2.1330450-005
I=   27 G=1 J=1 FLUX=  6.5412713-006

CANDID2D HAS COPIED FLUX FROM LUN   42 ONTO LUN   48

IMAXIN=   27 JMAXIN=   20 IMAXOUT=   27 JMAXOUT=   20
I=    1 G=1 J=1 FLUX=  4.4073824-002
I=    2 G=1 J=1 FLUX=  4.4073824-002
I=    3 G=1 J=1 FLUX=  4.4073824-002
I=    4 G=1 J=1 FLUX=  4.4073824-002
I=    5 G=1 J=1 FLUX=  4.4073824-002
I=    6 G=1 J=1 FLUX=  4.4073824-002
I=    7 G=1 J=1 FLUX=  4.4073824-002
I=    8 G=1 J=1 FLUX=  4.4073824-002
I=    9 G=1 J=1 FLUX=  4.4073824-002
I=   10 G=1 J=1 FLUX=  4.4073824-002
I=   11 G=1 J=1 FLUX=  4.4073824-002
I=   12 G=1 J=1 FLUX=  4.4073824-002
I=   13 G=1 J=1 FLUX=  2.2036912-002
I=   14 G=1 J=1 FLUX=  2.2036912-002
I=   15 G=1 J=1 FLUX=  2.2036912-002
I=   16 G=1 J=1 FLUX=  4.4073824-003
I=   17 G=1 J=1 FLUX=  4.4073824-003
I=   18 G=1 J=1 FLUX=  4.4073824-003
I=   19 G=1 J=1 FLUX=  4.4073824-003
I=   20 G=1 J=1 FLUX=  4.4073824-003
I=   21 G=1 J=1 FLUX=  4.4073824-003
I=   22 G=1 J=1 FLUX=  4.4073824-003
I=   23 G=1 J=1 FLUX=  4.4073824-003
I=   24 G=1 J=1 FLUX=  4.4073824-003
I=   25 G=1 J=1 FLUX=  4.4073824-003
I=   26 G=1 J=1 FLUX=  4.4073824-003
I=   27 G=1 J=1 FLUX=  4.4073824-003

CANDID2D HAS COPIED FLUX FROM LUN   49 ONTO LUN   48

IMAXIN=   27 JMAXIN=   20 IMAXOUT=   27 JMAXOUT=   20
```

PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 23

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	9,8936587-001	9,9994676-001	9,9998386-001	1,5536165-005	1,0000000+000	1,0000000+000	3,7106292-005
4,615							
2	9,8934433-001	9,9994809-001	9,9998427-001	1,5149896-005	1,0000000+000	1,0000000+000	3,6172743-005
3	9,8932333-001	9,9994939-001	9,9998466-001	1,4773270-005	1,0000000+000	1,0000000+000	3,5263176-005
4	9,8930285-001	9,9995066-001	9,9998504-001	1,4406020-005	1,0000000+000	1,0000000+000	3,4376862-005
5	9,8928288-001	9,9995190-001	9,9998541-001	1,4047937-005	1,0000000+000	1,0000000+000	3,3513235-005
6	9,8926341-001	9,9995310-001	9,9998578-001	1,3698773-005	1,0000000+000	1,0000000+000	3,2671829-005
7	9,8924442-001	9,9995428-001	9,9998613-001	1,3358319-005	1,0000000+000	1,0000000+000	3,1851756-005
8	9,8922590-001	9,9995542-001	9,9998647-001	1,3026340-005	1,0000000+000	1,0000000+000	3,1052710-005
9	9,8920785-001	9,9995654-001	9,9998681-001	1,2702635-005	1,0000000+000	1,0000000+000	3,0273965-005
10	9,8919024-001	9,9995762-001	9,9998714-001	1,2386994-005	1,0000000+000	1,0000000+000	2,9515097-005
11	9,8917307-001	9,9995868-001	9,9998746-001	1,2079205-005	1,0000000+000	1,0000000+000	2,8775525-005
12	9,8915633-001	9,9995972-001	9,9998777-001	1,1779082-005	1,0000000+000	1,0000000+000	2,8054797-005
13	9,8914000-001	9,9996072-001	9,9998807-001	1,1486434-005	1,0000000+000	1,0000000+000	2,7352347-005
14	9,8912408-001	9,9996170-001	9,9998837-001	1,1201061-005	1,0000000+000	1,0000000+000	2,6667723-005
15	9,8910855-001	9,9996266-001	9,9998866-001	1,0922791-005	1,0000000+000	1,0000000+000	2,6000533-005
16	9,8909341-001	9,9996359-001	9,9998894-001	1,0651473-005	1,0000000+000	1,0000000+000	2,5350091-005
17	9,8907865-001	9,9996450-001	9,9998922-001	1,0386894-005	1,0000000+000	1,0000000+000	2,4716224-005
18	9,8906425-001	9,9996539-001	9,9998949-001	1,0128901-005	1,0000000+000	1,0000000+000	2,4098335-005
19	9,8905022-001	9,9996625-001	9,9998975-001	9,8773216-006	1,0000000+000	1,0000000+000	2,3496090-005
20	9,8903653-001	9,9996709-001	9,9999000-001	9,6319914-006	1,0000000+000	1,0000000+000	2,2909080-005
21	9,8902318-001	9,9996791-001	9,9999025-001	9,3927854-006	1,0000000+000	1,0000000+000	2,2336826-005
22	9,8901016-001	9,9996871-001	9,9999049-001	9,1595339-006	1,0000000+000	1,0000000+000	2,1779066-005
23	9,8899746-001	9,9996949-001	9,9999073-001	8,9320643-006	1,0000000+000	1,0000000+000	2,1235348-005
24	9,8898509-001	9,9997025-001	9,9999096-001	8,7102580-006	1,0000000+000	1,0000000+000	2,0705338-005
25	9,8897301-001	9,9997099-001	9,9999118-001	8,4939650-006	1,0000000+000	1,0000000+000	2,0188643-005
26	9,8896124-001	9,9997172-001	9,9999140-001	8,2830567-006	1,0000000+000	1,0000000+000	1,9684987-005
27	9,8894976-001	9,9997242-001	9,9999162-001	8,0773800-006	1,0000000+000	1,0000000+000	1,9194049-005
28	9,8893857-001	9,9997311-001	9,9999182-001	7,8768217-006	1,0000000+000	1,0000000+000	1,8715393-005
29	9,8892765-001	9,9997378-001	9,9999203-001	7,6812588-006	1,0000000+000	1,0000000+000	1,8248786-005
30	9,8891701-001	9,9997443-001	9,9999223-001	7,4905669-006	1,0000000+000	1,0000000+000	1,7793835-005
31	9,8890663-001	9,9997507-001	9,9999242-001	7,3045961-006	1,0000000+000	1,0000000+000	1,7350365-005
32	9,8889650-001	9,9997569-001	9,9979261-001	7,1232544-006	1,0000000+000	1,0000000+000	1,6918013-005
33	9,8888663-001	9,9997629-001	9,9999279-001	6,9464209-006	1,0000000+000	1,0000000+000	1,6496531-005
34	9,8887701-001	9,9997688-001	9,9999297-001	6,7739731-006	1,0000000+000	1,0000000+000	1,6085614-005
35	9,8886762-001	9,9997746-001	9,9999314-001	6,6058211-006	1,0000000+000	1,0000000+000	1,5685015-005
36	9,8885847-001	9,9997802-001	9,9999331-001	6,4418510-006	1,0000000+000	1,0000000+000	1,5294354-005
37	9,8884954-001	9,9997857-001	9,9999348-001	6,2819452-006	1,0000000+000	1,0000000+000	1,4913559-005
38	9,8884083-001	9,9997910-001	9,9999364-001	6,1260197-006	1,0000000+000	1,0000000+000	1,4542253-005
39	9,8883234-001	9,9997962-001	9,9999380-001	5,9739717-006	1,0000000+000	1,0000000+000	1,4180274-005
40	9,8882407-001	9,9998013-001	9,9999395-001	5,8256966-006	1,0000000+000	1,0000000+000	1,3827375-005
41	9,8881599-001	9,9998062-001	9,9999410-001	5,6811069-006	1,0000000+000	1,0000000+000	1,3483208-005
42	9,8880812-001	9,9998110-001	9,9999425-001	5,5400905-006	1,0000000+000	1,0000000+000	1,3147685-005
43	9,8880044-001	9,9998157-001	9,9999439-001	5,4025879-006	1,0000000+000	1,0000000+000	1,2820572-005
44	9,8879296-001	9,9998203-001	9,9999453-001	5,2684991-006	1,0000000+000	1,0000000+000	1,2501696-005
45	9,8878566-001	9,9998248-001	9,9999467-001	5,1377491-006	1,0000000+000	1,0000000+000	1,2190663-005
46	9,8877854-001	9,9998291-001	9,9999480-001	5,0102349-006	1,0000000+000	1,0000000+000	1,1887503-005

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   47  9,8877159-001  9,9998334-001  9,9999493-001  4,8858983-006  1,0000000+000  1,0000000+000  1,1591896-005
   48  9,8876482-001  9,9998375-001  9,9999506-001  4,7646456-006  1,0000000+000  1,0000000+000  1,1303666-005
   49  9,8875822-001  9,9998416-001  9,9999518-001  4,6464004-006  1,0000000+000  1,0000000+000  1,1022552-005
   50  9,8875178-001  9,9998455-001  9,9999530-001  4,5310906-006  1,0000000+000  1,0000000+000  1,0748481-005
   51  9,8874550-001  9,9998493-001  9,9999541-001  4,4186470-006  1,0000000+000  1,0000000+000  1,0481323-005
   52  9,8873938-001  9,9998531-001  9,9999553-001  4,3089935-006  1,0000000+000  1,0000000+000  1,0220800-005
   53  9,8873341-001  9,9998567-001  9,9999564-001  4,2020665-006  1,0000000+000  1,0000000+000  9,9667232-006
I=     1 G=1 J=1 FLUX=  5,1718495-003
I=     2 G=1 J=1 FLUX=  5,1385294-003
I=     3 G=1 J=1 FLUX=  5,0721934-003
I=     4 G=1 J=1 FLUX=  4,9734220-003
I=     5 G=1 J=1 FLUX=  4,8430731-003
I=     6 G=1 J=1 FLUX=  4,6822664-003
I=     7 G=1 J=1 FLUX=  4,4923613-003
I=     8 G=1 J=1 FLUX=  4,2749295-003
I=     9 G=1 J=1 FLUX=  4,0317192-003
I=    10 G=1 J=1 FLUX=  3,7646115-003
I=    11 G=1 J=1 FLUX=  3,4755668-003
I=    12 G=1 J=1 FLUX=  3,1665580-003
I=    13 G=1 J=1 FLUX=  2,9330162-003
I=    14 G=1 J=1 FLUX=  2,7957125-003
I=    15 G=1 J=1 FLUX=  2,6608042-003
I=    16 G=1 J=1 FLUX=  2,0217562-003
I=    17 G=1 J=1 FLUX=  1,3043831-003
I=    18 G=1 J=1 FLUX=  8,4824506-004
I=    19 G=1 J=1 FLUX=  5,5488369-004
I=    20 G=1 J=1 FLUX=  3,6446894-004
I=    21 G=1 J=1 FLUX=  2,3987215-004
I=    22 G=1 J=1 FLUX=  1,5767282-004
I=    23 G=1 J=1 FLUX=  1,0289210-004
I=    24 G=1 J=1 FLUX=  6,5820914-005
I=    25 G=1 J=1 FLUX=  4,0064684-005
I=    26 G=1 J=1 FLUX=  2,1311388-005
I=    27 G=1 J=1 FLUX=  6,5354896-006

CANDID2D HAS COPIED FLUX FROM LUN    42 ONTO LUN    48

IMAXIN=    27 JMAXIN=    20 IMAXOUT=    27 JMAXOUT=    20
I=     1 G=1 J=1 FLUX=  4,4073824-002
I=     2 G=1 J=1 FLUX=  4,4073824-002
I=     3 G=1 J=1 FLUX=  4,4073824-002
I=     4 G=1 J=1 FLUX=  4,4073824-002
I=     5 G=1 J=1 FLUX=  4,4073824-002
I=     6 G=1 J=1 FLUX=  4,4073824-002
I=     7 G=1 J=1 FLUX=  4,4073824-002
I=     8 G=1 J=1 FLUX=  4,4073824-002
I=     9 G=1 J=1 FLUX=  4,4073824-002
I=    10 G=1 J=1 FLUX=  4,4073824-002
I=    11 G=1 J=1 FLUX=  4,4073824-002
I=    12 G=1 J=1 FLUX=  4,4073824-002
I=    13 G=1 J=1 FLUX=  2,2036912-002
```

```
I=   14 G=1 J=1 FLUX=  2,2036912-002
I=   15 G=1 J=1 FLUX=  2,2036912-002
I=   16 G=1 J=1 FLUX=  4,4073824-003
I=   17 G=1 J=1 FLUX=  4,4073824-003
I=   18 G=1 J=1 FLUX=  4,4073824-003
I=   19 G=1 J=1 FLUX=  4,4073824-003
I=   20 G=1 J=1 FLUX=  4,4073824-003
I=   21 G=1 J=1 FLUX=  4,4073824-003
I=   22 G=1 J=1 FLUX=  4,4073824-003
I=   23 G=1 J=1 FLUX=  4,4073824-003
I=   24 G=1 J=1 FLUX=  4,4073824-003
I=   25 G=1 J=1 FLUX=  4,4073824-003
I=   26 G=1 J=1 FLUX=  4,4073824-003
I=   27 G=1 J=1 FLUX=  4,4073824-003

CANDID2D HAS COPIED FLUX FROM LUN   49 ONTO LUN   48

IMAXIN=   27 JMAXIN=   20 IMAXOUT=   27 JMAXOUT=   20

CANDID2D IS PREPARING X SECTIONS ONLY ON LUN   48


     PROB, NO,    2,00000+000   2DCANDID  K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH          PAGE NO,   24
                                          FLUXES IN CHANNEL NO,      1 ARE

  ZMESH    GROUP   1      GROUP   2     ZMESH
     1   5,17185-003   3,31884-004     1
     2   1,53882-002   9,87479-004     2
     3   2,52256-002   1,61876-003     3
     4   3,44419-002   2,21018-003     4
     5   4,28102-002   2,74718-003     5
     6   5,01243-002   3,21653-003     6
     7   5,62041-002   3,60669-003     7
     8   6,09001-002   3,90803-003     8
     9   6,40965-002   4,11315-003     9
    10   6,57146-002   4,21698-003    10
    11   6,57146-002   4,21698-003    11
    12   6,40965-002   4,11315-003    12
    13   6,09001-002   3,90803-003    13
    14   5,62041-002   3,60669-003    14
    15   5,01243-002   3,21653-003    15
    16   4,28102-002   2,74718-003    16
    17   3,44419-002   2,21018-003    17
    18   2,52256-002   1,61876-003    18
    19   1,53882-002   9,87479-004    19
    20   5,17185-003   3,31884-004    20
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PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 25

FLUXES IN CHANNEL NO, 2 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	5,13853-003	3,30332-004	1
2	1,52891-002	9,82863-004	2
3	2,50631-002	1,61119-003	3
4	3,42200-002	2,19985-003	4
5	4,25344-002	2,73434-003	5
6	4,98013-002	3,20150-003	6
7	5,58420-002	3,58983-003	7
8	6,05077-002	3,88976-003	8
9	6,36835-002	4,09392-003	9
10	6,52912-002	4,19727-003	10
11	6,52912-002	4,19727-003	11
12	6,36835-002	4,09392-003	12
13	6,05077-002	3,88976-003	13
14	5,58420-002	3,58983-003	14
15	4,98013-002	3,20150-003	15
16	4,25344-002	2,73434-003	16
17	3,42200-002	2,19985-003	17
18	2,50631-002	1,61119-003	18
19	1,52891-002	9,82863-004	19
20	5,13853-003	3,30332-004	20

PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 26

FLUXES IN CHANNEL NO, 3 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	5,07219-003	3,27286-004	1
2	1,50917-002	9,73799-004	2
3	2,47396-002	1,59633-003	3
4	3,37783-002	2,17956-003	4
5	4,19853-002	2,70912-003	5
6	4,91584-002	3,17197-003	6
7	5,51211-002	3,55672-003	7
8	5,97266-002	3,85389-003	8
9	6,28614-002	4,05616-003	9
10	6,44483-002	4,15856-003	10
11	6,44483-002	4,15856-003	11
12	6,28614-002	4,05616-003	12
13	5,97266-002	3,85389-003	13
14	5,51211-002	3,55672-003	14
15	4,91584-002	3,17197-003	15
16	4,19853-002	2,70912-003	16
17	3,37783-002	2,17956-003	17
18	2,47396-002	1,59633-003	18
19	1,50917-002	9,73799-004	19
20	5,07219-003	3,27286-004	20

PROB, NO, 2,00000+000 ZDCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 27

FLUXES IN CHANNEL NO, 4 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	4,97342-003	3,22858-004	1
2	1,47978-002	9,60623-004	2
3	2,42578-002	1,57473-003	3
4	3,31205-002	2,15007-003	4
5	4,11677-002	2,67246-003	5
6	4,82012-002	3,12905-003	6
7	5,40478-002	3,50860-003	7
8	5,85635-002	3,80174-003	8
9	6,16373-002	4,00128-003	9
10	6,31933-002	4,10229-003	10
11	6,31933-002	4,10229-003	11
12	6,16373-002	4,00128-003	12
13	5,85635-002	3,80174-003	13
14	5,40478-002	3,50860-003	14
15	4,82012-002	3,12905-003	15
16	4,11677-002	2,67246-003	16
17	3,31205-002	2,15007-003	17
18	2,42578-002	1,57473-003	18
19	1,47978-002	9,60623-004	19
20	4,97342-003	3,22858-004	20

PROB, NO, 2,00000+000 ZDCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 28

FLUXES IN CHANNEL NO, 5 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	4,84307-003	3,17223-004	1
2	1,44100-002	9,43859-004	2
3	2,36220-002	1,54725-003	3
4	3,22525-002	2,11255-003	4
5	4,00887-002	2,62583-003	5
6	4,69379-002	3,07445-003	6
7	5,26312-002	3,44737-003	7
8	5,70286-002	3,73540-003	8
9	6,00218-002	3,93146-003	9
10	6,15371-002	4,03070-003	10
11	6,15371-002	4,03070-003	11
12	6,00218-002	3,93146-003	12
13	5,70286-002	3,73540-003	13
14	5,26312-002	3,44737-003	14
15	4,69379-002	3,07445-003	15
16	4,00887-002	2,62583-003	16
17	3,22525-002	2,11255-003	17
18	2,36220-002	1,54725-003	18
19	1,44100-002	9,43859-004	19
20	4,84307-003	3,17223-004	20

PROB. NO. 2.00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 29

FLUXES IN CHANNEL NO. 6 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	4.68227-003	3.10632-004	1
2	1.39315-002	9.24247-004	2
3	2.28377-002	1.51510-003	3
4	3.11816-002	2.06865-003	4
5	3.87576-002	2.57127-003	5
6	4.53794-002	3.01057-003	6
7	5.08837-002	3.37574-003	7
8	5.51351-002	3.65778-003	8
9	5.80289-002	3.84976-003	9
10	5.94938-002	3.94695-003	10
11	5.94938-002	3.94695-003	11
12	5.80289-002	3.84976-003	12
13	5.51351-002	3.65778-003	13
14	5.08837-002	3.37574-003	14
15	4.53794-002	3.01057-003	15
16	3.87576-002	2.57127-003	16
17	3.11816-002	2.06865-003	17
18	2.28377-002	1.51510-003	18
19	1.39315-002	9.24247-004	19
20	4.68227-003	3.10632-004	20

PROB. NO. 2.00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 30

FLUXES IN CHANNEL NO. 7 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	4.49236-003	3.03417-004	1
2	1.33665-002	9.02779-004	2
3	2.19114-002	1.47991-003	3
4	2.99169-002	2.02060-003	4
5	3.71857-002	2.51154-003	5
6	4.35388-002	2.94064-003	6
7	4.88199-002	3.29733-003	7
8	5.28989-002	3.57282-003	8
9	5.56753-002	3.76034-003	9
10	5.70809-002	3.85527-003	10
11	5.70809-002	3.85527-003	11
12	5.56753-002	3.76034-003	12
13	5.28989-002	3.57282-003	13
14	4.88199-002	3.29733-003	14
15	4.35388-002	2.94064-003	15
16	3.71857-002	2.51154-003	16
17	2.99169-002	2.02060-003	17
18	2.19114-002	1.47991-003	18
19	1.33665-002	9.02779-004	19
20	4.49236-003	3.03417-004	20

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 31

FLUXES IN CHANNEL NO, 8 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	4,27493-003	2,96015-004	1
2	1,27195-002	8,80755-004	2
3	2,08509-002	1,44381-003	3
4	2,84689-002	1,97131-003	4
5	3,53859-002	2,45027-003	5
6	4,14315-002	2,86890-003	6
7	4,64570-002	3,21689-003	7
8	5,03386-002	3,48566-003	8
9	5,29806-002	3,66861-003	9
10	5,43181-002	3,76122-003	10
11	5,43181-002	3,76122-003	11
12	5,29806-002	3,66861-003	12
13	5,03386-002	3,48566-003	13
14	4,64570-002	3,21689-003	14
15	4,14315-002	2,86890-003	15
16	3,53859-002	2,45027-003	16
17	2,84689-002	1,97131-003	17
18	2,08509-002	1,44381-003	18
19	1,27195-002	8,80755-004	19
20	4,27493-003	2,96015-004	20

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 32

FLUXES IN CHANNEL NO, 9 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	4,03172-003	2,88992-004	1
2	1,19959-002	8,59860-004	2
3	1,96647-002	1,40956-003	3
4	2,68492-002	1,92454-003	4
5	3,33727-002	2,39214-003	5
6	3,90744-002	2,80084-003	6
7	4,38140-002	3,14057-003	7
8	4,74747-002	3,40297-003	8
9	4,99664-002	3,58157-003	9
10	5,12278-002	3,67199-003	10
11	5,12278-002	3,67199-003	11
12	4,99664-002	3,58157-003	12
13	4,74747-002	3,40297-003	13
14	4,38140-002	3,14057-003	14
15	3,90744-002	2,80084-003	15
16	3,33727-002	2,39214-003	16
17	2,68492-002	1,92454-003	17
18	1,96647-002	1,40956-003	18
19	1,19959-002	8,59860-004	19
20	4,03172-003	2,88992-004	20

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 33

FLUXES IN CHANNEL NO, 10 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	3,76461-003	2,83077-004	1
2	1,12011-002	8,42262-004	2
3	1,83619-002	1,38071-003	3
4	2,50704-002	1,88515-003	4
5	3,11617-002	2,34318-003	5
6	3,64857-002	2,74352-003	6
7	4,09112-002	3,07629-003	7
8	4,43294-002	3,33332-003	8
9	4,66561-002	3,50827-003	9
10	4,78339-002	3,59684-003	10
11	4,78339-002	3,59684-003	11
12	4,66561-002	3,50827-003	12
13	4,43294-002	3,33332-003	13
14	4,09112-002	3,07629-003	14
15	3,64857-002	2,74352-003	15
16	3,11617-002	2,34318-003	16
17	2,50704-002	1,88515-003	17
18	1,83619-002	1,38071-003	18
19	1,12011-002	8,42262-004	19
20	3,76461-003	2,83077-004	20

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 34

FLUXES IN CHANNEL NO, 11 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	3,47557-003	2,79210-004	1
2	1,03411-002	8,30756-004	2
3	1,69520-002	1,36185-003	3
4	2,31455-002	1,85940-003	4
5	2,87691-002	2,31117-003	5
6	3,36843-002	2,70604-003	6
7	3,77701-002	3,03427-003	7
8	4,09258-002	3,28779-003	8
9	4,30739-002	3,46035-003	9
10	4,41613-002	3,54770-003	10
11	4,41613-002	3,54770-003	11
12	4,30739-002	3,46035-003	12
13	4,09258-002	3,28779-003	13
14	3,77701-002	3,03427-003	14
15	3,36843-002	2,70604-003	15
16	2,87691-002	2,31117-003	16
17	2,31455-002	1,85940-003	17
18	1,69520-002	1,36185-003	18
19	1,03411-002	8,30756-004	19
20	3,47557-003	2,79210-004	20

PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 35

FLUXES IN CHANNEL NO, 12 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	3,16656-003	2,78603-004	1
2	9,42170-003	8,28949-004	2
3	1,54449-002	1,35888-003	3
4	2,10877-002	1,85536-003	4
5	2,62113-002	2,30615-003	5
6	3,06895-002	2,70015-003	6
7	3,44120-002	3,02767-003	7
8	3,72872-002	3,28063-003	8
9	3,92442-002	3,45282-003	9
10	4,02349-002	3,53999-003	10
11	4,02349-002	3,53999-003	11
12	3,92442-002	3,45282-003	12
13	3,72872-002	3,28063-003	13
14	3,44120-002	3,02767-003	14
15	3,06895-002	2,70015-003	15
16	2,62113-002	2,30615-003	16
17	2,10877-002	1,85536-003	17
18	1,54449-002	1,35888-003	18
19	9,42170-003	8,28949-004	19
20	3,16656-003	2,78603-004	20

PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 36

FLUXES IN CHANNEL NO, 13 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	2,93302-003	2,81575-004	1
2	8,72683-003	8,37791-004	2
3	1,43058-002	1,37338-003	3
4	1,95324-002	1,87515-003	4
5	2,42781-002	2,33075-003	5
6	2,84261-002	2,72895-003	6
7	3,18740-002	3,05996-003	7
8	3,45371-002	3,31563-003	8
9	3,63498-002	3,48965-003	9
10	3,72675-002	3,57775-003	10
11	3,72675-002	3,57775-003	11
12	3,63498-002	3,48965-003	12
13	3,45371-002	3,31563-003	13
14	3,18740-002	3,05996-003	14
15	2,84261-002	2,72895-003	15
16	2,42781-002	2,33075-003	16
17	1,95324-002	1,87515-003	17
18	1,43058-002	1,37338-003	18
19	8,72683-003	8,37791-004	19
20	2,93302-003	2,81575-004	20

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 37

FLUXES IN CHANNEL NO, 14 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	2,79571-003	2,83211-004	1
2	8,31830-003	8,42660-004	2
3	1,36361-002	1,38136-003	3
4	1,86181-002	1,88605-003	4
5	2,31416-002	2,34429-003	5
6	2,70953-002	2,74481-003	6
7	3,03819-002	3,07775-003	7
8	3,29204-002	3,33490-003	8
9	3,46482-002	3,50993-003	9
10	3,55229-002	3,59854-003	10
11	3,55229-002	3,59854-003	11
12	3,46482-002	3,50993-003	12
13	3,29204-002	3,33490-003	13
14	3,03819-002	3,07775-003	14
15	2,70953-002	2,74481-003	15
16	2,31416-002	2,34429-003	16
17	1,86181-002	1,88605-003	17
18	1,36361-002	1,38136-003	18
19	8,31830-003	8,42660-004	19
20	2,79571-003	2,83211-004	20

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 38

FLUXES IN CHANNEL NO, 15 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	2,66080-003	2,84961-004	1
2	7,91689-003	8,47867-004	2
3	1,29780-002	1,38990-003	3
4	1,77196-002	1,89770-003	4
5	2,20249-002	2,35878-003	5
6	2,57878-002	2,76177-003	6
7	2,89158-002	3,09676-003	7
8	3,13318-002	3,35550-003	8
9	3,29762-002	3,53162-003	9
10	3,38087-002	3,62077-003	10
11	3,38087-002	3,62077-003	11
12	3,29762-002	3,53162-003	12
13	3,13318-002	3,35550-003	13
14	2,89158-002	3,09676-003	14
15	2,57878-002	2,76177-003	15
16	2,20249-002	2,35878-003	16
17	1,77196-002	1,89770-003	17
18	1,29780-002	1,38990-003	18
19	7,91689-003	8,47867-004	19
20	2,66080-003	2,84961-004	20

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 39

FLUXES IN CHANNEL NO, 16 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	2,02176-003	2,94611-004	1
2	6,01549-003	8,76579-004	2
3	9,86109-003	1,43696-003	3
4	1,34639-002	1,96196-003	4
5	1,67352-002	2,43866-003	5
6	1,95944-002	2,85530-003	6
7	2,19711-002	3,20163-003	7
8	2,38068-002	3,46914-003	8
9	2,50563-002	3,65122-003	9
10	2,56888-002	3,74339-003	10
11	2,56888-002	3,74339-003	11
12	2,50563-002	3,65122-003	12
13	2,38068-002	3,46914-003	13
14	2,19711-002	3,20163-003	14
15	1,95944-002	2,85530-003	15
16	1,67352-002	2,43866-003	16
17	1,34639-002	1,96196-003	17
18	9,86109-003	1,43696-003	18
19	6,01549-003	8,76579-004	19
20	2,02176-003	2,94611-004	20

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 40

FLUXES IN CHANNEL NO, 17 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	1,30438-003	2,48579-004	1
2	3,88103-003	7,39617-004	2
3	6,36212-003	1,21244-003	3
4	8,68654-003	1,65541-003	4
5	1,07971-002	2,05762-003	5
6	1,26418-002	2,40917-003	6
7	1,41751-002	2,70139-003	7
8	1,53595-002	2,92710-003	8
9	1,61657-002	3,08073-003	9
10	1,65738-002	3,15850-003	10
11	1,65738-002	3,15850-003	11
12	1,61657-002	3,08073-003	12
13	1,53595-002	2,92710-003	13
14	1,41751-002	2,70139-003	14
15	1,26418-002	2,40917-003	15
16	1,07971-002	2,05762-003	16
17	8,68654-003	1,65541-003	17
18	6,36212-003	1,21244-003	18
19	3,88103-003	7,39617-004	19
20	1,30438-003	2,48579-004	20

PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 41

FLUXES IN CHANNEL NO, 18 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	8,48245-004	1,90996-004	1
2	2,52385-003	5,68286-004	2
3	4,13731-003	9,31583-004	3
4	5,64889-003	1,27194-003	4
5	7,02138-003	1,58098-003	5
6	8,22098-003	1,85109-003	6
7	9,21815-003	2,07562-003	7
8	9,98834-003	2,24904-003	8
9	1,05126-002	2,36708-003	9
10	1,07780-002	2,42684-003	10
11	1,07780-002	2,42684-003	11
12	1,05126-002	2,36708-003	12
13	9,98834-003	2,24904-003	13
14	9,21815-003	2,07562-003	14
15	8,22098-003	1,85109-003	15
16	7,02138-003	1,58098-003	16
17	5,64889-003	1,27194-003	17
18	4,13731-003	9,31583-004	18
19	2,52385-003	5,68286-004	19
20	8,48245-004	1,90996-004	20

PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 42

FLUXES IN CHANNEL NO, 19 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	5,54884-004	1,39738-004	1
2	1,65099-003	4,15773-004	2
3	2,70644-003	6,81571-004	3
4	3,69525-003	9,30586-004	4
5	4,59307-003	1,15669-003	5
6	5,37779-003	1,35431-003	6
7	6,03010-003	1,51858-003	7
8	6,53392-003	1,64546-003	8
9	6,87686-003	1,73182-003	9
10	7,05047-003	1,77554-003	10
11	7,05047-003	1,77554-003	11
12	6,87686-003	1,73182-003	12
13	6,53392-003	1,64546-003	13
14	6,03010-003	1,51858-003	14
15	5,37779-003	1,35431-003	15
16	4,59307-003	1,15669-003	16
17	3,69525-003	9,30586-004	17
18	2,70644-003	6,81571-004	18
19	1,65099-003	4,15773-004	19
20	5,54884-004	1,39738-004	20

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 43

FLUXES IN CHANNEL NO, 20 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	3,64469-004	9,92671-005	1
2	1,08443-003	2,95357-004	2
3	1,77769-003	4,84174-004	3
4	2,42718-003	6,61070-004	4
5	3,01690-003	8,21687-004	5
6	3,53234-003	9,62072-004	6
7	3,96080-003	1,07877-003	7
8	4,29173-003	1,16890-003	8
9	4,51699-003	1,23025-003	9
10	4,63102-003	1,26131-003	10
11	4,63102-003	1,26131-003	11
12	4,51699-003	1,23025-003	12
13	4,29173-003	1,16890-003	13
14	3,96080-003	1,07877-003	14
15	3,53234-003	9,62072-004	15
16	3,01690-003	8,21687-004	16
17	2,42718-003	6,61070-004	17
18	1,77769-003	4,84174-004	18
19	1,08443-003	2,95357-004	19
20	3,64469-004	9,92671-005	20

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 44

FLUXES IN CHANNEL NO, 21 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	2,39872-004	6,91120-005	1
2	7,13710-004	2,05634-004	2
3	1,16997-003	3,37093-004	3
4	1,59743-003	4,60251-004	4
5	1,98555-003	5,72077-004	5
6	2,32478-003	6,69816-004	6
7	2,60677-003	7,51062-004	7
8	2,82457-003	8,13814-004	8
9	2,97282-003	8,56528-004	9
10	3,04786-003	8,78151-004	10
11	3,04786-003	8,78151-004	11
12	2,97282-003	8,56528-004	12
13	2,82457-003	8,13814-004	13
14	2,60677-003	7,51062-004	14
15	2,32478-003	6,69816-004	15
16	1,98555-003	5,72077-004	16
17	1,59743-003	4,60251-004	17
18	1,16997-003	3,37093-004	18
19	7,13710-004	2,05634-004	19
20	2,39872-004	6,91120-005	20

PROB. NO. 2.00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 45

FLUXES IN CHANNEL NO. 22 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	1.57673-004	4.73257-005	1
2	4.69136-004	1.40812-004	2
3	7.69048-004	2.30831-004	3
4	1.05002-003	3.15166-004	4
5	1.30514-003	3.91740-004	5
6	1.52813-003	4.58669-004	6
7	1.71348-003	5.14304-004	7
8	1.85665-003	5.57275-004	8
9	1.95409-003	5.86524-004	9
10	2.00342-003	6.01330-004	10
11	2.00342-003	6.01330-004	11
12	1.95409-003	5.86524-004	12
13	1.85665-003	5.57275-004	13
14	1.71348-003	5.14304-004	14
15	1.52813-003	4.58669-004	15
16	1.30514-003	3.91740-004	16
17	1.05002-003	3.15166-004	17
18	7.69048-004	2.30831-004	18
19	4.69136-004	1.40812-004	19
20	1.57673-004	4.73257-005	20

PROB. NO. 2.00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 46

FLUXES IN CHANNEL NO. 23 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	1.02892-004	3.18179-005	1
2	3.06143-004	9.46703-005	2
3	5.01855-004	1.55192-004	3
4	6.85210-004	2.11891-004	4
5	8.51693-004	2.63374-004	5
6	9.97205-004	3.08371-004	6
7	1.11816-003	3.45775-004	7
8	1.21159-003	3.74665-004	8
9	1.27518-003	3.94330-004	9
10	1.30737-003	4.04285-004	10
11	1.30737-003	4.04285-004	11
12	1.27518-003	3.94330-004	12
13	1.21159-003	3.74665-004	13
14	1.11816-003	3.45775-004	14
15	9.97205-004	3.08371-004	15
16	8.51693-004	2.63374-004	16
17	6.85210-004	2.11891-004	17
18	5.01855-004	1.55192-004	18
19	3.06143-004	9.46703-005	19
20	1.02892-004	3.18179-005	20

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 47

FLUXES IN CHANNEL NO, 24 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	6,58209-005	2,07957-005	1
2	1,95842-004	6,18751-005	2
3	3,21041-004	1,01431-004	3
4	4,38335-004	1,38489-004	4
5	5,44835-004	1,72137-004	5
6	6,37920-004	2,01547-004	6
7	7,15297-004	2,25994-004	7
8	7,75061-004	2,44876-004	8
9	8,15741-004	2,57728-004	9
10	8,36334-004	2,64234-004	10
11	8,36334-004	2,64234-004	11
12	8,15741-004	2,57728-004	12
13	7,75061-004	2,44876-004	13
14	7,15297-004	2,25994-004	14
15	6,37920-004	2,01547-004	15
16	5,44835-004	1,72137-004	16
17	4,38335-004	1,38489-004	17
18	3,21041-004	1,01431-004	18
19	1,95842-004	6,18751-005	19
20	6,58209-005	2,07957-005	20

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 48

FLUXES IN CHANNEL NO, 25 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	4,00647-005	1,28478-005	1
2	1,19208-004	3,82272-005	2
3	1,95415-004	6,26652-005	3
4	2,66811-004	8,55602-005	4
5	3,31637-004	1,06348-004	5
6	3,88297-004	1,24518-004	6
7	4,35396-004	1,39622-004	7
8	4,71774-004	1,51287-004	8
9	4,96535-004	1,59228-004	9
10	5,09070-004	1,63247-004	10
11	5,09070-004	1,63247-004	11
12	4,96535-004	1,59228-004	12
13	4,71774-004	1,51287-004	13
14	4,35396-004	1,39622-004	14
15	3,88297-004	1,24518-004	15
16	3,31637-004	1,06348-004	16
17	2,66811-004	8,55602-005	17
18	1,95415-004	6,26652-005	18
19	1,19208-004	3,82272-005	19
20	4,00647-005	1,28478-005	20

PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 49

FLUXES IN CHANNEL NO, 26 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	2,13114-005	6,89852-006	1
2	6,34094-005	2,05257-005	2
3	1,03946-004	3,36475-005	3
4	1,41923-004	4,59407-005	4
5	1,76406-004	5,71028-005	5
6	2,06545-004	6,68588-005	6
7	2,31598-004	7,49685-005	7
8	2,50948-004	8,12322-005	8
9	2,64119-004	8,54957-005	9
10	2,70787-004	8,76540-005	10
11	2,70787-004	8,76540-005	11
12	2,64119-004	8,54957-005	12
13	2,50948-004	8,12322-005	13
14	2,31598-004	7,49685-005	14
15	2,06545-004	6,68588-005	15
16	1,76406-004	5,71028-005	16
17	1,41923-004	4,59407-005	17
18	1,03946-004	3,36475-005	18
19	6,34094-005	2,05257-005	19
20	2,13114-005	6,89852-006	20

PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 50

FLUXES IN CHANNEL NO, 27 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	6,53549-006	2,12514-006	1
2	1,94455-005	6,32310-006	2
3	3,18768-005	1,03654-005	3
4	4,35231-005	1,41524-005	4
5	5,40978-005	1,75910-005	5
6	6,33403-005	2,05964-005	6
7	7,10233-005	2,30946-005	7
8	7,69574-005	2,50242-005	8
9	8,09965-005	2,63376-005	9
10	8,30413-005	2,70025-005	10
11	8,30413-005	2,70025-005	11
12	8,09965-005	2,63376-005	12
13	7,69574-005	2,50242-005	13
14	7,10233-005	2,30946-005	14
15	6,33403-005	2,05964-005	15
16	5,40978-005	1,75910-005	16
17	4,35231-005	1,41524-005	17
18	3,18768-005	1,03654-005	18
19	1,94455-005	6,32310-006	19
20	6,53549-006	2,12514-006	20

FLUX NORMALIZATION FACTOR IS 7,57008-002

NORMALIZED POWER GENERATED AT EACH MESH POINT

ZMESH	RMESH 1	RMESH 2	RMESH 3	RMESH 4	RMESH 5	RMESH 6	RMESH 7	ZMESH
1	3,97334-006	3,94839-006	3,89877-006	3,82500-006	3,72788-006	3,60846-006	3,46805*006	1
2	1,18222-005	1,17480-005	1,16003-005	1,13808-005	1,10918-005	1,07365-005	1,03188*005	2
3	1,93799-005	1,92583-005	1,90162-005	1,86564-005	1,81827-005	1,76002-005	1,69154*005	3
4	2,64605-005	2,62943-005	2,59639-005	2,54726-005	2,48258-005	2,40305-005	2,30955*005	4
5	3,28895-005	3,26830-005	3,22722-005	3,16616-005	3,08576-005	2,98691-005	2,87070*005	5
6	3,85087-005	3,82668-005	3,77859-005	3,70709-005	3,61296-005	3,49722-005	3,36115*005	6
7	4,31796-005	4,29085-005	4,23692-005	4,15675-005	4,05120-005	3,92142-005	3,76885*005	7
8	4,67873-005	4,64935-005	4,59092-005	4,50405-005	4,38969-005	4,24906-005	4,08374*005	8
9	4,92430-005	4,89338-005	4,83187-005	4,74045-005	4,62008-005	4,47208-005	4,29808*005	9
10	5,04861-005	5,01691-005	4,95386-005	4,86012-005	4,73671-005	4,58498-005	4,40658*005	10
11	5,04861-005	5,01691-005	4,95386-005	4,86012-005	4,73671-005	4,58498-005	4,40658*005	11
12	4,92430-005	4,89338-005	4,83187-005	4,74045-005	4,62008-005	4,47208-005	4,29808*005	12
13	4,67873-005	4,64935-005	4,59092-005	4,50405-005	4,38969-005	4,24906-005	4,08374*005	13
14	4,31796-005	4,29885-005	4,23692-005	4,15675-005	4,05120-005	3,92142-005	3,76885*005	14
15	3,85087-005	3,82668-005	3,77859-005	3,70709-005	3,61296-005	3,49722-005	3,36115*005	15
16	3,28895-005	3,26830-005	3,22722-005	3,16616-005	3,08576-005	2,98691-005	2,87070*005	16
17	2,64605-005	2,62943-005	2,59639-005	2,54726-005	2,48258-005	2,40305-005	2,30955*005	17
18	1,93799-005	1,92583-005	1,90162-005	1,86564-005	1,81827-005	1,76002-005	1,69154*005	18
19	1,18222-005	1,17480-005	1,16003-005	1,13808-005	1,10918-005	1,07365-005	1,03188*005	19
20	3,97334-006	3,94839-006	3,89877-006	3,82500-006	3,72788-006	3,60846-006	3,46805*006	20

ZMESH	RMESH 8	RMESH 9	RMESH 10	RMESH 11	RMESH 12	RMESH 13	RMESH 14	ZMESH
1	3,30825-006	3,13090-006	2,93810-006	2,73227-006	2,51613-006	1,60934-006	1,54536*006	1
2	9,84330-006	9,31560-006	8,74195-006	8,12954-006	7,48642-006	4,78838-006	4,59803*006	2
3	1,61360-005	1,52709-005	1,43306-005	1,33266-005	1,22724-005	7,84952-006	7,53749*006	3
4	2,20313-005	2,08502-005	1,95663-005	1,81956-005	1,67561-005	1,07174-005	1,02913*005	4
5	2,73842-005	2,59161-005	2,43202-005	2,26165-005	2,08273-005	1,33213-005	1,27918*005	5
6	3,20628-005	3,03439-005	2,84753-005	2,64805-005	2,43857-005	1,55973-005	1,49773*005	6
7	3,59518-005	3,40244-005	3,19293-005	2,96925-005	2,73435-005	1,74892-005	1,67939*005	7
8	3,89557-005	3,68672-005	3,45970-005	3,21733-005	2,96281-005	1,89504-005	1,81971*005	8
9	4,10003-005	3,88022-005	3,64129-005	3,38619-005	3,11832-005	1,99450-005	1,91522*005	9
10	4,20353-005	3,97818-005	3,73321-005	3,47168-005	3,19704-005	2,04485-005	1,96357*005	10
11	4,20353-005	3,97818-005	3,73321-005	3,47168-005	3,19704-005	2,04485-005	1,96357*005	11
12	4,10003-005	3,88022-005	3,64129-005	3,38619-005	3,11832-005	1,99450-005	1,91522*005	12
13	3,89557-005	3,68672-005	3,45970-005	3,21733-005	2,96281-005	1,89504-005	1,81971*005	13
14	3,59518-005	3,40244-005	3,19293-005	2,96925-005	2,73435-005	1,74892-005	1,67939*005	14
15	3,20628-005	3,03439-005	2,84753-005	2,64805-005	2,43857-005	1,55973-005	1,49773*005	15
16	2,73842-005	2,59161-005	2,43202-005	2,26165-005	2,08273-005	1,33213-005	1,27918*005	16
17	2,20313-005	2,08502-005	1,95663-005	1,81956-005	1,67561-005	1,07174-005	1,02913*005	17
18	1,61360-005	1,52709-005	1,43306-005	1,33266-005	1,22724-005	7,84952-006	7,53749*006	18
19	9,84330-006	9,31560-006	8,74195-006	8,12954-006	7,48642-006	4,78838-006	4,59803*006	19
20	3,30825-006	3,13090-006	2,93810-006	2,73227-006	2,51613-006	1,60934-006	1,54536*006	20

PROB, NO. 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 52

NORMALIZED POWER GENERATED AT EACH MESH POINT

ZMESH	RMESH 15	RMESH 16	RMESH 17	RMESH 18	RMESH 19	RMESH 20	RMESH 21	ZMESH
1	1,48261-006	1,69140-007	1,10070-007	7,20527-008	4,73726-008	3,12370-008	2,06194-008	1
2	4,41133-006	5,03257-007	3,27499-007	2,14384-007	1,40951-007	9,29418-008	6,13505-008	2
3	7,23143-006	8,24981-007	5,36864-007	3,51436-007	2,31059-007	1,52358-007	1,00571-007	3
4	9,87346-006	1,12639-006	7,33010-007	4,79835-007	3,15478-007	2,08023-007	1,37315-007	4
5	1,22724-005	1,40007-006	9,11107-007	5,96419-007	3,92128-007	2,58565-007	1,70678-007	5
6	1,43691-005	1,63927-006	1,06677-006	6,98317-007	4,59123-007	3,02741-007	1,99838-007	6
7	1,61120-005	1,83810-006	1,19616-006	7,83020-007	5,14813-007	3,39462-007	2,24078-007	7
8	1,74582-005	1,99168-006	1,29610-006	8,48442-007	5,57827-007	3,67825-007	2,42800-007	8
9	1,83745-005	2,09621-006	1,36413-006	8,92973-007	5,87104-007	3,87130-007	2,55543-007	9
10	1,88384-005	2,14913-006	1,39857-006	9,15516-007	6,01926-007	3,96903-007	2,61994-007	10
11	1,88384-005	2,14913-006	1,39857-006	9,15516-007	6,01926-007	3,96903-007	2,61994-007	11
12	1,83745-005	2,09621-006	1,36413-006	8,92973-007	5,87104-007	3,87130-007	2,55543-007	12
13	1,74582-005	1,99168-006	1,29610-006	8,48442-007	5,57827-007	3,67825-007	2,42800-007	13
14	1,61120-005	1,83810-006	1,19616-006	7,83020-007	5,14813-007	3,39462-007	2,24078-007	14
15	1,43691-005	1,63927-006	1,06677-006	6,98317-007	4,59123-007	3,02741-007	1,99838-007	15
16	1,22724-005	1,40007-006	9,11107-007	5,96419-007	3,92128-007	2,58565-007	1,70678-007	16
17	9,87346-006	1,12639-006	7,33010-007	4,79835-007	3,15478-007	2,08023-007	1,37315-007	17
18	7,23143-006	8,24981-007	5,36864-007	3,51436-007	2,31059-007	1,52358-007	1,00571-007	18
19	4,41133-006	5,03257-007	3,27499-007	2,14384-007	1,40951-007	9,29418-008	6,13505-008	19
20	1,48261-006	1,69140-007	1,10070-007	7,20527-008	4,73726-008	3,12370-008	2,06194-008	20

ZMESH	RMESH 22	RMESH 23	RMESH 24	RMESH 25	RMESH 26	RMESH 27	ZMESH
1	1,35842-008	8,87969-009	5,68754-009	3,46503-009	1,84417-009	5,65701-010	1
2	4,04181-008	2,64204-008	1,69226-008	1,03098-008	5,48711-009	1,68317-009	2
3	6,62567-008	4,33106-008	2,77409-008	1,69006-008	8,99493-009	2,75920-009	3
4	9,04639-008	5,91343-008	3,78762-008	2,30753-008	1,22813-008	3,76729-009	4
5	1,12444-007	7,35020-008	4,70788-008	2,86819-008	1,52652-008	4,68261-009	5
6	1,31655-007	8,60597-008	5,51222-008	3,35822-008	1,78733-008	5,48263-009	6
7	1,47624-007	9,64984-008	6,18083-008	3,76555-008	2,00412-008	6,14765-009	7
8	1,59958-007	1,04561-007	6,69725-008	4,08017-008	2,17157-008	6,66130-009	8
9	1,68353-007	1,10049-007	7,04876-008	4,29432-008	2,28555-008	7,01092-009	9
10	1,72603-007	1,12827-007	7,22671-008	4,40273-008	2,34324-008	7,18791-009	10
11	1,72603-007	1,12827-007	7,22671-008	4,40273-008	2,34324-008	7,18791-009	11
12	1,68353-007	1,10049-007	7,04876-008	4,29432-008	2,28555-008	7,01092-009	12
13	1,59958-007	1,04561-007	6,69725-008	4,08017-008	2,17157-008	6,66130-009	13
14	1,47624-007	9,64984-008	6,18083-008	3,76555-008	2,00412-008	6,14765-009	14
15	1,31655-007	8,60597-008	5,51222-008	3,35822-008	1,78733-008	5,48263-009	15
16	1,12444-007	7,35020-008	4,70788-008	2,86819-008	1,52652-008	4,68261-009	16
17	9,04639-008	5,91343-008	3,78762-008	2,30753-008	1,22813-008	3,76729-009	17
18	6,62567-008	4,33106-008	2,77409-008	1,69006-008	8,99493-009	2,75920-009	18
19	4,04181-008	2,64204-008	1,69226-008	1,03098-008	5,48711-009	1,68317-009	19
20	1,35842-008	8,87969-009	5,68754-009	3,46503-009	1,84417-009	5,65701-010	20

PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 53

FLUX-VOLUME INTEGRALS BY GROUP AND REGION

GROUP	REGION 1	REGION 2	REGION 3	GROUP
1	8,03450+001	1,38243+001	6,58017+001	1
2	5,83593+000	1,40211+000	1,42225+001	2

PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 54

POWER DISTRIBUTION BY REGION

REGION	POWER
1	8,253303-001
2	1,009609-001
3	7,370885-002

PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 55

LEFT BOUNDARY FLUXES BY POINT AND GROUP

ZMESH	GROUP 1	GROUP 2	ZMESH
1	3,91513-004	2,51239-005	1
2	1,16490-003	7,47530-005	2
3	1,90960-003	1,22541-004	3
4	2,60728-003	1,67313-004	4
5	3,24077-003	2,07964-004	5
6	3,79445-003	2,43494-004	6
7	4,25470-003	2,73029-004	7
8	4,61019-003	2,95841-004	8
9	4,85215-003	3,11369-004	9
10	4,97465-003	3,19229-004	10
11	4,97465-003	3,19229-004	11
12	4,85215-003	3,11369-004	12
13	4,61019-003	2,95841-004	13
14	4,25470-003	2,73029-004	14
15	3,79445-003	2,43494-004	15
16	3,24077-003	2,07964-004	16
17	2,60728-003	1,67313-004	17
18	1,90960-003	1,22541-004	18
19	1,16490-003	7,47530-005	19
20	3,91513-004	2,51239-005	20

PROB. NO. 2.00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 56

LEFT BOUNDARY CURRENTS BY POINT AND GROUP

ZMESH	GROUP 1	GROUP 2	ZMESH
1	0.00000+000	0.00000+000	1
2	0.00000+000	0.00000+000	2
3	0.00000+000	0.00000+000	3
4	0.00000+000	0.00000+000	4
5	0.00000+000	0.00000+000	5
6	0.00000+000	0.00000+000	6
7	0.00000+000	0.00000+000	7
8	0.00000+000	0.00000+000	8
9	0.00000+000	0.00000+000	9
10	0.00000+000	0.00000+000	10
11	0.00000+000	0.00000+000	11
12	0.00000+000	0.00000+000	12
13	0.00000+000	0.00000+000	13
14	0.00000+000	0.00000+000	14
15	0.00000+000	0.00000+000	15
16	0.00000+000	0.00000+000	16
17	0.00000+000	0.00000+000	17
18	0.00000+000	0.00000+000	18
19	0.00000+000	0.00000+000	19
20	0.00000+000	0.00000+000	20

PROB. NO. 2.00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 57

FLUX ON LEFT INTERFACE OF CHANNEL NO. 13

ZMESH	GROUP 1	GROUP 2	ZMESH
1	2.27331-004	2.12503-005	1
2	6.76395-004	6.32276-005	2
3	1.10880-003	1.03648-004	3
4	1.51391-003	1.41516-004	4
5	1.88174-003	1.75900-004	5
6	2.20323-003	2.05952-004	6
7	2.47048-003	2.30934-004	7
8	2.67689-003	2.50228-004	8
9	2.81739-003	2.63362-004	9
10	2.88851-003	2.70010-004	10
11	2.88851-003	2.70010-004	11
12	2.81739-003	2.63362-004	12
13	2.67689-003	2.50228-004	13
14	2.47048-003	2.30934-004	14
15	2.20323-003	2.05952-004	15
16	1.88174-003	1.75900-004	16
17	1.51391-003	1.41516-004	17
18	1.10880-003	1.03648-004	18
19	6.76395-004	6.32276-005	19
20	2.27331-004	2.12503-005	20

PROB. NO. 2.00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 58

CURRENT ON LEFT INTERFACE OF CHANNEL NO. 13

ZMESH	GROUP 1	GROUP 2	ZMESH
1	-2.61442-005	1.72719-007	1
2	-7.77889-005	5.13904-007	2
3	-1.27518-004	8.42434-007	3
4	-1.74107-004	1.15022-006	4
5	-2.16410-004	1.42969-006	5
6	-2.53383-004	1.67395-006	6
7	-2.84117-004	1.87699-006	7
8	-3.07856-004	2.03381-006	8
9	-3.24014-004	2.14056-006	9
10	-3.32194-004	2.19460-006	10
11	-3.32194-004	2.19460-006	11
12	-3.24014-004	2.14056-006	12
13	-3.07856-004	2.03381-006	13
14	-2.84117-004	1.87699-006	14
15	-2.53383-004	1.67395-006	15
16	-2.16410-004	1.42969-006	16
17	-1.74107-004	1.15022-006	17
18	-1.27518-004	8.42434-007	18
19	-7.77889-005	5.13904-007	19
20	-2.61442-005	1.72719-007	20

PROB. NO. 2.00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 59

FLUX ON LEFT INTERFACE OF CHANNEL NO. 16

ZMESH	GROUP 1	GROUP 2	ZMESH
1	1.96400-004	2.16496-005	1
2	5.84363-004	6.44158-005	2
3	9.57938-004	1.05596-004	3
4	1.30793-003	1.44176-004	4
5	1.62571-003	1.79206-004	5
6	1.90346-003	2.09823-004	6
7	2.13434-003	2.35273-004	7
8	2.31267-003	2.54931-004	8
9	2.43405-003	2.68311-004	9
10	2.49550-003	2.75085-004	10
11	2.49550-003	2.75085-004	11
12	2.43405-003	2.68311-004	12
13	2.31267-003	2.54931-004	13
14	2.13434-003	2.35273-004	14
15	1.90346-003	2.09823-004	15
16	1.62571-003	1.79206-004	16
17	1.30793-003	1.44176-004	17
18	9.57938-004	1.05596-004	18
19	5.84363-004	6.44158-005	19
20	1.96400-004	2.16496-005	20

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 60

CURRENT ON LEFT INTERFACE OF CHANNEL NO, 16

ZMESH	GROUP 1	GROUP 2	ZMESH
1	-2,47928-005	2,06294-007	1
2	-7,37678-005	6,13801-007	2
3	-1,20926-004	1,00820-006	3
4	-1,65107-004	1,37381-006	4
5	-2,05223-004	1,70760-006	5
6	-2,40285+004	1,99935-006	6
7	-2,69431-004	2,24186-006	7
8	-2,91942-004	2,42917-006	8
9	-3,07265-004	2,55667-006	9
10	-3,15022-004	2,62121-006	10
11	-3,15022-004	2,62121-006	11
12	-3,07265-004	2,55667-006	12
13	-2,91942-004	2,42917-006	13
14	-2,69431-004	2,24186-006	14
15	-2,40285-004	1,99935-006	15
16	-2,05223-004	1,70760-006	16
17	-1,65107-004	1,37381-006	17
18	-1,20926-004	1,00820-006	18
19	-7,37678-005	6,13801-007	19
20	-2,47928-005	2,06294-007	20

BOTTOM BOUNDARY FLUXES BY POINT AND GROUP

RMESH	GROUP 1	GROUP 2	RMESH
1	0,00000+000	0,00000+000	1
2	0,00000+000	0,00000+000	2
3	0,00000+000	0,00000+000	3
4	0,00000+000	0,00000+000	4
5	0,00000+000	0,00000+000	5
6	0,00000+000	0,00000+000	6
7	0,00000+000	0,00000+000	7
8	0,00000+000	0,00000+000	8
9	0,00000+000	0,00000+000	9
10	0,00000+000	0,00000+000	10
11	0,00000+000	0,00000+000	11
12	0,00000+000	0,00000+000	12
13	0,00000+000	0,00000+000	13
14	0,00000+000	0,00000+000	14
15	0,00000+000	0,00000+000	15
16	0,00000+000	0,00000+000	16
17	0,00000+000	0,00000+000	17
18	0,00000+000	0,00000+000	18
19	0,00000+000	0,00000+000	19
20	0,00000+000	0,00000+000	20
21	0,00000+000	0,00000+000	21
22	0,00000+000	0,00000+000	22
23	0,00000+000	0,00000+000	23
24	0,00000+000	0,00000+000	24
25	0,00000+000	0,00000+000	25
26	0,00000+000	0,00000+000	26
27	0,00000+000	0,00000+000	27

BOTTOM BOUNDARY CURRENTS BY POINT AND GROUP

RMESH	GROUP 1	GROUP 2	RMESH
1	-5.32088-004	-1.74766-005	1
2	-5.28660-004	-1.73949-005	2
3	-5.21835-004	-1.72345-005	3
4	-5.11673-004	-1.70013-005	4
5	-4.98263-004	-1.67046-005	5
6	-4.81719-004	-1.63575-005	6
7	-4.62181-004	-1.59776-005	7
8	-4.39811-004	-1.55878-005	8
9	-4.14789-004	-1.52180-005	9
10	-3.87309-004	-1.49065-005	10
11	-3.57572-004	-1.47829-005	11
12	-3.25780-004	-1.46709-005	12
13	-3.32765-004	-1.71620-005	13
14	-3.17187-004	-1.72617-005	14
15	-3.01881-004	-1.73684-005	15
16	-1.26913-004	-1.02208-005	16
17	-8.18806-005	-8.62384-006	17
18	-5.32473-005	-6.62615-006	18
19	-3.48320-005	-4.84787-006	19
20	-2.28790-005	-3.44383-006	20
21	-1.50576-005	-2.39767-006	21
22	-9.89767-006	-1.64185-006	22
23	-6.45889-006	-1.10384-006	23
24	-4.13181-006	-7.21456-007	24
25	-2.51500-006	-4.45724-007	25
26	-1.33779-006	-2.39327-007	26
27	-4.10255-007	-7.37266-008	27

TOP BOUNDARY FLUXES BY POINT AND GROUP

RMESH	GROUP 1	GROUP 2	RMESH
1	0.00000+000	0.00000+000	1
2	0.00000+000	0.00000+000	2
3	0.00000+000	0.00000+000	3
4	0.00000+000	0.00000+000	4
5	0.00000+000	0.00000+000	5
6	0.00000+000	0.00000+000	6
7	0.00000+000	0.00000+000	7
8	0.00000+000	0.00000+000	8
9	0.00000+000	0.00000+000	9
10	0.00000+000	0.00000+000	10
11	0.00000+000	0.00000+000	11
12	0.00000+000	0.00000+000	12
13	0.00000+000	0.00000+000	13
14	0.00000+000	0.00000+000	14
15	0.00000+000	0.00000+000	15
16	0.00000+000	0.00000+000	16
17	0.00000+000	0.00000+000	17
18	0.00000+000	0.00000+000	18
19	0.00000+000	0.00000+000	19
20	0.00000+000	0.00000+000	20
21	0.00000+000	0.00000+000	21
22	0.00000+000	0.00000+000	22
23	0.00000+000	0.00000+000	23
24	0.00000+000	0.00000+000	24
25	0.00000+000	0.00000+000	25
26	0.00000+000	0.00000+000	26
27	0.00000+000	0.00000+000	27

PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 64

TOP BOUNDARY CURRENTS BY POINT AND GROUP

RMESH	GROUP 1	GROUP 2	RMESH
1	-5,32088-004	-1,74766-005	1
2	-5,28660-004	-1,73949-005	2
3	-5,21835-004	-1,72345-005	3
4	-5,11673-004	-1,70013-005	4
5	-4,98263-004	-1,67046-005	5
6	-4,81719-004	-1,63575-005	6
7	-4,62181-004	-1,59776-005	7
8	-4,39811-004	-1,55878-005	8
9	-4,14789-004	-1,52180-005	9
10	-3,87309-004	-1,49065-005	10
11	-3,57572-004	-1,47029-005	11
12	-3,25780-004	-1,46709-005	12
13	-3,32765-004	-1,71620-005	13
14	-3,17187-004	-1,72617-005	14
15	-3,01881-004	-1,73684-005	15
16	-1,26913-004	-1,02208-005	16
17	-8,18806-005	-8,62384-006	17
18	-5,32473-005	-6,62615-006	18
19	-3,48320-005	-4,84787-006	19
20	-2,28790-005	-3,44883-006	20
21	-1,50576-005	-2,39767-006	21
22	-9,89767-006	-1,64185-006	22
23	-6,45889-006	-1,10384-006	23
24	-4,13181-006	-7,21456-007	24
25	-2,51500-006	-4,45724-007	25
26	-1,33779-006	-2,39327-007	26
27	-4,10255-007	-7,37266-008	27

PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 65

RIGHT BOUNDARY FLUXES BY POINT AND GROUP

ZMESH	GROUP 1	GROUP 2	ZMESH
1	0,00000+000	0,00000+000	1
2	0,00000+000	0,00000+000	2
3	0,00000+000	0,00000+000	3
4	0,00000+000	0,00000+000	4
5	0,00000+000	0,00000+000	5
6	0,00000+000	0,00000+000	6
7	0,00000+000	0,00000+000	7
8	0,00000+000	0,00000+000	8
9	0,00000+000	0,00000+000	9
10	0,00000+000	0,00000+000	10
11	0,00000+000	0,00000+000	11
12	0,00000+000	0,00000+000	12
13	0,00000+000	0,00000+000	13
14	0,00000+000	0,00000+000	14
15	0,00000+000	0,00000+000	15
16	0,00000+000	0,00000+000	16
17	0,00000+000	0,00000+000	17
18	0,00000+000	0,00000+000	18
19	0,00000+000	0,00000+000	19
20	0,00000+000	0,00000+000	20

PROB, NO, 2,00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 66

RIGHT BOUNDARY CURRENTS BY POINT AND GROUP

ZMESH	GROUP 1	GROUP 2	ZMESH
1	-2,82945-007	-5,08479-008	1
2	-8,41869-007	-1,51292-007	2
3	-1,38006-006	-2,48010-007	3
4	-1,88428-006	-3,38622-007	4
5	-2,34209-006	-4,20895-007	5
6	-2,74224-006	-4,92805-007	6
7	-3,07486-006	-5,52580-007	7
8	-3,33177-006	-5,98749-007	8
9	-3,50664-006	-6,30175-007	9
10	-3,59516-006	-6,46084-007	10
11	-3,59516-006	-6,46084-007	11
12	-3,50664-006	-6,30175-007	12
13	-3,33177-006	-5,98749-007	13
14	-3,07486-006	-5,52580-007	14
15	-2,74224-006	-4,92805-007	15
16	-2,34209-006	-4,20895-007	16
17	-1,88428-006	-3,38622-007	17
18	-1,38006-006	-2,48010-007	18
19	-8,41869-007	-1,51292-007	19
20	-2,82945-007	-5,08479-008	20

PROB. NO. 2.00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 67

LEAKAGES BY GROUP ON ALL BOUNDARIES

GROUP	LEFT	BOTTOM	TOP	RIGHT
1	0.000000+000	-3.785361-001	3.785361-001	2.153865-002
2	0.000000+000	-2.402097-002	2.402097-002	3.870691-003

PROB. NO. 2.00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 68

LEAKAGE ON LEFT SIDE OF EACH REGION BY GROUP

GROUP	REGION 1	REGION 2	REGION 3	GROUP
1	0.00000+000	-5.90376-001	-6.25926-001	1
2	0.00000+000	3.90025-003	5.20816-003	2

PROB. NO. 2.00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 69

LEAKAGE ON BOTTOM SIDE OF EACH REGION BY GROUP

GROUP	REGION 1	REGION 2	REGION 3	GROUP
1	-2.24058-001	-4.25138-002	-1.11964-001	1
2	-8.33003-003	-2.31644-003	-1.33745-002	2

PROB. NO. 2.00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 70

LEAKAGE ON RIGHT SIDE OF EACH REGION BY GROUP

GROUP	REGION 1	REGION 2	REGION 3	GROUP
1	5.90376-001	6.25926-001	2.15386-002	1
2	-3.90025-003	-5.20816-003	3.87069-003	2

PROB. NO. 2.00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 71

LEAKAGE ON TOP SIDE OF EACH REGION BY GROUP

GROUP	REGION 1	REGION 2	REGION 3	GROUP
1	2.24058-001	4.25138-002	1.11964-001	1
2	8.33003-003	2.31644-003	1.33745-002	2

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 72

LEAKAGE BY REGION AND GROUP

GROUP	REGION 1	REGION 2	REGION 3	GROUP
1	5,90376-001	3,55499-002	-6,04387-001	1
2	-3,90025-003	-1,30791-003	9,07885-003	2

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 73

ABSORPTION BY REGION AND GROUP

GROUP	REGION 1	REGION 2	REGION 3	GROUP
1	1,05884+000	1,34655-001	5,82959-001	1
2	1,34221-001	2,25875-002	1,83188-001	2

PROB, NO, 2,00000+000 2DCANDID K=CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO, 74

FISSION SOURCE BY REGION AND GROUP

GROUP	REGION 1	REGION 2	REGION 3	GROUP
1	2,09699+000	2,54972-001	2,02471-001	1
2	1,64662-002	2,00211-003	1,58986-003	2

REG	C	G	H	1X1	GP	SCAT	FLXVLM
1	1	1	1	1	0	0,0000+000	0,0000+000
1	1	1	2	2	1	0,0000+000	8,0345+001
1	1	2	1	7	1	1,6242-003	8,0345+001
1	1	2	2	8	2	0,0000+000	5,8359+000
2	2	1	1	3	0	0,0000+000	0,0000+000
2	2	1	2	4	1	0,0000+000	1,3824+001
2	2	2	1	9	1	1,7281-003	1,3824+001
2	2	2	2	10	2	0,0000+000	1,4021+000
3	3	1	1	5	0	0,0000+000	0,0000+000
3	3	1	2	6	1	0,0000+000	6,5802+001
3	3	2	1	11	1	3,3042-003	6,5802+001
3	3	2	2	12	2	0,0000+000	1,4223+001

PROB. NO. 2.00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 75

SCATTER SOURCE BY REGION AND GROUP

GROUP	REGION 1	REGION 2	REGION 3	GROUP
1	0.00000+000	0.00000+000	0.00000+000	1
2	1.30493-001	2.38891-002	2.17422-001	2

PROB. NO. 2.00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 76

TOTAL BALANCE BY REGION AND GROUP

GROUP	REGION 1	REGION 2	REGION 3	GROUP
1	4.47777-001	8.47672-002	2.23900-001	1
2	1.66381-002	4.61164-003	2.67448-002	2

PROB. NO. 2.00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 77

BALANCE SUMS BY REGION

REGION	LEAKAGE	ABSORPTION	BUCKLING	FISSION	SCATTER	EXTERNAL	TOTAL	REGION
1	5.86476-001	1.19306+000	0.00000+000	2.11346+000	1.30493-001	0.00000+000	4.64416-001	1
2	3.42420-002	1.57242-001	0.00000+000	2.56974-001	2.38891-002	0.00000+000	8.93789-002	2
3	-5.95308-001	7.66147-001	0.00000+000	2.04061-001	2.17422-001	0.00000+000	2.50645-001	3
ALL	2.54093-002	2.11645+000	0.00000+000	2.57449+000	3.71804-001	0.00000+000	8.04439-001	ALL

PROB. NO. 2.00000+000 2DCANDID K-CALC (NO ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 78

BALANCE SUMS BY GROUP

GROUP	LEAKAGE	ABSORPTION	BUCKLING	FISSION	SCATTER	EXTERNAL	TOTAL	GROUP
1	2.15386-002	1.77645+000	0.00000+000	2.55443+000	0.00000+000	0.00000+000	7.56444-001	1
2	3.87069-003	3.39997-001	0.00000+000	2.00581-002	3.71804-001	0.00000+000	4.79946-002	2
ALL	2.54093-002	2.11645+000	0.00000+000	2.57449+000	3.71804-001	0.00000+000	8.04439-001	ALL

2. Sample Problem 2

a. Description

(1) Problem Type

Real k_{eff} with Chebyshev acceleration

(2) Configuration

Same as Sample Problem 1

(3) Convergence Criteria

Same as Sample Problem 1

b. Output Listing

PROB. NO. 3.00000+000 2DCANDID K-CALC (W/ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 23

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	1.3773697+000	6.1440170-002	3.0971785+000	1.6558092-001	1.0000000+000	1.0000000+000	3.0357383+000
4.614							
2	1.3327728+000	2.3260586-001	1.2291780+000	9.4351252-002	1.0000000+000	1.0000000+000	9.9657212-001
3	1.3007313+000	4.3227500-001	1.1166810+000	6.7356246-002	1.0000000+000	1.0000000+000	6.8440604-001
4	1.2770434+000	5.5538333-001	1.0741421+000	5.4212842-002	1.0000000+000	1.0000000+000	5.1875873-001
5	1.2593540+000	6.3341824-001	1.0527936+000	4.6239459-002	1.0000000+000	1.0000000+000	4.1937532-001
6	1.2460554+000	6.9264789-001	1.0403481+000	4.0566803-002	1.0000000+000	1.0000000+000	3.4770019-001
7	1.2359993+000	7.4214974-001	1.0331508+000	3.6130244-002	1.0000000+000	1.0000000+000	2.9100104-001
8	1.2283286+000	7.8503622-001	1.0317257+000	3.2465991-002	1.0000000+000	1.0000000+000	2.4668948-001
9	1.2223844+000	8.2203109-001	1.0303336+000	2.9337948-002	1.0000000+000	1.0000000+000	2.0830246-001
10	1.2176492+000	8.5360629-001	1.0289328+000	2.6610098-002	1.0000000+000	1.0000000+000	1.7532654-001
11	1.2137044+000	8.8061696-001	1.0275521+000	2.4196198-002	1.0000000+000	1.0000000+000	1.4693513-001
12	1.2101739+000	8.9155540-001	1.0256558+000	2.2037956-002	1.0000000+000	1.0000000+000	1.3410042-001
13	1.2067851+000	8.9699044-001	1.0232507+000	2.0082774-002	1.0000000+000	1.0000000+000	1.2626031-001
14	1.2033687+000	9.0181376-001	1.0205935+000	1.8305807-002	1.0000000+000	1.0000000+000	1.1877973-001
15	1.1998310+000	9.0536106-001	1.0179032+000	1.6696202-002	1.0000000+000	1.0000000+000	1.1254212-001
16	1.1961292+000	9.0817362-001	1.0153233+000	1.5486144-002	9.1207133-001	1.0157843+000	1.0714973-001
17	1.1922483+000	9.1108706-001	1.0128980+000	1.6070502-002	9.1207133-001	1.1541610+000	1.0181095-001
18	1.1881516+000	9.1453672-001	1.0110641+000	1.9015912-002	9.1207133-001	1.5105853+000	9.6527356-002
19	1.1837515+000	9.1934397-001	1.0098062+000	2.5999353-002	9.1207133-001	2.3477837+000	9.0462262-002
20	1.1788621+000	9.2761269-001	1.0080144+000	4.1376828-002	9.1207133-001	4.5147047+000	8.0401710-002
21	1.1731275+000	9.4684469-001	1.0050043+000	6.4633023-002	9.1207133-001	9.6648508+000	5.8159641-002
22	1.1666187+000	9.7340278-001	1.0006301+000	4.5482408-003	9.1207133-001	1.0000000+000	2.7197303-002
23	1.1604084+000	9.7434306-001	1.0006125+000	4.3284806-003	9.1207133-001	1.0000000+000	2.6269419-002
24	1.1544771+000	9.7525706-001	1.0005489+000	4.1226426-003	9.1207133-001	1.0000000+000	2.5291833-002
25	1.1488063+000	9.7614630-001	1.0004689+000	3.9924957-003	9.1207133-001	1.0157843+000	2.4322611-002
26	1.1433797+000	9.7701327-001	1.0003749+000	4.3274390-003	9.1207133-001	1.1541610+000	2.3361611-002
27	1.1381862+000	9.7792441-001	1.0002138+000	5.3930639-003	9.1207133-001	1.5105853+000	2.2289375-002
28	1.1332186+000	9.7908584-001	9.9991031-001	7.9395698-003	9.1207133-001	2.3477837+000	2.0824177-002
29	1.1284732+000	9.8074002-001	9.9933376-001	1.4301811-002	9.1207133-001	4.5147047+000	1.8593736-002
30	1.1239474+000	9.8385790-001	9.9823993-001	2.8053446-002	9.1207133-001	9.6648508+000	1.4382030-002
31	1.1196198+000	9.9032313-001	9.9695521-001	2.5979073-003	9.1207133-001	1.0000000+000	6.6320769-003
32	1.1154387+000	9.9066249-001	9.9696029-001	2.5092589-003	9.1207133-001	1.0000000+000	6.2978076-003
33	1.1114055+000	9.9098670-001	9.9719377-001	2.4197259-003	9.1207133-001	1.0000000+000	6.2070707-003
34	1.1075157+000	9.9129685-001	9.9738810-001	2.3330860-003	9.1207133-001	1.0000000+000	6.0912480-003
35	1.1037628+000	9.9159428-001	9.9755294-001	2.2880641-003	9.6419436-001	1.0167014+000	5.9586676-003
36	1.1001418+000	9.9188456-001	9.9769051-001	2.5277702-003	9.6419436-001	1.1644195+000	5.8059492-003
37	1.0966479+000	9.9220279-001	9.9778413-001	3.2564947-003	9.6419436-001	1.5559873+000	5.5813413-003
38	1.0932759+000	9.9260648-001	9.9780507-001	5.1256609-003	9.6419436-001	2.5437080+000	5.1985938-003

39	1.0900199+000	9.9322250-001	9.9769430-001	1.0926652-002	9.6419436-001	5.6494419+000	4.4714930-003
40	1.0868699+000	9.9444751-001	9.9729650-001	3.5247607-002	9.6419436-001	1.9145094+001	2.8489933-003
41	1.0837652+000	9.9613636-001	9.9792469-001	1.7191877-003	9.6419436-001	1.0000000+000	1.7883350-003
42	1.0807627+000	9.9645570-001	9.9785057-001	1.6613108-003	9.6419436-001	1.0000000+000	1.3948703-003
43	1.0778631+000	9.9673019-001	9.9782322-001	1.6038813-003	9.6419436-001	1.0000000+000	1.0930276-003
44	1.0750590+000	9.9696675-001	9.9778824-001	1.5506469-003	9.6419436-001	1.0000000+000	8.2149629-004
45	1.0723475+000	9.9716824-001	9.9775547-001	1.4993167-003	9.6419436-001	1.0000000+000	5.8723061-004
46	1.0697267+000	9.9729144-001	9.9773616-001	1.4492507-003	9.6419436-001	1.0000000+000	4.4472591-004
47	1.0671948+000	9.9735024-001	9.9787529-001	1.4238084-003	9.6660746-001	1.0167439+000	5.2504663-004
48	1.0647498+000	9.9740950-001	9.9799153-001	1.5755067-003	9.6660746-001	1.1648989+000	5.8202744-004
49	1.0623899+000	9.9744009-001	9.9807602-001	2.0337856-003	9.6660746-001	1.5581555+000	6.3593485-004
50	1.0601132+000	9.9746160-001	9.9811176-001	3.2125185-003	9.6660746-001	2.5535736+000	6.5015908-004
51	1.0579171+000	9.9750057-001	9.9806370-001	6.9143997-003	9.6660746-001	5.7159538+000	5.6312907-004
52	1.0557946+000	9.9759138-001	9.9810617-001	2.3221798-002	9.6660746-001	2.0055868+001	5.1478355-004
53	1.0536833+000	9.9723455-001	9.9830932-001	1.1080239-003	9.6660746-001	1.0000000+000	1.0747721-003
54	1.0516396+000	9.9747928-001	9.9828621-001	1.0716284-003	9.6660746-001	1.0000000+000	8.0692697-004
55	1.0496615+000	9.9768629-001	9.9826548-001	1.0367321-003	9.6660746-001	1.0000000+000	5.7918797-004
56	1.0477476+000	9.9786253-001	9.9827461-001	1.0027949-003	9.6660746-001	1.0000000+000	4.1208164-004
57	1.0458967+000	9.9792076-001	9.9831286-001	9.8598885-004	9.6726517-001	1.0167555+000	3.9209949-004
58	1.0441074+000	9.9793839-001	9.9843138-001	1.0922605-003	9.6726517-001	1.1650296+000	4.9268889-004
59	1.0423777+000	9.9796018-001	9.9852232-001	1.4124967-003	9.6726517-001	1.5587475+000	5.6213769-004
60	1.0407055+000	9.9799055-001	9.9857686-001	2.2377346-003	9.6726517-001	2.5562758+000	5.8630969-004
61	1.0390893+000	9.9803849-001	9.9857031-001	4.8404579-003	9.6726517-001	5.7343547+000	5.3182036-004
62	1.0375294+000	9.9814570-001	9.9855878-001	1.6433739-002	9.6726517-001	2.0319333+001	4.1308139-004
63	1.0359759+000	9.9791799-001	9.9879120-001	7.8254628-004	9.6726517-001	1.0000000+000	8.7321700-004
64	1.0344774+000	9.9810716-001	9.9871688-001	7.5425922-004	9.6726517-001	1.0000000+000	6.0972634-004
65	1.0330359+000	9.9826687-001	9.9871895-001	7.2547161-004	9.6726517-001	1.0000000+000	4.5208292-004
66	1.0316427+000	9.9840242-001	9.9872972-001	7.0099569-004	9.6726517-001	1.0000000+000	3.2729840-004
67	1.0302952+000	9.9848283-001	9.9875368-001	6.8929570-004	9.6626205-001	1.0167378+000	2.7084941-004
68	1.0289923+000	9.9849447-001	9.9883259-001	7.6357274-004	9.6626205-001	1.1648302+000	3.3812571-004
69	1.0277327+000	9.9850913-001	9.9890237-001	9.8722120-004	9.6626205-001	1.5578448+000	3.9324163-004
70	1.0265148+000	9.9852985-001	9.9894471-001	1.5629428-003	9.6626205-001	2.5521567+000	4.1486417-004
71	1.0253376+000	9.9856342-001	9.9894167-001	3.3723690-003	9.6626205-001	5.7063376+000	3.7825119-004
72	1.0242014+000	9.9863750-001	9.9893652-001	1.1302609-002	9.6626205-001	1.9920224+001	2.9901630-004
73	1.0230711+000	9.9846944-001	9.9910304-001	5.5281714-004	9.6626205-001	1.0000000+000	6.3360680-004
74	1.0219807+000	9.9860646-001	9.9904922-001	5.3294342-004	9.6626205-001	1.0000000+000	4.4275273-004
75	1.0209317+000	9.9872282-001	9.9905119-001	5.1266159-004	9.6626205-001	1.0000000+000	3.2836711-004
76	1.0199179+000	9.9882202-001	9.9906481-001	4.9534655-004	9.6626205-001	1.0000000+000	2.4279214-004
77	1.0189374+000	9.9887344-001	9.9908335-001	4.8704823-004	9.6622521-001	1.0167372+000	2.0961779-004
78	1.0179895+000	9.9888253-001	9.9913955-001	5.3950043-004	9.6622521-001	1.1648229+000	2.5702696-004
79	1.0170730+000	9.9889391-001	9.9919116-001	6.9751567-004	9.6622521-001	1.5578116+000	2.9724988-004
80	1.0161870+000	9.9890992-001	9.9922244-001	1.1044349-003	9.6622521-001	2.5520057+000	3.1251994-004
81	1.0153305+000	9.9893571-001	9.9922014-001	2.3841482-003	9.6622521-001	5.7053137+000	2.8442613-004

82	1.0145034+000	9.9899248-001	9.9921880-001	8.0013345-003	9.6622521-001	1.9905862+001	2.2631927-004
83	1.0136803+000	9.9887359-001	9.9933977-001	3.9398856-004	9.6622521-001	1.0000000+000	4.6617433-004
84	1.0128862+000	9.9897448-001	9.9930155-001	3.7989776-004	9.6622521-001	1.0000000+000	3.2706837-004
85	1.0121219+000	9.9906026-001	9.9930279-001	3.6551969-004	9.6622521-001	1.0000000+000	2.4252513-004
86	1.0113834+000	9.9913347-001	9.9931293-001	3.5317877-004	9.6622521-001	1.0000000+000	1.7945815-004
87	1.0106691+000	9.9917102-001	9.9932649-001	3.4725098-004	9.6623731-001	1.0167374+000	1.5546939-004
88	1.0099786+000	9.9917779-001	9.9936810-001	3.8463668-004	9.6623731-001	1.1648253+000	1.9031519-004
89	1.0093110+000	9.9918626-001	9.9940624-001	4.9729913-004	9.6623731-001	1.5578225+000	2.1998353-004
90	1.0086657+000	9.9919816-001	9.9942934-001	7.8750542-004	9.6623731-001	2.5520553+000	2.3117744-004
91	1.0080418+000	9.9921736-001	9.9942763-001	1.7006365-003	9.6623731-001	5.7056501+000	2.1027136-004
92	1.0074393+000	9.9925950-001	9.9942700-001	5.7146687-003	9.6623731-001	1.9910579+001	1.6750081-004
93	1.0068398+000	9.9917277-001	9.9951576-001	2.8248924-004	9.6623731-001	1.0000000+000	3.4299037-004
94	1.0062613+000	9.9924701-001	9.9948796-001	2.7239305-004	9.6623731-001	1.0000000+000	2.4094831-004
95	1.0057046+000	9.9931017-001	9.9948885-001	2.6209280-004	9.6623731-001	1.0000000+000	1.7867536-004
96	1.0051667+000	9.9936409-001	9.9949645-001	2.5324058-004	9.6623731-001	1.0000000+000	1.3235353-004
97	1.0046464+000	9.9939151-001	9.9950648-001	2.4898484-004	9.6622485-001	1.0167372+000	1.1496604-004
98	1.0041434+000	9.9939653-001	9.9953692-001	2.7578556-004	9.6622485-001	1.1648228+000	1.4039397-004
99	1.0036572+000	9.9940281-001	9.9956502-001	3.5656671-004	9.6622485-001	1.5578113+000	1.6221032-004
100	1.0031871+000	9.9941162-001	9.9958203-001	5.6468544-004	9.6622485-001	2.5520042+000	1.7040376-004

```
AN ERROR WAS ENCOUNTERED IN SUBROUTINE  KEFFCALC  AT STATEMENT NUMBER     692
TIME EXCEEDED
I=    1 G=1 J=1 FLUX=  3.6594463-003
I=    2 G=1 J=1 FLUX=  3.6354098-003
I=    3 G=1 J=1 FLUX=  3.5883951-003
I=    4 G=1 J=1 FLUX=  3.5188231-003
I=    5 G=1 J=1 FLUX=  3.4272996-003
I=    6 G=1 J=1 FLUX=  3.3146073-003
I=    7 G=1 J=1 FLUX=  3.1816875-003
I=    8 G=1 J=1 FLUX=  3.0296161-003
I=    9 G=1 J=1 FLUX=  2.8595774-003
I=   10 G=1 J=1 FLUX=  2.6728328-003
I=   11 G=1 J=1 FLUX=  2.4706859-003
I=   12 G=1 J=1 FLUX=  2.2544475-003
I=   13 G=1 J=1 FLUX=  2.0905787-003
I=   14 G=1 J=1 FLUX=  1.9933852-003
I=   15 G=1 J=1 FLUX=  1.8970939-003
I=   16 G=1 J=1 FLUX=  1.4410688-003
I=   17 G=1 J=1 FLUX=  9.2933781-004
I=   18 G=1 J=1 FLUX=  6.0408248-004
I=   19 G=1 J=1 FLUX=  3.9498282-004
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I=    20 G=1 J=1 FLUX=  2.5931899-004
I=    21 G=1 J=1 FLUX=  1.7058829-004
I=    22 G=1 J=1 FLUX=  1.1207857-004
I=    23 G=1 J=1 FLUX=  7.3105303-005
I=    24 G=1 J=1 FLUX=  4.6745756-005
I=    25 G=1 J=1 FLUX=  2.8442587-005
I=    26 G=1 J=1 FLUX=  1.5124290-005
I=    27 G=1 J=1 FLUX=  4.6371388-006

CANDID2D HAS COPIED FLUX FROM LUN    3 ONTO LUN   48

IMAXIN=   27 JMAXIN=   20 IMAXOUT=   27 JMAXOUT=   20
I=     1 G=1 J=1 FLUX=  4.4073824-002
I=     2 G=1 J=1 FLUX=  4.4073824-002
I=     3 G=1 J=1 FLUX=  4.4073824-002
I=     4 G=1 J=1 FLUX=  4.4073824-002
I=     5 G=1 J=1 FLUX=  4.4073824-002
I=     6 G=1 J=1 FLUX=  4.4073824-002
I=     7 G=1 J=1 FLUX=  4.4073824-002
I=     8 G=1 J=1 FLUX=  4.4073824-002
I=     9 G=1 J=1 FLUX=  4.4073824-002
I=    10 G=1 J=1 FLUX=  4.4073824-002
I=    11 G=1 J=1 FLUX=  4.4073824-002
I=    12 G=1 J=1 FLUX=  4.4073824-002
I=    13 G=1 J=1 FLUX=  2.2036912-002
I=    14 G=1 J=1 FLUX=  2.2036912-002
I=    15 G=1 J=1 FLUX=  2.2036912-002
I=    16 G=1 J=1 FLUX=  4.4073824-003
I=    17 G=1 J=1 FLUX=  4.4073824-003
I=    18 G=1 J=1 FLUX=  4.4073824-003
I=    19 G=1 J=1 FLUX=  4.4073824-003
I=    20 G=1 J=1 FLUX=  4.4073824-003
I=    21 G=1 J=1 FLUX=  4.4073824-003
I=    22 G=1 J=1 FLUX=  4.4073824-003
I=    23 G=1 J=1 FLUX=  4.4073824-003
I=    24 G=1 J=1 FLUX=  4.4073824-003
I=    25 G=1 J=1 FLUX=  4.4073824-003
I=    26 G=1 J=1 FLUX=  4.4073824-003
I=    27 G=1 J=1 FLUX=  4.4073824-003

CANDID2D HAS COPIED FLUX FROM LUN   49 ONTO LUN   48

IMAXIN=   27 JMAXIN=   20 IMAXOUT=   27 JMAXOUT=   20
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PROB. NO. 3.00000+000 2DCANDID K-CALC (W/ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 23

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	1.0027327+000	9.9942585-001	9.9958078-001	2.1378649-004	1.0000000+000	1.0000000+000	1.5493376-004
4.617							
2	1.0022946+000	9.9943272-001	9.9960833-001	2.0617798-004	1.0000000+000	1.0000000+000	1.7561878-004
3	1.0018723+000	9.9943950-001	9.9962746-001	1.9879536-004	1.0000000+000	1.0000000+000	1.8796067-004
4	1.0014652+000	9.9944653-001	9.9964386-001	1.9168714-004	1.0000000+000	1.0000000+000	1.9732976-004
5	1.0010729+000	9.9945387-001	9.9965840-001	1.8485222-004	1.0000000+000	1.0000000+000	2.0453440-004
6	1.0006947+000	9.9946147-001	9.9967139-001	1.8126731-004	9.6434338-001	1.0167040+000	2.0991643-004
7	1.0003300+000	9.9946943-001	9.9968263-001	2.0027757-004	9.6434338-001	1.1644491+000	2.1320526-004
8	9.9997829-001	9.9947849-001	9.9968943-001	2.5825787-004	9.6434338-001	1.5561211+000	2.1093128-004
9	9.9963879-001	9.9949039-001	9.9968816-001	4.0769378-004	9.6434338-001	2.5443150+000	1.9777182-004
10	9.9931029-001	9.9950926-001	9.9969458-001	8.7630108-004	9.6434338-001	5.6535044+000	1.8531368-004
11	9.9898930-001	9.9954871-001	9.9970703-001	2.9019440-003	9.6434338-001	1.9198935+001	1.5831660-004
12	9.9865933-001	9.9955335-001	9.9972314-001	1.5407437-004	9.6434338-001	1.0000000+000	1.6979383-004
13	9.9834006-001	9.9959041-001	9.9972048-001	1.4896361-004	9.6434338-001	1.0000000+000	1.3006896-004
14	9.9803124-001	9.9962259-001	9.9971759-001	1.4403271-004	9.6434338-001	1.0000000+000	9.5004871-005
15	9.9773263-001	9.9965051-001	9.9971568-001	1.3924930-004	9.6434338-001	1.0000000+000	6.5169181-005
16	9.9744401-001	9.9965890-001	9.9972467-001	1.3684635-004	9.6678942-001	1.0167471+000	6.5770029-005
17	9.9716512-001	9.9966181-001	9.9974419-001	1.5151471-004	9.6678942-001	1.1649350+000	8.2373968-005
18	9.9689567-001	9.9966544-001	9.9975918-001	1.9585058-004	9.6678942-001	1.5583192+000	9.3747876-005
19	9.9663532-001	9.9967051-001	9.9976797-001	3.1022030-004	9.6678942-001	2.5543206+000	9.7467011-005
20	9.9638375-001	9.9967869-001	9.9976648-001	6.7120668-004	9.6678942-001	5.7210328+000	8.7790409-005
21	9.9614081-001	9.9969649-001	9.9976653-001	2.2780028-003	9.6678942-001	2.0128072+001	7.0037626-005
22	9.9589896-001	9.9966111-001	9.9980156-001	1.1219412-004	9.6678942-001	1.0000000+000	1.4045429-004
23	9.9566555-001	9.9969186-001	9.9979135-001	1.0819777-004	9.6678942-001	1.0000000+000	9.9490033-005
24	9.9544082-001	9.9971798-001	9.9979162-001	1.0415257-004	9.6678942-001	1.0000000+000	7.3639254-005
25	9.9522362-001	9.9974026-001	9.9979475-001	1.0064396-004	9.6678942-001	1.0000000+000	5.4490942-005
26	9.9501357-001	9.9975181-001	9.9979883-001	9.8952543-005	9.6631278-001	1.0167387+000	4.7020701-005
27	9.9481050-001	9.9975387-001	9.9981147-001	1.0960429-004	9.6631278-001	1.1648403+000	5.7596320-005
28	9.9461421-001	9.9975645-001	9.9982302-001	1.4171780-004	9.6631278-001	1.5578904+000	6.6572014-005
29	9.9442444-001	9.9976008-001	9.9983002-001	2.2448330-004	9.6631278-001	2.5523647+000	6.9936737-005
30	9.9424100-001	9.9976594-001	9.9982950-001	4.8519520-004	9.6631278-001	5.7077478+000	6.3561805-005
31	9.9406389-001	9.9977874-001	9.9982926-001	1.6353000-003	9.6631278-001	1.9940030+001	5.0525021-005
32	9.9388768-001	9.9975290-001	9.9985607-001	8.1356782-005	9.6631278-001	1.0000000+000	1.0316767-004
33	9.9371766-001	9.9977521-001	9.9984770-001	7.8442643-005	9.6631278-001	1.0000000+000	7.2493276-005
34	9.9355405-001	9.9979419-001	9.9984797-001	7.5471563-005	9.6631278-001	1.0000000+000	5.3781740-005
35	9.9339594-001	9.9981040-001	9.9985027-001	7.2918670-005	9.6631278-001	1.0000000+000	3.9871520-005
36	9.9324305-001	9.9981857-001	9.9985331-001	7.1690123-005	9.6617411-001	1.0167363+000	3.4743789-005
37	9.9309524-001	9.9982009-001	9.9986232-001	7.9403604-005	9.6617411-001	1.1648128+000	4.2231346-005
38	9.9295237-001	9.9982200-001	9.9987076-001	1.0266203-004	9.6617411-001	1.5577657+000	4.8765665-005
39	9.9281424-001	9.9982467-001	9.9987587-001	1.6260047-004	9.6617411-001	2.5517963+000	5.1201743-005
40	9.9268072-001	9.9982899-001	9.9987551-001	3.5133072-004	9.6617411-001	5.7038945+000	4.6524117-005
41	9.9255178-001	9.9983840-001	9.9987553-001	1.1822386-003	9.6617411-001	1.9885983+001	3.7134247-005

42	9,9242348-001	9,9981991-001	9,9989483-001	5,9032241-005	9,6617411-001	1,0000000+000	7.4922340-005
43	9,9229968-001	9,9983612-001	9,9988887-001	5,6924930-005	9,6617411-001	1,0000000+000	5.2749310-005
44	9,9218053-001	9,9984993-001	9,9988905-001	5.4774742-005	9,6617411-001	1,0000000+000	3.9114355-005
45	9,9206539-001	9,9986173-001	9,9989081-001	5,2922569-005	9,6617411-001	1,0000000+000	2,9074741-005
46	9,9195405-001	9,9986759-001	9,9989303-001	5,2030515-005	9,6618562-001	1,0167365+000	2,5439615-005
47	9,9184641-001	9,9986871-001	9,9989959-001	5,7628299-005	9,6618562-001	1,1648150+000	3.0884970-005
48	9,9174236-001	9,9987010-001	9,9990575-001	7,4508614-005	9,6618562-001	1,5577760+000	3,5644873-005
49	9,9164177-001	9,9987206-001	9,9990947-001	1,1801322-004	9,6618562-001	2,5518435+000	3,7412741-005
50	9,9154454-001	9,9987522-001	9,9990921-001	2,5501718-004	9,6618562-001	5,7042142+000	3,3986682-005
51	9,9145063-001	9,9988211-001	9,9990926-001	8,5847660-004	9,6618562-001	1,9890458+001	2,7152098-005
52	9,9135720-001	9,9986867-001	9,9992335-001	4.2886483-005	9,6618562-001	1,0000000+000	5,4687509-005
53	9,9126703-001	9,9988049-001	9,9991899-001	4,1356393-005	9,6618562-001	1,0000000+000	3,8497601-005
54	9,9118025-001	9,9989057-001	9,9991912-001	3,9795564-005	9,6618562-001	1,0000000+000	2,8547016-005
55	9,9109639-001	9,9989918-001	9,9992040-001	3,8449885-005	9,6618562-001	1,0000000+000	2.1215877-005
56	9,9101529-001	9,9990345-001	9,9992202-001	3,7801663-005	9,6618520-001	1,0167365+000	1,8567909-005
57	9,9093689-001	9,9990427-001	9,9992680-001	4,1868516-005	9,6618520-001	1,1648150+000	2,2537322-005
58	9,9086111-001	9,9990528-001	9,9993129-001	5.4132587-005	9.6618520-001	1,5577756+000	2.6009307-005
59	9,9078785-001	9,9990671-001	9,9993401-001	8,5740906-005	9,6618520-001	2,5518417+000	2,7297996-005
60	9,9071703-001	9,9990902-001	9,9993382-001	1,8528631-004	9,6618520-001	5,7042024+000	2.4796638-005
61	9,9064864-001	9,9991405-001	9,9993386-001	6,2381103-004	9,6618520-001	1,9890293+001	1.9810788-005
62	9,9058059-001	9,9990425-001	9,9994412-001	3,1179178-005	9.6618520-001	1,0000000+000	3.9865554-005
63	9,9051492-001	9,9991288-001	9,9994097-001	3,0066128-005	9,6618520-001	1,0000000+000	2,8085487-005
64	9,9045171-001	9,9992023-001	9,9994105-001	2,8931491-005	9,6618520-001	1,0000000+000	2,0817621-005
65	9,9039063-001	9,9992651-001	9,9994198-001	2,7953212-005	9,6618520-001	1,0000000+000	1,5473823-005
66	9,9033157-001	9,9992962-001	9,9994316-001	2,7481865-005	9,6618637-001	1,0167365+000	1,3546829-005
67	9,9027447-001	9,9993021-001	9,9994665-001	3,0438378-005	9,6618637-001	1,1648152+000	1,6438484-005
68	9,9021928-001	9,9993096-001	9,9994993-001	3,9354421-005	9,6618637-001	1,5577767+000	1,8969949-005
69	9,9016593-001	9,9993200-001	9,9995191-001	6,2334364-005	9,6618637-001	2,5518465+000	1,9908941-005
70	9,9011435-001	9,9993368-001	9,9995177-001	1,3470937-004	9,6618637-001	5,7042350+000	1,8083854-005
71	9,9006453-001	9,9993735-001	9,9995180-001	4,5358228-004	9,6618637-001	1,9890748+001	1,4449222-005
72	9,9001497-001	9,9993021-001	9,9995930-001	2,2678226-005	9,6618637-001	1,0000000+000	2,9093368-005
73	9,8996714-001	9,9993651-001	9,9995699-001	2,1868955-005	9,6618637-001	1,0000000+000	2,0480191-005
74	9,8992111-001	9,9994186-001	9,9995704-001	2,1043486-005	9,6618637-001	1,0000000+000	1,5176993-005
75	9,8987662-001	9,9994644-001	9,9995772-001	2,0332000-005	9,6618637-001	1,0000000+000	1,1281852-005
76	9,8983361-001	9,9994871-001	9,9995858-001	1,9989122-005	9,6618972-001	1,0167366+000	9,8786404-006
77	9,8979202-001	9,9994914-001	9,9996113-001	2.2139526-005	9,6618972-001	1,1648159+000	1,1985117-005
78	9,8975182-001	9,9994968-001	9,9996351-001	2,8624714-005	9,6618972-001	1,5577797+000	1,3830257-005
79	9,8971296-001	9,9995044-001	9,9996496-001	4,5339807-005	9,6618972-001	2.5518603+000	1.4514415-005
80	9,8967540-001	9,9995167-001	9,9996485-001	9,7986002-005	9.6618972-001	5,7043280+000	1.3183468-005
81	9,8963912-001	9,9995435-001	9,9996488-001	3,2996937-004	9,6618972-001	1,9892052+001	1,0535121-005
82	9,8960302-001	9,9994915-001	9,9997036-001	1,6500699-005	9,6618972-001	1,0000000+000	2.1209111-005
83	9,8956819-001	9,9995373-001	9,9996867-001	1,5912479-005	9,6618972-001	1,0000000+000	1,4939782-005
84	9,8953466-001	9,9995764-001	9,9996870-001	1,5311628-005	9,6618972-001	1,0000000+000	1,1063763-005
85	9,8950226-001	9,9996097-001	9,9996920-001	1,4793866-005	9,6618972-001	1.0000000+000	8,2235783-006
86	9,8947093-001	9,9996262-001	9,9996983-001	1,4544371-005	9.6618504-001	1,0167365+000	7.2015537-006
87	9,8944064-001	9.9996294-001	9.9997168-001	1,6109040-005	9,6618504-001	1,1648149+000	8,7353837-006

88	9,8941137-001	9,9996334-001	9,9997342-001	2,0827735-005	9,6618504-001	1,5577755+000	1,0080068-005
89	9,8938307-001	9,9996389-001	9,9997447-001	3,2989899-005	9,6618504-001	2,5518410+000	1,0578500-005
90	9,8935571-001	9,9996479-001	9,9997439-001	7,1296071-005	9,6618504-001	5,7041979+000	9,6083240-006
91	9,8932928-001	9,9996674-001	9,9997441-001	2,4008606-004	9,6618504-001	1,9890229+001	7,6787255-006
92	9,8930299-001	9,9996295-001	9,9997843-001	1,2009241-005	9,6618504-001	1,0000000+000	1,5480575-005
93	9,8927762-001	9,9996629-001	9,9997718-001	1,1580883-005	9,6618504-001	1,0000000+000	1,0892647-005
94	9,8925321-001	9,9996914-001	9,9997720-001	1,1143837-005	9,6618504-001	1,0000000+000	8,0648169-006
95	9,8922961-001	9,9997157-001	9,9997756-001	1,0767020-005	9,6618504-001	1,0000000+000	5,9922895-006
96	9,8920679-001	9,9997277-001	9,9997802-001	1,0585421-005	9,6618608-001	1,0167365+000	5,2495889-006
97	9,8918473-001	9,9997300-001	9,9997937-001	1,1724156-005	9,6618608-001	1,1648151+000	6,3660264-006
98	9,8916341-001	9,9997329-001	9,9998063-001	1,5158428-005	9,6618608-001	1,5577764+000	7,3457195-006
99	9,8914280-001	9,9997369-001	9,9998140-001	2,4010160-005	9,6618608-001	2,5518453+000	7,7087461-006
100	9,8912287-001	9,9997434-001	9,9998135-001	5,1890304-005	9,6618608-001	5,7042269+000	7,0017850-006
101	9,8910363-001	9,9997577-001	9,9998136-001	1,7474715-004	9,6618608-001	1,9890635+001	5,5956916-006
102	9,8908448-001	9,9997300-001	9,9998437-001	8,7416672-006	9,6618608-001	1,0000000+000	1,1366181-005
103	9,8906600-001	9,9997544-001	9,9998337-001	8,4307690-006	9,6618608-001	1,0000000+000	7,9284218-006
104	9,8904822-001	9,9997752-001	9,9998340-001	8,1118903-006	9,6618608-001	1,0000000+000	5,8814621-006
105	9,8903103-001	9,9997929-001	9,9998365-001	7,8377560-006	9,6618608-001	1,0000000+000	4,3670298-006
106	9,8901441-001	9,9998016-001	9,9998399-001	7,7055417-006	9,6620586-001	1,0167368+000	3,8248691-006
107	9,8899835-001	9,9998033-001	9,9998497-001	8,5344854-006	9,6620586-001	1,1648191+000	4,6383502-006
108	9,8898282-001	9,9998054-001	9,9998589-001	1,1034532-005	9,6620586-001	1,5577942+000	5,3520926-006
109	9,8896781-001	9,9998084-001	9,9998645-001	1,7478518-005	9,6620586-001	2,5519264+000	5,6164863-006
110	9,8895330-001	9,9998131-001	9,9998641-001	3,7777078-005	9,6620586-001	5,7047763+000	5,1012175-006
111	9,8893928-001	9,9998235-001	9,9998642-001	1,2725923-004	9,6620586-001	1,9898330+001	4,0777813-006
112	9,8892533-001	9,9998033-001	9,9998857-001	6,3647725-006	9,6620586-001	1,0000000+000	8,2335173-006

```
AN ERROR WAS ENCOUNTERED IN SUBROUTINE  KEFFCALC  AT STATEMENT NUMBER    692
TIME EXCEEDED
I=    1 G=1 J=1 FLUX=  3,5040583-003
I=    2 G=1 J=1 FLUX=  3,4814672-003
I=    3 G=1 J=1 FLUX=  3,4365104-003
I=    4 G=1 J=1 FLUX=  3,3695793-003
I=    5 G=1 J=1 FLUX=  3,2812536-003
I=    6 G=1 J=1 FLUX=  3,1722913-003
I=    7 G=1 J=1 FLUX=  3,0436136-003
I=    8 G=1 J=1 FLUX=  2,8962864-003
I=    9 G=1 J=1 FLUX=  2,7314991-003
I=   10 G=1 J=1 FLUX=  2,5505310-003
I=   11 G=1 J=1 FLUX=  2,3547101-003
I=   12 G=1 J=1 FLUX=  2,1453715-003
I=   13 G=1 J=1 FLUX=  1,9871602-003
I=   14 G=1 J=1 FLUX=  1,8941384-003
I=   15 G=1 J=1 FLUX=  1,8027334-003
I=   16 G=1 J=1 FLUX=  1,3697621-003
I=   17 G=1 J=1 FLUX=  8,8372715-004
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I=   18 G=1 J=1 FLUX=  5,7468678-004
I=   19 G=1 J=1 FLUX=  3,7593169-004
I=   20 G=1 J=1 FLUX=  2,4692492-004
I=   21 G=1 J=1 FLUX=  1,6251072-004
I=   22 G=1 J=1 FLUX=  1,0682112-004
I=   23 G=1 J=1 FLUX=  6,9707672-005
I=   24 G=1 J=1 FLUX=  4,4592393-005
I=   25 G=1 J=1 FLUX=  2,7142946-005
I=   26 G=1 J=1 FLUX=  1,4437945-005
I=   27 G=1 J=1 FLUX=  4,4276220-006

CANDID2D HAS COPIED FLUX FROM LUN    3 ONTO LUN   48

IMAXIN=   27 JMAXIN=   20 IMAXOUT=   27 JMAXOUT=   20
I=    1 G=1 J=1 FLUX=  4,4073824-002
I=    2 G=1 J=1 FLUX=  4,4073824-002
I=    3 G=1 J=1 FLUX=  4,4073824-002
I=    4 G=1 J=1 FLUX=  4,4073824-002
I=    5 G=1 J=1 FLUX=  4,4073824-002
I=    6 G=1 J=1 FLUX=  4,4073824-002
I=    7 G=1 J=1 FLUX=  4,4073824-002
I=    8 G=1 J=1 FLUX=  4,4073824-002
I=    9 G=1 J=1 FLUX=  4,4073824-002
I=   10 G=1 J=1 FLUX=  4,4073824-002
I=   11 G=1 J=1 FLUX=  4,4073824-002
I=   12 G=1 J=1 FLUX=  4,4073824-002
I=   13 G=1 J=1 FLUX=  2,2036912-002
I=   14 G=1 J=1 FLUX=  2,2036912-002
I=   15 G=1 J=1 FLUX=  2,2036912-002
I=   16 G=1 J=1 FLUX=  4,4073824-003
I=   17 G=1 J=1 FLUX=  4,4073824-003
I=   18 G=1 J=1 FLUX=  4,4073824-003
I=   19 G=1 J=1 FLUX=  4,4073824-003
I=   20 G=1 J=1 FLUX=  4,4073824-003
I=   21 G=1 J=1 FLUX=  4,4073824-003
I=   22 G=1 J=1 FLUX=  4,4073824-003
I=   23 G=1 J=1 FLUX=  4,4073824-003
I=   24 G=1 J=1 FLUX=  4,4073824-003
I=   25 G=1 J=1 FLUX=  4,4073824-003
I=   26 G=1 J=1 FLUX=  4,4073824-003
I=   27 G=1 J=1 FLUX=  4,4073824-003

CANDID2D HAS COPIED FLUX FROM LUN   49 ONTO LUN   48

IMAXIN=   27 JMAXIN=   20 IMAXOUT=   27 JMAXOUT=   20
```

PROB. NO. 3,00000+080 2DCANDID K=CALC (W/ACC) , RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 23

ITERATION HISTORY

ITERATION	K=EFFECTIVE	K=LOWER	K=UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	9,8891187-001	9,9998211-001	9,9998791-001	6,1376133-006	1,0000000+000	1,0000000+000	5,8004953-006
4,622							
2	9,8889892-001	9,9998362-001	9,9998790-001	5,9059428-006	1,0000000+000	1,0000000+000	4,2824831-006
3	9,8888640-001	9,9998491-001	9,9998809-001	5,7061746-006	1,0000000+000	1,0000000+000	5,1833333-006
4	9,8887430-001	9,9998555-001	9,9998834-001	5,5176053-006	1,0000000+000	1,0000000+000	2,7859496-006
5	9,8886260-001	9,9998567-001	9,9998906-001	5,3340231-006	1,0000000+000	1,0000000+000	3,3846591-006
6	9,8885130-001	9,9998581-001	9,9998979-001	5,2410119-006	9,6672793-001	1,0167460+000	3,9803999-006
7	9,8884038-001	9,9998596-001	9,9999039-001	5,8003520-006	9,6672793-001	1,1649228+000	4,4361950-006
8	9,8882984-001	9,9998614-001	9,9999083-001	7,4916910-006	9,6672793-001	1,5582639+000	4,6917849-006
9	9,8881967-001	9,9998639-001	9,9999101-001	1,1852418-005	9,6672793-001	2,5540681+000	4,6253554-006
10	9,8880986-001	9,9998677-001	9,9999076-001	2,5618106-005	9,6672793-001	5,7193155+000	3,9838487-006
11	9,8880036-001	9,9998762-001	9,9999090-001	8,7159980-005	9,6672793-001	2,0103615+001	3,2879616-006
12	9,8879088-001	9,9998659-001	9,9999212-001	4,3292561-006	9,6672793-001	1,0000000+000	5,5273849-006

I=	1	G=1	J=1	FLUX= 3,5027445-003
I=	2	G=1	J=1	FLUX= 3,4801677-003
I=	3	G=1	J=1	FLUX= 3,4352274-003
I=	4	G=1	J=1	FLUX= 3,3683167-003
I=	5	G=1	J=1	FLUX= 3,2800168-003
I=	6	G=1	J=1	FLUX= 3,1710861-003
I=	7	G=1	J=1	FLUX= 3,0424459-003
I=	8	G=1	J=1	FLUX= 2,8951619-003
I=	9	G=1	J=1	FLUX= 2,7304223-003
I=	10	G=1	J=1	FLUX= 2,5495051-003
I=	11	G=1	J=1	FLUX= 2,3537304-003
I=	12	G=1	J=1	FLUX= 2,1444581-003
I=	13	G=1	J=1	FLUX= 1,9862941-003
I=	14	G=1	J=1	FLUX= 1,8933073-003
I=	15	G=1	J=1	FLUX= 1,8019434-003
I=	16	G=1	J=1	FLUX= 1,3691657-003
I=	17	G=1	J=1	FLUX= 8,8334609-004
I=	18	G=1	J=1	FLUX= 5,7444137-004
I=	19	G=1	J=1	FLUX= 3,7577267-004
I=	20	G=1	J=1	FLUX= 2,4682142-004
I=	21	G=1	J=1	FLUX= 1,6244389-004
I=	22	G=1	J=1	FLUX= 1,0677709-004
I=	23	G=1	J=1	FLUX= 6,9879172-005
I=	24	G=1	J=1	FLUX= 4,4574303-005
I=	25	G=1	J=1	FLUX= 2,7132087-005
I=	26	G=1	J=1	FLUX= 1,4432172-005
I=	27	G=1	J=1	FLUX= 4,4258606-006

```
CANDID2D HAS COPIED FLUX FROM LUN    3 ONTO LUN   48

IMAXIN=    27 JMAXIN=    20 IMAXOUT=    27 JMAXOUT=    20
I=     1 G=1  J=1  FLUX=   4,4073824-002
I=     2 G=1  J=1  FLUX=   4,4073824-002
I=     3 G=1  J=1  FLUX=   4,4073824-002
I=     4 G=1  J=1  FLUX=   4,4073824-002
I=     5 G=1  J=1  FLUX=   4,4073824-002
I=     6 G=1  J=1  FLUX=   4,4073824-002
I=     7 G=1  J=1  FLUX=   4,4073824-002
I=     8 G=1  J=1  FLUX=   4,4073824-002
I=     9 G=1  J=1  FLUX=   4,4073824-002
I=    10 G=1  J=1  FLUX=   4,4073824-002
I=    11 G=1  J=1  FLUX=   4,4073824-002
I=    12 G=1  J=1  FLUX=   4,4073824-002
I=    13 G=1  J=1  FLUX=   2,2036912-002
I=    14 G=1  J=1  FLUX=   2,2036912-002
I=    15 G=1  J=1  FLUX=   2,2036912-002
I=    16 G=1  J=1  FLUX=   4,4073824-003
I=    17 G=1  J=1  FLUX=   4,4073824-003
I=    18 G=1  J=1  FLUX=   4,4073824-003
I=    19 G=1  J=1  FLUX=   4,4073824-003
I=    20 G=1  J=1  FLUX=   4,4073824-003
I=    21 G=1  J=1  FLUX=   4,4073824-003
I=    22 G=1  J=1  FLUX=   4,4073824-003
I=    23 G=1  J=1  FLUX=   4,4073824-003
I=    24 G=1  J=1  FLUX=   4,4073824-003
I=    25 G=1  J=1  FLUX=   4,4073824-003
I=    26 G=1  J=1  FLUX=   4,4073824-003
I=    27 G=1  J=1  FLUX=   4,4073824-003

CANDID2D HAS COPIED FLUX FROM LUN   49 ONTO LUN   48

IMAXIN=    27 JMAXIN=    20 IMAXOUT=    27 JMAXOUT=    20

CANDID2D IS PREPARING X SECTIONS ONLY ON LUN   48
```

3. Sample Problem 3

a. Description

(1) Problem Type

Dimension search varying the z direction uniformly to obtain $k_{eff} = 1.025$.

(2) Configuration

Same as Sample Problem 1.

(3) Convergence Criteria

k_{eff} difference $= 10^{-5}$.

k_{eff} bounds $= 10^{-5}$.

Sum of flux differences $= 10^{-5}$.

$|k_{eff} - 1.025| \leq 5 \times 10^{-5}$.

b. Output Listing

```
PROB. NO.   1.00000+000  2DCANDID  DIMENSION SEARCH, RZ, TWO GROUPS, 20 X 27 MESH          PAGE NO.   1

                    CODE DEPENDENT DATA OR INPUT IF DIFFERENT THAN ZERO.


                              BUCKLING DATA HAVE NOT BEEN INPUT.


                          VOLUME SOURCE DATA HAVE NOT BEEN INPUT.


               ALL FLUX VALUES WILL BE PRINTED.


               ENERGY GROUPS IN CROSS SECTION DATA.................            2
               ENERGY GROUPS TO USE IN PROBLEM.....................            2
               NUMBER OF REGIONS...................................            3
               MAXIMUM NUMBER OF OUTER ITERATIONS..................        10000
               MAXIMUM NUMBER OF INNER ITERATIONS / CHANNEL CALC...            4
               MAXIMUM NUMBER OF EXTRAPOLATIONS ON K-EFFECTIVE.....            4
               MAXIMUM NUMBER OF INTERPOLATIONS ON K-EFFECTIVE.....           20
               PRINT FREQUENCY FOR CRITICALITY SEARCH..............            1
               PRINT FREQUENCY ON FISSION SOURCE K.................      1000000


               DESIRED K-EFFECTIVE.................................  1.0250+000
               UPPER BOUND ON SEARCH PARAMETER.....................  1.0000+001
               SECOND GUESS ON SEARCH PARAMETER....................  1.5000+000
               LOWER BOUND ON SEARCH PARAMETER..................... -1.0000+001
               CONVERGENCE CRITERION ON OUTER BOUNDS OF K..........  1.0000-005
               CONVERGENCE CRITERION FOR SOURCES...................  1.0000-003
               SMALLEST FLUX VALUE USED IN COMPUTING K-EFFECTIVE...  1.0000-006
               AGREEMENT REQUIRED IN NEUTRON BALANCE...............  1.0000-003
               FIRST GUESS AT K-EFFECTIVE..........................  1.0000+000
               CONVERGENCE CRITERION ON FLUX PER INNER ITERATION...  1.0000-003
               CONVERGENCE CRITERION FOR SUM OF FLUX DIFFERENCES...  1.0000-005
```

PROB, NO. 1.00000+000 2DCANDID DIMENSION SEARCH, RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 11

PROBLEM TYPE

CRITICALITY SEARCH VARYING THE Y-DIMENSION UNIFORMLY

FRACTIONAL MODIFIER.................. 5.0000-002
CONVERGENCE CRITERION (EPSILON)...... 5.0000-005

FLUX CONVERGENCE CRITERION (DELTA)... 1.0000-005

PROB, NO. 1.00000+000 2DCANDID DIMENSION SEARCH, RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 13

CONTROL VALUE (X) = 1.444000+000 NXT = 0 NINT = 0

PROB, NO. 1.00000+000 2DCANDID DIMENSION SEARCH, RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 2

REACTOR GEOMETRY

GEOMETRY TYPE	LEFT BOUND	RIGHT BOUND	BOTTOM BOUND	TOP BOUND
RZ WITHOUT INVERSION	0.0000+000	7.8100+001	0.0000+000	6.0000+001

REGION BOUNDARIES

REGION NO.	LEFT BDRY.	RIGHT BDRY.	BOTTOM BDRY.	TOP BDRY.
1	0.0000+000	2.3168+001	0.0000+000	6.0000+001
2	2.3168+001	2.5902+001	0.0000+000	6.0000+001
3	2.5902+001	7.8100+001	0.0000+000	6.0000+001

MESH DEFINITION

INCREMENT METHOD - X(R) DIRECTION

X(R)	INCREMENTS	X(R)	INCREMENTS	X(R)	INCREMENTS	X(R)	INCREMENT	X(R)
0.0000+000	12	2.3168+001	3	2.5902+001	12	7.8100+001		

IMAX = 27

X(R) PLUS DELTA X(R) FROM LEFT TO RIGHT OF REACTOR

MESH NO.	1	2	3	4	5	6	7	8	9	10
ABSCISSA	1.9307+000	3.8613+000	5.7920+000	7.7227+000	9.6533+000	1.1584+001	1.3515+001	1.5445+001	1.7376+001	1.9307+001
MESH NO.	11	12	13	14	15	16	17	18	19	20
ABSCISSA	2.1237+001	2.3168+001	2.4079+001	2.4991+001	2.5902+001	3.0252+001	3.4602+001	3.8951+001	4.3301+001	4.7651+001
MESH NO.	21	22	23	24	25	26	27			
ABSCISSA	5.2001+001	5.6351+001	6.0701+001	6.5050+001	6.9400+001	7.3750+001	7.8100+001			

```
PROB. NO.   1.00000+000  2DCANDID  DIMENSION SEARCH, RZ, TWO GROUPS, 20 X 27 MESH        PAGE NO.    4
                                        MESH DEFINITION


                              INCREMENT METHCD - Y(Z) DIRECTION

         Y(Z)  INCREMENTS        Y(Z)  INCREMENTS        Y(Z)  INCREMENTS        Y(Z)  INCREMENTS        Y(Z)

     0.0000+000    20         6.0000+001

    JMAX =    20


                         Y(Z) PLUS DELTA Y(Z) FRCM BOTTOM TO TOP OF REACTOR

Y(Z) MESH NO.       1          2          3          4          5          6          7          8          9         10
 ORDINATE 3.0000+000 6.0000+000 9.0000+000 1.2000+001 1.5000+001 1.8000+001 2.1000+001 2.4000+001 2.7000+001 3.0000+001

Y(Z) MESH NO.      11         12         13         14         15         16         17         18         19         20
 ORDINATE 3.3000+001 3.6000+001 3.9000+001 4.2000+001 4.5000+001 4.8000+001 5.1000+001 5.4000+001 5.7000+001 6.0000+001


    PROB. NO.   1.00000+000  2DCANDID  DIMENSION SEARCH, RZ, TWO GROUPS, 20 X 27 MESH        PAGE NO.   23
                      THE LAST Y(Z) COORDINATES USED IN THIS PROBLEM ARE GIVEN BELOW.
                      NOTE - Y(Z) BOTTOM =   0.0000+000

 MESH NO.           1          2          3          4          5          6          7          8          9         10
 ORDINATE 3.2166+000 6.4332+000 9.6498+000 1.2866+001 1.6083+001 1.9300+001 2.2516+001 2.5733+001 2.8949+001 3.2166+001

 MESH NO.          11         12         13         14         15         16         17         18         19         20
 ORDINATE 3.5383+001 3.8599+001 4.1816+001 4.5032+001 4.8249+001 5.1466+001 5.4682+001 5.7899+001 6.1115+001 6.4332+001

CANDID2D IS PREPARING X SECTIONS AND COEFFICIENTS ON LUN   43
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PROB. NO. 1.00000+000 2DCANDID DIMENSION SEARCH, RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 24

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	9.7052596-001	6.6329144-002	3.1440882+000	1.6001128-001	1.0000000+000	1.0000000+000	3.0777590+000
4.604							
2	9.5549969-001	2.3727288-001	1.2502260+000	9.5238998-002	1.0000000+000	1.0000000+000	1.0129531+000
3	9.4885777-001	4.3435897-001	1.1342587+000	7.0901127-002	1.0000000+000	1.0000000+000	6.9989977-001
4	9.4756525-001	5.5918884-001	1.0899794+000	5.8765122-002	1.0000000+000	1.0000000+000	5.3079057-001
5	9.4982784-001	6.3999222-001	1.0673236+000	5.1152899-002	1.0000000+000	1.0000000+000	4.2733140-001
6	9.5442377-001	7.0154760-001	1.0537236+000	4.5551726-002	1.0000000+000	1.0000000+000	3.5217598-001
7	9.6050041-001	7.5294330-001	1.0469086+000	4.1034577-002	1.0000000+000	1.0000000+000	2.9396533-001
8	9.6744533-001	7.9718329-001	1.0442636+000	3.7201811-002	1.0000000+000	1.0000000+000	2.47[illegible]8034-001
9	9.7481008-001	8.3519415-001	1.0417356+000	3.3851776-002	1.0000000+000	1.0000000+000	2.0654141-001
10	9.8226053-001	8.6684379-001	1.0393630+000	3.0867123-002	1.0000000+000	1.0000000+000	1.7251916-001
11	9.8953977-001	8.8691789-001	1.0371593+000	2.8169426-002	1.0000000+000	1.0000000+000	1.5024138-001
12	9.9642263-001	8.9416112-001	1.0346438+000	2.5693228-002	1.0000000+000	1.0000000+000	1.4048266-001
13	1.0027509+000	8.9993725-001	1.0317438+000	2.3392236-002	1.0000000+000	1.0000000+000	1.318[illegible]652-001
14	1.0084387+000	9.0505383-001	1.0286574+000	2.1257319-002	1.0000000+000	1.0000000+000	1.236[illegible]354-001
15	1.0134558+000	9.0856927-001	1.0255798+000	1.9293229-002	1.0000000+000	1.0000000+000	1.17[illegible]1057-001
16	1.0178108+000	9.1174683-001	1.0226440+000	1.7778727-002	9.0760404-001	1.0157358+000	1.1089720-001
17	1.0215300+000	9.1500944-001	1.0198869+000	1.8295565-002	9.0760404-001	1.1532902+000	1.0487751-001
18	1.0245993+000	9.1883110-001	1.0170744+000	2.1406420-002	9.0760404-001	1.5068170+000	9.8243332-002
19	1.0269399+000	9.2408210-001	1.0152860+000	2.8754356-002	9.0760404-001	2.3323867+000	9.12[illegible]3878-002
20	1.0283674+000	9.3290515-001	1.0132723+000	4.4115122-002	9.0760404-001	4.4383000+000	8.0367111-002
21	1.0285543+000	9.5231395-001	1.0101569+000	6.1825005-002	9.0760404-001	9.2713734+000	5.7842958-002
22	1.0276902+000	9.7759903-001	1.0062390+000	3.0910585-003	9.0760404-001	1.0000000+000	2.8639953-002
23	1.0269160+000	9.7853851-001	1.0057638+000	2.9002621-003	9.0760404-001	1.0000000+000	2.7225297-002
24	1.0262197+000	9.7939345-001	1.0053407+000	2.7254182-003	9.0760404-001	1.0000000+000	2.5947279-002
25	1.0255914+000	9.8022186-001	1.0049552+000	2.6043499-003	9.0760404-001	1.0157358+000	2.4733338-002
26	1.0250237+000	9.8104171-001	1.0045972+000	2.7821125-003	9.0760404-001	1.1532902+000	2.3555512-002
27	1.0245134+000	9.8195274-001	1.0042210+000	3.3947643-003	9.0760404-001	1.5068170+000	2.2268238-002
28	1.0240626+000	9.8311897-001	1.0037695+000	4.8099436-003	9.0760404-001	2.3323867+000	2.065[illegible]567-002
29	1.0236785+000	9.8488407-001	1.0032896+000	7.9824661-003	9.0760404-001	4.4383000+000	1.8465506-002
30	1.0233741+000	9.8813737-001	1.0024926+000	1.2749399-002	9.0760404-001	9.2713734+000	1.4355185-002
31	1.0231599+000	9.9424449-001	1.0012415+000	7.2595869-004	9.0760404-001	1.0000000+000	6.9969855-003
32	1.0229652+000	9.9457359-001	1.0011762+000	6.8338314-004	9.0760404-001	1.0000000+000	6.6025942-003
33	1.0227832+000	9.9488416-001	1.0011156+000	6.4808622-004	9.0760404-001	1.0000000+000	6.2314630-003
34	1.0226128+000	9.9517737-001	1.0010588+000	6.2448102-004	9.0760404-001	1.0157358+000	5.8814219-003
35	1.0224541+000	9.9545863-001	1.0010044+000	6.7161038-004	9.0760404-001	1.1532902+000	5.5458013-003
36	1.0223072+000	9.9576009-001	1.0009460+000	8.2487260-004	9.0760404-001	1.5068170+000	5.1859350-003
37	1.0221736+000	9.9612909-001	1.0008740+000	1.1774291-003	9.0760404-001	2.3323867+000	4.7448846-003
38	1.0220566+000	9.9665354-001	1.0007704+000	1.9725234-003	9.0760404-001	4.4383000+000	4.1168519-003
39	1.0219654+000	9.9752537-001	1.0005958+000	3.1864231-003	9.0760404-001	9.2713734+000	3.0704109-003
40	1.0219167+000	9.9889265-001	1.0003147+000	1.8115272-004	9.0760404-001	1.0000000+000	1.422[illegible]516-003
41	1.0218718+000	9.9895768-001	1.0002996+000	1.7210671-004	9.0760404-001	1.0000000+000	1.3419140-003
42	1.0218310+000	9.9901904-001	1.0002855+000	1.6296316-004	9.0760404-001	1.0000000+000	1.2664864-003
43	1.0217942+000	9.9907693-001	1.0002723+000	1.5668051-004	9.0760404-001	1.0157358+000	1.1953475-003
44	1.0217611+000	9.9913238-001	1.0002595+000	1.6834519-004	9.0760404-001	1.1532902+000	1.1271522-003

45	1.0217316+000	9.9919170-001	1.0002458+000	2.0661518-004	9.0760404-001	1.5068170+000	1.054[illegible]832-003
46	1.0217064+000	9.9926409-001	1.0002288+000	2.9464265-004	9.0760404-001	2.3323867+000	9.6466494-004
47	1.0216866+000	9.9936648-001	1.0002042+000	4.9275447-004	9.0760404-001	4.4383000+000	8.377[illegible]079-004
48	1.0216755+000	9.9953522-001	1.0001625+000	7.9289569-004	9.0760404-001	9.2713734+000	6.2729736-004
49	1.0216785+000	9.9979688-001	1.0000948+000	4.5183240-005	9.0760404-001	1.0000000+000	2.9791650-004
50	1.0216820+000	9.9980962-001	1.0000909+000	4.3083609-005	9.0760404-001	1.0000000+000	2.8128290-004
51	1.0216861+000	9.9982163-001	1.0000872+000	4.1014641-005	9.0760404-001	1.0000000+000	2.6557595-004
52	1.0216909+000	9.9983294-001	1.0000837+000	3.9666333-005	9.0760404-001	1.0157058+000	2.5073742-004
53	1.0216962+000	9.9984375-001	1.0000803+000	4.2885544-005	9.0760404-001	1.1532902+000	2.365[illegible]046-004
54	1.0217020+000	9.9985530-001	1.0000766+000	5.3033485-005	9.0760404-001	1.5068170+000	2.2125212-004
55	1.0217086+000	9.9986938-001	1.0000720+000	7.6465318-005	9.0760404-001	2.3323867+000	2.0262715-004
56	1.0217163+000	9.9988926-001	1.0000655+000	1.3061693-004	9.0760404-001	4.4383000+000	1.7627073-004
57	1.0217261+000	9.9992194-001	1.0000547+000	2.2419544-004	9.0760404-001	9.2713734+000	1.3278832-004
58	1.0217396+000	9.9997067-001	1.0000374+000	1.7811546-005	9.0760404-001	1.0000000+000	6.6716078-005
59	1.0217528+000	9.9997284-001	1.0000362+000	1.7230024-005	9.0760404-001	1.0000000+000	6.338[illegible]809-005
60	1.0217658+000	9.9997500-001	1.0000351+000	1.6689240-005	9.0760404-001	1.0000000+000	6.3051767-005
61	1.0217785+000	9.9997709-001	1.0000339+000	1.6174166-005	9.0760404-001	1.0000000+000	5.6819583-005
62	1.0217910+000	9.9997904-001	1.0000328+000	1.5942094-005	9.6913734-001	1.0167885+000	5.3751632-005
63	1.0218033+000	9.9998090-001	1.0000317+000	1.7714563-005	9.6913734-001	1.1654018+000	5.0802017-005

A CONTROL CHANGE WILL BE MADE USING KEFF= 1.0221076+000

FNTH	FNM1	TAUNTH	TAUNM1	DELKNTH	DELKNM1
5.0802017-005	5.3751632-005	-3.1967269-003	-3.2089744-003	1.2247532-005	1.2489152-005

X	Y	YP	YPP	GAMMA	RTO	TEST
6.2000000+001	1.0217910+000	1.2368342-005	-2.4162000-007	1.0221076+000	5.1189232+001	6.3306552-004

LOGICAL BRANCH TRACE BY STATEMENT NUMBER THRU CNVGCRIT

BRANCH NO	STATEMENT NO
1	30
2	35
3	40
4	45
5	55
6	80
7	105
8	107
9	110
10	115
11	120

CONTROL VALUE (X) = 1.500000+000 NXT = 0 NINT = 0

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PROB, NO,   1.00000+000   2DCANDID  DIMENSION SEARCH, RZ, TWO GROUPS, 20 X 27 MESH          PAGE NO.   26

                          THE LAST Y(Z) COORDINATES USED IN THIS PROBLEM ARE GIVEN BELOW.
                          NOTE - Y(Z) BOTTOM =   0.0000+000

MESH NO.           1          2          3          4          5          6          7          8          9         10
ORDINATE 3.2250+000 6.4500+000 9.6750+000 1.2900+001 1.6125+001 1.9350+001 2.2575+001 2.5800+001 2.9025+001 3.2250+001

MESH NO.          11         12         13         14         15         16         17         18         19         20
ORDINATE 3.5475+001 3.8700+001 4.1925+001 4.5150+001 4.8375+001 5.1600+001 5.4825+001 5.8050+001 6.1275+001 6.4500+001

CANDID2D IS PREPARING X SECTIONS AND COEFFICIENTS ON LUN   55


PROB, NO,   1.00000+000   2DCANDID  DIMENSION SEARCH, RZ, TWO GROUPS, 20 X 27 MESH          PAGE NO.   27

     ITERATION HISTORY
ITERATION   K-EFFECTIVE      K-LOWER          K-UPPER      CHANGE IN PHI      SIGMA          ALPHA          ERRLAM
        1  1.0221485+000  1.0000006+000  1.0004925+000  4.6467302-005  1.0000000+000  1.0000000+000  4.9182936-004
    4,441
        2  1.0221880+000  1.0000050+000  1.0003655+000  4.2315767-005  1.0000000+000  1.0000000+000  3.6554204-004
        3  1.0222261+000  1.0000087+000  1.0003186+000  3.9759127-005  1.0000000+000  1.0000000+000  3.0985600-004
        4  1.0222630+000  1.0000113+000  1.0002829+000  3.7874628-005  1.0000000+000  1.0000000+000  2.7158402-004
        5  1.0222986+000  1.0000121+000  1.0002512+000  3.6333739-005  1.0000000+000  1.0000000+000  2.3915750-004
        6  1.0223332+000  1.0000127+000  1.0002221+000  3.4989745-005  1.0000000+000  1.0000000+000  2.0946717-004
        7  1.0223667+000  1.0000130+000  1.0001956+000  3.3771488-005  1.0000000+000  1.0000000+000  1.8263160-004
        8  1.0223992+000  1.0000132+000  1.0001718+000  3.2640844-005  1.0000000+000  1.0000000+000  1.5858124-004
        9  1.0224306+000  1.0000134+000  1.0001507+000  3.1575769-005  1.0000000+000  1.0000000+000  1.3729758-004
       10  1.0224611+000  1.0000134+000  1.0001321+000  3.0562673-005  1.0000000+000  1.0000000+000  1.1867128-004
       11  1.0224906+000  1.0000134+000  1.0001159+000  2.9592621-005  1.0000000+000  1.0000000+000  1.0251999-004
       12  1.0225193+000  1.0000134+000  1.0001020+000  2.8659067-005  1.0000000+000  1.0000000+000  8.8625733-005
       13  1.0225470+000  1.0000133+000  1.0000900+000  2.7757329-005  1.0000000+000  1.0000000+000  7.6757802-005
       14  1.0225738+000  1.0000131+000  1.0000798+000  2.6884718-005  1.0000000+000  1.0000000+000  6.6692010-005
       15  1.0225998+000  1.0000128+000  1.0000710+000  2.6040217-005  1.0000000+000  1.0000000+000  5.8268284-005
       16  1.0226250+000  1.0000124+000  1.0000636+000  2.5647139-005  9.6858806-001  1.0167788+000  5.1188574-005
       17  1.0226494+000  1.0000120+000  1.0000571+000  2.8476237-005  9.6858806-001  1.1652926+000  4.5097549-005
       18  1.0226730+000  1.0000118+000  1.0000510+000  3.6948845-005  9.6858806-001  1.5599395+000  3.9181410-005
       19  1.0226960+000  1.0000117+000  1.0000455+000  5.8887073-005  9.6858806-001  2.5617283+000  3.3822871-005
       20  1.0227184+000  1.0000119+000  1.0000430+000  1.2923698-004  9.6858806-001  5.7717265+000  3.1188887-005
       21  1.0227407+000  1.0000133+000  1.0000379+000  4.6195375-004  9.6858806-001  2.0870786+001  2.4637615-005
       22  1.0227650+000  1.0000205+000  1.0000308+000  2.3890014-005  9.6858806-001  1.0000000+000  1.0355870-005
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23	1.0227887+000	1.0000208+000	1.0000284+000	2.3141324-005	9.6858806-001	1.0000000+000	7.5347198-006
24	1.0228115+000	1.0000211+000	1.0000262+000	2.2397352-005	9.6858806-001	1.0000000+000	5.1484967-006
25	1.0228337+000	1.0000207+000	1.0000243+000	2.1670705-005	9.6858806-001	1.0000000+000	3.6194979-006
26	1.0228551+000	1.0000191+000	1.0000237+000	2.1313356-005	9.6755655-001	1.0167606+000	4.5506167-006
27	1.0228758+000	1.0000178+000	1.0000235+000	2.3618125-005	9.6755655-001	1.1650875+000	5.7004800-006
28	1.0228958+000	1.0000168+000	1.0000233+000	3.0559909-005	9.6755655-001	1.5590099+000	6.4903579-006
29	1.0229152+000	1.0000163+000	1.0000230+000	4.8472940-005	9.6755655-001	2.5574748+000	6.7489163-006
30	1.0229339+000	1.0000164+000	1.0000225+000	1.0518160-004	9.6755655-001	5.7425448+000	6.0774910-006
31	1.0229519+000	1.0000169+000	1.0000214+000	3.6103836-004	9.6755655-001	2.0438282+001	4.4848712-006
32	1.0229698+000	1.0000141+000	1.0000243+000	1.7498772-005	9.6755655-001	1.0000000+000	1.0252930-005
33	1.0229870+000	1.0000149+000	1.0000222+000	1.6894417-005	9.6755655-001	1.0000000+000	7.2693510-006
34	1.0230036+000	1.0000149+000	1.0000203+000	1.6278935-005	9.6755655-001	1.0000000+000	5.4387492-006
35	1.0230197+000	1.0000148+000	1.0000188+000	1.5749452-005	9.6755655-001	1.0000000+000	3.9907754-006
36	1.0230353+000	1.0000145+000	1.0000178+000	1.5503533-005	9.6747436-001	1.0167592+000	3.3468823-006
37	1.0230503+000	1.0000137+000	1.0000177+000	1.7195889-005	9.6747436-001	1.1650712+000	3.9850129-006
38	1.0230649+000	1.0000129+000	1.0000175+000	2.2271788-005	9.6747436-001	1.5589358+000	4.6330097-006
39	1.0230790+000	1.0000124+000	1.0000173+000	3.5366789-005	9.6747436-001	2.5571365+000	4.8928778-006
40	1.0230927+000	1.0000124+000	1.0000169+000	7.6846037-005	9.6747436-001	5.7402321+000	4.4804183-006
41	1.0231059+000	1.0000124+000	1.0000160+000	2.6406515-004	9.6747436-001	2.0404587+001	3.5727571-006
42	1.0231190+000	1.0000104+000	1.0000179+000	1.2903741-005	9.6747436-001	1.0000000+000	7.4967102-006
43	1.0231317+000	1.0000111+000	1.0000163+000	1.2453492-005	9.6747436-001	1.0000000+000	5.2403775-006
44	1.0231440+000	1.0000110+000	1.0000149+000	1.1993477-005	9.6747436-001	1.0000000+000	3.9017759-006
45	1.0231558+000	1.0000109+000	1.0000138+000	1.1601176-005	9.6747436-001	1.0000000+000	2.8935319-006

A CONTROL CHANGE WILL BE MADE USING KEFF= 1.0233260+000

FNTH	FNM1	TAUNTH	TAUNM1	DELKNTH	DELKNM1
2.8935319-006	3.9017759-006	-1.8441939-003	-1.8560324-003	1.1838507-005	1.2236414-005

X	Y	YP	YPP	GAMMA	RTO	TEST
4.4000000+001	1.0231440+000	1.2037461-005	-3.9790757-007	1.0233260+000	3.0251902+001	3.6405660-004

LOGICAL BRANCH TRACE BY STATEMENT NUMBER THRU CNVGCRIT

BRANCH NO	STATEMENT NO
1	30
2	35
3	40
4	45
5	55
6	80
7	105
8	107
9	110
10	115
11	120

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    PROB. NO.   1.00000+000  2DCANDID  DIMENSION SEARCH, RZ, TWO GROUPS, 20 X 27 MESH          PAGE NO.   28
CONTROL VALUE (X) =   1.576935+000     NXT =     0     NINT =     0


    PROB. NO.   1.00000+000  2DCANDID  DIMENSION SEARCH, RZ, TWO GROUPS, 20 X 27 MESH          PAGE NO.   29
                                    THE LAST Y(Z) COORDINATES USED IN THIS PROBLEM ARE GIVEN BELOW.
                                    NOTE - Y(Z) BOTTOM =   0.0000+000

 MESH NO.          1          2          3          4          5          6          7          8          9         10
 ORDINATE 3.2365+000 6.4731+000 9.7096+000 1.2946+001 1.6183+001 1.9419+001 2.2656+001 2.5892+001 2.9129+001 3.2365+001

 MESH NO.         11         12         13         14         15         16         17         18         19         20
 ORDINATE 3.5602+001 3.8838+001 4.2075+001 4.5312+001 4.8548+001 5.1785+001 5.5021+001 5.6258+001 6.1494+001 6.4731+001

CANDID2D IS PREPARING X SECTIONS AND COEFFICIENTS ON LUN   43
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PROB. NO. 1.00000+000 2DCANDID DIMENSION SEARCH, RZ, TWO GROUPS, 20 X 27 MESH PAGE NO. 30

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	1.0233855+000	1.0000320+000	1.0006601+000	6.4984712-005	1.0000000+000	1.0000000+000	6.2813351-004
4,445							
2	1.0234428+000	1.0000373+000	1.0004887+000	5.9428703-005	1.0000000+000	1.0000000+000	4.5142288-004
3	1.0234979+000	1.0000396+000	1.0004260+000	5.5887757-005	1.0000000+000	1.0000000+000	3.8641508-004
4	1.0235510+000	1.0000414+000	1.0003780+000	5.3186870-005	1.0000000+000	1.0000000+000	3.3659299-004
5	1.0236023+000	1.0000424+000	1.0003348+000	5.0916839-005	1.0000000+000	1.0000000+000	2.9239207-004
6	1.0236517+000	1.0000423+000	1.0002951+000	4.8897568-005	1.0000000+000	1.0000000+000	2.5276220-004
7	1.0236995+000	1.0000415+000	1.0002588+000	4.7042814-005	1.0000000+000	1.0000000+000	2.1720785-004
8	1.0237455+000	1.0000408+000	1.0002260+000	4.5306940-005	1.0000000+000	1.0000000+000	1.8527388-004
9	1.0237899+000	1.0000395+000	1.0001970+000	4.3663578-005	1.0000000+000	1.0000000+000	1.5754232-004
10	1.0238327+000	1.0000383+000	1.0001715+000	4.2096272-005	1.0000000+000	1.0000000+000	1.3324924-004
11	1.0238741+000	1.0000370+000	1.0001494+000	4.0593996-005	1.0000000+000	1.0000000+000	1.1240717-004
12	1.0239139+000	1.0000357+000	1.0001303+000	3.9147924-005	1.0000000+000	1.0000000+000	9.4660500-005
13	1.0239524+000	1.0000345+000	1.0001140+000	3.7751532-005	1.0000000+000	1.0000000+000	7.9545483-005
14	1.0239894+000	1.0000332+000	1.0001001+000	3.6401241-005	1.0000000+000	1.0000000+000	6.6900422-005
15	1.0240251+000	1.0000320+000	1.0000883+000	3.5096319-005	1.0000000+000	1.0000000+000	5.6288060-005
16	1.0240596+000	1.0000308+000	1.0000782+000	3.4402910-005	9.6415173-001	1.0167007+000	4.7390815-005
17	1.0240928+000	1.0000297+000	1.0000696+000	3.7990349-005	9.6415173-001	1.1644111+000	3.9899198-005
18	1.0241247+000	1.0000287+000	1.0000614+000	4.8946537-005	9.6415173-001	1.5559491+000	3.2762124-005
19	1.0241556+000	1.0000278+000	1.0000528+000	7.7153411-005	9.6415173-001	2.5435343+000	2.5040383-005
20	1.0241853+000	1.0000270+000	1.0000492+000	1.6536652-004	9.6415173-001	5.6482807+000	2.2210035-005
21	1.0242143+000	1.0000258+000	1.0000438+000	5.4441813-004	9.6415173-001	1.9129745+001	1.7989660-005
22	1.0242440+000	1.0000247+000	1.0000380+000	2.9236675-005	9.6415173-001	1.0000000+000	1.3317476-005
23	1.0242729+000	1.0000252+000	1.0000351+000	2.8341350-005	9.6415173-001	1.0000000+000	9.8722812-006
24	1.0243009+000	1.0000254+000	1.0000325+000	2.7450885-005	9.6415173-001	1.0000000+000	7.0921378-006
25	1.0243280+000	1.0000250+000	1.0000303+000	2.6580169-005	9.6415173-001	1.0000000+000	5.3055701-006
26	1.0243543+000	1.0000240+000	1.0000296+000	2.6161594-005	9.6828094-001	1.0167734+000	5.5650598-006
27	1.0243797+000	1.0000224+000	1.0000294+000	2.9015460-005	9.6828094-001	1.1652315+000	6.9487432-006
28	1.0244042+000	1.0000212+000	1.0000291+000	3.7586108-005	9.6828094-001	1.5596626+000	7.8984303-006
29	1.0244280+000	1.0000205+000	1.0000287+000	5.9726778-005	9.6828094-001	2.5604604+000	8.2022161-006
30	1.0244510+000	1.0000207+000	1.0000281+000	1.3012900-004	9.6828094-001	5.7630070+000	7.3642295-006
31	1.0244733+000	1.0000208+000	1.0000267+000	4.5313222-004	9.6828094-001	2.0740111+001	5.8620644-006
32	1.0244955+000	1.0000175+000	1.0000302+000	2.1797057-005	9.6828094-001	1.0000000+000	1.2672303-005
33	1.0245169+000	1.0000185+000	1.0000275+000	2.1043264-005	9.6828094-001	1.0000000+000	9.0029498-006
34	1.0245376+000	1.0000185+000	1.0000252+000	2.0280621-005	9.6828094-001	1.0000000+000	6.7179499-006
35	1.0245576+000	1.0000184+000	1.0000233+000	1.9621351-005	9.6828094-001	1.0000000+000	4.8848742-006
36	1.0245770+000	1.0000180+000	1.0000221+000	1.9315224-005	9.6749259-001	1.0167595+000	4.0733430-006
37	1.0245957+000	1.0000170+000	1.0000219+000	2.1423917-005	9.6749259-001	1.1650748+000	4.9410446-006
38	1.0246138+000	1.0000160+000	1.0000217+000	2.7747963-005	9.6749259-001	1.5589523+000	5.7461148-006
39	1.0246314+000	1.0000153+000	1.0000214+000	4.4062409-005	9.6749259-001	2.5572115+000	6.0697203-006
40	1.0246484+000	1.0000153+000	1.0000209+000	9.5737450-005	9.6749259-001	5.7407450+000	5.5600831-006
41	1.0246648+000	1.0000154+000	1.0000198+000	3.2898390-004	9.6749259-001	2.0412052+001	4.3958426-006
42	1.0246811+000	1.0000129+000	1.0000222+000	1.6062597-005	9.6749259-001	1.0000000+000	9.2873815-006
43	1.0246969+000	1.0000137+000	1.0000202+000	1.5501378-005	9.6749259-001	1.0000000+000	6.5140484-006

44	1.0247121+000	1.0000137+000	1.0000185+000	1.4929347-005	9.6749259-001	1.0000000+000	4.8596121-006
45	1.0247269+000	1.0000135+000	1.0000171+000	1.4441428-005	9.6749259-001	1.0000000+000	3.5958074-006
46	1.0247411+000	1.0000133+000	1.0000163+000	1.4215536-005	9.6731810-001	1.0167564+000	3.0023220-006
47	1.0247549+000	1.0000125+000	1.0000161+000	1.5766799-005	9.6731810-001	1.1650401+000	3.6155689-006
48	1.0247682+000	1.0000118+000	1.0000160+000	2.0419446-005	9.6731810-001	1.5587951+000	4.2074244-006
49	1.0247812+000	1.0000113+000	1.0000157+000	3.2419914-005	9.6731810-001	2.5564935+000	4.4461049-006
50	1.0247937+000	1.0000113+000	1.0000154+000	7.0406947-005	9.6731810-001	5.7358408+000	4.0727027-006
51	1.0248057+000	1.0000113+000	1.0000146+000	2.4137482-004	9.6731810-001	2.0340839+001	3.2472017-006
52	1.0248178+000	1.0000095+000	1.0000163+000	1.1825563-005	9.6731810-001	1.0000000+000	6.7757792-006
53	1.0248294+000	1.0000101+000	1.0000149+000	1.1415252-005	9.6731810-001	1.0000000+000	4.7827489-006
54	1.0248406+000	1.0000101+000	1.0000136+000	1.0995768-005	9.6731810-001	1.0000000+000	3.5596022-006
55	1.0248514+000	1.0000100+000	1.0000126+000	1.0636371-005	9.6731810-001	1.0000000+000	2.6400376-006
56	1.0248619+000	1.0000098+000	1.0000120+000	1.0469958-005	9.6731490-001	1.0167564+000	2.2201857-006
57	1.0248721+000	1.0000092+000	1.0000119+000	1.1612410-005	9.6731490-001	1.1650395+000	2.6716443-006
58	1.0248819+000	1.0000087+000	1.0000118+000	1.5038974-005	9.6731490-001	1.5587922+000	3.1058735-006
59	1.0248914+000	1.0000083+000	1.0000116+000	2.3877098-005	9.6731490-001	2.5564804+000	3.2801472-006
60	1.0249006+000	1.0000083+000	1.0000113+000	5.1853695-005	9.6731490-001	5.7357508+000	3.0039228-006
61	1.0249095+000	1.0000083+000	1.0000107+000	1.7776632-004	9.6731490-001	2.0339536+001	2.3961184-006
62	1.0249184+000	1.0000070+000	1.0000120+000	8.7103664-006	9.6731490-001	1.0000000+000	5.0469826-006
63	1.0249269+000	1.0000074+000	1.0000109+000	8.4074899-006	9.6731490-001	1.0000000+000	3.5472040-006
64	1.0249352+000	1.0000074+000	1.0000100+000	8.0985807-006	9.6731490-001	1.0000000+000	2.6216730-006
65	1.0249431+000	1.0000073+000	1.0000093+000	7.8342898-006	9.6731490-001	1.0000000+000	1.9434374-006
66	1.0249509+000	1.0000072+000	1.0000088+000	7.7116541-006	9.6736577-001	1.0167573+000	1.6343838-006
67	1.0249583+000	1.0000068+000	1.0000088+000	8.5531445-006	9.6736577-001	1.1650496+000	1.9667496-006
68	1.0249656+000	1.0000064+000	1.0000087+000	1.1077206-005	9.6736577-001	1.5588381+000	2.2864842-006
69	1.0249726+000	1.0000061+000	1.0000085+000	1.7587963-005	9.6736577-001	2.5566897+000	2.4147157-006
70	1.0249794+000	1.0000061+000	1.0000083+000	3.8201890-005	9.6736577-001	5.7371798+000	2.2113090-006
71	1.0249859+000	1.0000061+000	1.0000079+000	1.3106516-004	9.6736577-001	2.0360245+001	1.7644488-006
72	1.0249924+000	1.0000051+000	1.0000088+000	6.4143492-006	9.6736577-001	1.0000000+000	3.7035788-006
73	1.0249987+000	1.0000054+000	1.0000081+000	6.1926933-006	9.6736577-001	1.0000000+000	2.6162888-006
74	1.0250048+000	1.0000055+000	1.0000074+000	5.9650454-006	9.6736577-001	1.0000000+000	1.9333092-006
75	1.0250107+000	1.0000054+000	1.0000068+000	5.7700809-006	9.6736577-001	1.0000000+000	1.4338584-006

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I=    1 G=1 J=1 FLUX=  7.7985272-003
I=    2 G=1 J=1 FLUX=  7.7490592-003
I=    3 G=1 J=1 FLUX=  7.6505297-003
I=    4 G=1 J=1 FLUX=  7.5037866-003
I=    5 G=1 J=1 FLUX=  7.3100825-003
I=    6 G=1 J=1 FLUX=  7.0710508-003
I=    7 G=1 J=1 FLUX=  6.7886744-003
I=    8 G=1 J=1 FLUX=  6.4652444-003
I=    9 G=1 J=1 FLUX=  6.1033099-003
I=   10 G=1 J=1 FLUX=  5.7056129-003
I=   11 G=1 J=1 FLUX=  5.2750099-003
I=   12 G=1 J=1 FLUX=  4.8143740-003
I=   13 G=1 J=1 FLUX=  4.4660126-003
I=   14 G=1 J=1 FLUX=  4.2607754-003
I=   15 G=1 J=1 FLUX=  4.0587140-003
I=   16 G=1 J=1 FLUX=  3.0994909-003
```

```
I=   17 G=1 J=1 FLUX=  2.0148563-003
I=   18 G=1 J=1 FLUX=  1.3201280-003
I=   19 G=1 J=1 FLUX=  8.7000607-004
I=   20 G=1 J=1 FLUX=  5.7565127-004
I=   21 G=1 J=1 FLUX=  3.8157592-004
I=   22 G=1 J=1 FLUX=  2.5254322-004
I=   23 G=1 J=1 FLUX=  1.6585976-004
I=   24 G=1 J=1 FLUX=  1.0670934-004
I=   25 G=1 J=1 FLUX=  6.5260251-005
I=   26 G=1 J=1 FLUX=  3.4831566-005
I=   27 G=1 J=1 FLUX=  1.0700660-005

CANDID2D HAS COPIED FLUX FROM LUN   42 ONTO LUN   48

IMAXIN=   27 JMAXIN=   20 IMAXOUT=   27 JMAXOUT=   20
I=    1 G=1 J=1 FLUX=  4.4073824-002
I=    2 G=1 J=1 FLUX=  4.4073824-002
I=    3 G=1 J=1 FLUX=  4.4073824-002
I=    4 G=1 J=1 FLUX=  4.4073824-002
I=    5 G=1 J=1 FLUX=  4.4073824-002
I=    6 G=1 J=1 FLUX=  4.4073824-002
I=    7 G=1 J=1 FLUX=  4.4073824-002
I=    8 G=1 J=1 FLUX=  4.4073824-002
I=    9 G=1 J=1 FLUX=  4.4073824-002
I=   10 G=1 J=1 FLUX=  4.4073824-002
I=   11 G=1 J=1 FLUX=  4.4073824-002
I=   12 G=1 J=1 FLUX=  4.4073824-002
I=   13 G=1 J=1 FLUX=  2.2036912-002
I=   14 G=1 J=1 FLUX=  2.2036912-002
I=   15 G=1 J=1 FLUX=  2.2036912-002
I=   16 G=1 J=1 FLUX=  4.4073824-003
I=   17 G=1 J=1 FLUX=  4.4073824-003
I=   18 G=1 J=1 FLUX=  4.4073824-003
I=   19 G=1 J=1 FLUX=  4.4073824-003
I=   20 G=1 J=1 FLUX=  4.4073824-003
I=   21 G=1 J=1 FLUX=  4.4073824-003
I=   22 G=1 J=1 FLUX=  4.4073824-003
I=   23 G=1 J=1 FLUX=  4.4073824-003
I=   24 G=1 J=1 FLUX=  4.4073824-003
I=   25 G=1 J=1 FLUX=  4.4073824-003
I=   26 G=1 J=1 FLUX=  4.4073824-003
I=   27 G=1 J=1 FLUX=  4.4073824-003

CANDID2D HAS COPIED FLUX FROM LUN   49 ONTO LUN   48

IMAXIN=   27 JMAXIN=   20 IMAXOUT=   27 JMAXOUT=   20

CANDID2D IS PREPARING X SECTIONS ONLY ON LUN   48
```

4. Sample Problem 4

a. Description

(1) Problem Type

Source calculation with Chebyshev acceleration and $\mu = 1/0.9$.

(2) Configuration

(a) Geometry

$r\theta$ (quarter circle)

(b) Region Definition

The reactor consists of 18 regions as follows:

Region No. 1: Internal thermal column (water).

Region No. 2: Stainless steel shroud.

Regions No. 3-11: Fuel regions composed of enriched uranium, stainless steel, and water.

Region No. 12: Control-rod region composed of zirconium and water.

Regions No. 13-15: Reflector composed of beryllium, aluminum, and water.

Region No. 16: Outer reflector composed of aluminum and water.

Region No. 17: Iron vessel wall.

Region No. 18: Water.

(c) Mesh Definition

r direction: 33 points.

θ direction: three points.

Buckling (B^2) = 0.052360.

(d) Boundary Conditions

Left: $\phi' = 0$.

Right: $\phi = 0$.

Bottom: $\phi' = 0.$

Top: $\phi' = 0.$

(e) Source

Neutron source density in region 15: 1.0.

(f) Number of Energy Groups: 16.

(3) Convergence Criterion

Sum of flux difference $= 10^{-5}$.

b. Output Listing

PROB. NO. 5.00000+000 2DCANDID SOURCE CALC(W/ACC), RT, 16 GROUPS, 33 X 3 MESH PAGE NO. 4

REACTOR GEOMETRY

GEOMETRY TYPE	LEFT BOUND	RIGHT BOUND	BOTTOM BOUND	TOP BOUND
2D - RO	0.0000+000	1.9548+002	0.0000+000	1.5708+000

REGION BOUNDARIES

REGION NO.	LEFT BDRY.	RIGHT BDRY.	BOTTOM BDRY.	TOP BDRY.
1	0.0000+000	6.6290+000	0.0000+000	1.5708+000
2	6.6290+000	6.8310+000	0.0000+000	1.5708+000
3	6.8310+000	7.2028+000	0.0000+000	1.5708+000
4	7.2028+000	7.3818+000	0.0000+000	1.5708+000
5	7.3818+000	7.5578+000	0.0000+000	1.5708+000
6	7.5578+000	7.7277+000	0.0000+000	1.5708+000
7	7.7277+000	7.8951+000	0.0000+000	1.5708+000
8	7.8951+000	8.0591+000	0.0000+000	1.5708+000
9	8.0591+000	2.3674+001	0.0000+000	1.5708+000
10	2.3674+001	2.3869+001	0.0000+000	1.5708+000
11	2.3869+001	2.4261+001	0.0000+000	1.5708+000
12	2.4261+001	2.5291+001	0.0000+000	1.5708+000
13	2.5291+001	3.0891+001	0.0000+000	1.5708+000
14	3.0891+001	4.0291+001	0.0000+000	1.5708+000
15	4.0291+001	4.0491+001	0.0000+000	1.5708+000
16	4.0491+001	4.3091+001	0.0000+000	1.5708+000
17	4.3091+001	5.5791+001	0.0000+000	1.5708+000
18	5.5791+001	1.2309+002	0.0000+000	1.5708+000
19	1.2309+002	1.3452+002	0.0000+000	1.5708+000
20	1.3452+002	1.9548+002	0.0000+000	1.5708+000

MESH DEFINITION

CONSTANT INTERVAL PER REGION METHOD = X(R) DIRECTON

X(R) LEFT	NO, MESH	X(R) RIGHT
0,0000+000	2	6.6290+000
6,6290+000	1	6.8310+000
6,8310+000	2	7.2028+000
7,2028+000	1	7.3818+000
7,3818+000	1	7.5578+000
7,5578+000	1	7.7277+000
7,7277+000	1	7.8951+000
7,8951+000	1	8.0591+000
8,0591+000	3	2.3674+001
2,3674+001	1	2.3869+001
2,3869+001	2	2.4261+001
2,4261+001	1	2.5291+001
2,5291+001	1	3.0891+001
3,0891+001	2	4.0291+001

X(R) LEFT	NO. MESH	X(R) RIGHT
4.0291+001	3	4.0491+001
4.0491+001	2	4.3091+001
4.3091+001	1	5.5791+001
5.5791+001	4	1.2309+002
1.2309+002	1	1.3452+002
1.3452+002	2	1.9548+002

IMAX = 33

X(R) PLUS DELTA X(R) FROM LEFT TO RIGHT OF REACTOR

MESH NO.	1	2	3	4	5	6	7	8	9	10
ABSCISSA	3.3145+000	6.6290+000	6.8310+000	7.0169+000	7.2028+000	7.3818+000	7.5578+000	7.7277+000	7.8951+000	8.0591+000
MESH NO.	11	12	13	14	15	16	17	18	19	20
ABSCISSA	1.3264+001	1.8469+001	2.3674+001	2.3869+001	2.4065+001	2.4261+001	2.5291+001	3.0891+001	3.5591+001	4.0291+001
MESH NO.	21	22	23	24	25	26	27	28	29	30
ABSCISSA	4.0358+001	4.0424+001	4.0491+001	4.1791+001	4.3091+001	5.5791+001	7.2616+001	8.9441+001	1.0627+002	1.2309+002
MESH NO.	31	32	33							
ABSCISSA	1.3452+002	1.6500+002	1.9548+002							

MESH DEFINITION

CONSTANT INTERVAL PER REGION METHOD - Y(Z) DIRECTION

Y(Z) BOTTOM	NO, MESH	Y(Z) TOP
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000
0,0000+000	3	1.5708+000

JMAX = 3

Y(Z) PLUS DELTA Y(Z) FRCM BOTTOM TO TOP OF REACTOR

Y(Z) MESH NO,	1	2	3
ORDINATE	5,2360-001	1,0472+000	1,5708+000

```
   PROB. NO.    5.00000+000  2DCANDID  SOURCE CALC( W/ACC ), RT, 16 GROUPS, 33 X 3 MESH        PAGE NO.    8
  Z                                          REGION MAP                                                           Z
 MESH                                (REGION NUMBER BY MESH POINT)                                              MESH
POINTS                                       R MESH POINTS                                                     POINTS
         1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25
      **************************************************************************************************
      3*  1   1*  2*  3   3*  4*  5*  6*  7*  8*  9   9   9* 10* 11  11* 12* 13* 14  14* 15  15  15* 16  16*  3
      *       *   *       *   *   *   *   *   *           *   *       *   *   *       *           *       *
      2*  1   1*  2*  3   3*  4*  5*  6*  7*  8*  9   9   9* 10* 11  11* 12* 13* 14  14* 15  15  15* 16  16*  2
      *       *   *       *   *   *   *   *   *           *   *       *   *   *       *           *       *
      1*  1   1*  2*  3   3*  4*  5*  6*  7*  8*  9   9   9* 10* 11  11* 12* 13* 14  14* 15  15  15* 16  16*  1
      **************************************************************************************************
         1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25
                                                R MESH POINTS


   PROB. NO.    5.00000+000  2DCANDID  SOURCE CALC( W/ACC ), RT, 16 GROUPS, 33 X 3 MESH        PAGE NO.    9
  Z                                          REGION MAP                                                           Z
 MESH                                (REGION NUMBER BY MESH POINT)                                              MESH
POINTS                                       R MESH POINTS                                                     POINTS
        26  27  28  29  30  31  32  33
      ********************************
      3* 17* 18  18  18  18* 19* 20  20*  3
      *   *               *   *       *
      2* 17* 18  18  18  18* 19* 20  20*  2
      *   *               *   *       *
      1* 17* 18  18  18  18* 19* 20  20*  1
      ********************************
        26  27  28  29  30  31  32  33

                                                R MESH POINTS
```

PROB. NO. 5.00000+000 2DCANDID SOURCE CALC(W/ACC), RT, 16 GROUPS, 33 X 3 MESH PAGE NO. 143

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	1.1111111+000	2.9929286-004	3.1753250+001	1.0180383+000	1.0000000+000	1.0000000+000	3.1753051+001
10.054							
2	1.1111111+000	5.6964586-004	2.3552273+000	4.6202040-001	1.0000000+000	1.0000000+000	2.3546576+000
3	1.1111111+000	8.9369064-003	1.7115041+000	2.2663113-001	1.0000000+000	1.0000000+000	1.7025672+000
4	1.1111111+000	7.7442631-002	1.4046963+000	1.5997858-001	1.0000000+000	1.0000000+000	1.3272536+000
5	1.1111111+000	6.8717976-001	1.2997538+000	1.4676681-001	1.0000000+000	1.0000000+000	6.1257400-001
6	1.1111111+000	8.2964448-001	1.2296130+000	1.4355254-001	1.0000000+000	1.0000000+000	3.9996856-001
7	1.1111111+000	9.0963385-001	1.1823985+000	1.4171337-001	1.0000000+000	1.0000000+000	2.7276460-001
8	1.1111111+000	9.1073017-001	1.1505645+000	1.4249271-001	9.8718817-001	1.0171065+000	2.3983430-001
9	1.1111111+000	9.1226405-001	1.1276390+000	1.6197320-001	9.8718817-001	1.1690032+000	2.1537491-001
10	1.1111111+000	9.1429026-001	1.1083307+000	2.1583471-001	9.8718817-001	1.5768954+000	1.9404048-001
11	1.1111111+000	9.1728440-001	1.0895339+000	3.5566303-001	9.8718817-001	2.6409309+000	1.7224950-001
12	1.1111111+000	9.2308412-001	1.0821272+000	8.3332899-001	9.8718817-001	6.3539592+000	1.5904303-001
13	1.1111111+000	9.4545779-001	1.0466844+000	4.1643848+000	9.8718817-001	3.3748853+001	1.0122657-001
6.6188020-001	2.0839379+000	1.3793172+000	8.4557880-001	1.4092980-001	1.0099471+000	9.9209798-001	
14	1.1111111+000	8.6961200-001	1.2782064+001	9.3797272-002	9.8718817-001	1.0000000+000	1.1912452+001
15	1.1111111+000	9.4713278-001	3.2991359+002	9.4047574-002	9.8718817-001	1.0000000+000	3.2896646+002
16	1.1111111+000	9.8217480-001	5.8665534+001	8.8281673-002	9.8718817-001	1.0000000+000	5.7683359+001
17	1.1111111+000	9.8286259-001	2.4787818+001	8.6627896-002	9.8718817-001	1.0000000+000	2.3804955+001
18	1.1111111+000	9.8349787-001	2.0786244+000	8.5613373-002	9.8718817-001	1.0000000+000	1.0951265+000
19	1.1111111+000	9.8400696-001	1.4978890+000	8.4732859-002	9.8718817-001	1.0000000+000	5.1388199-001
20	1.1111111+000	9.8438364-001	1.3140310+000	8.3893557-002	9.8718817-001	1.0000000+000	3.2964735-001
21	1.1111111+000	9.8468547-001	1.2248033+000	8.3075792-002	9.8718817-001	1.0000000+000	2.4011785-001
22	1.1111111+000	9.8494873-001	1.1725807+000	8.2273974-002	9.8718817-001	1.0000000+000	1.8763193-001
23	1.1111111+000	9.8514660-001	1.1417565+000	8.2886565-002	9.9209798-001	1.0171931+000	1.5660991-001
24	1.1111111+000	9.8532628-001	1.1200422+000	9.4412888-002	9.9209798-001	1.1699866+000	1.3471592-001
25	1.1111111+000	9.8551346-001	1.1026466+000	1.2619849-001	9.9209798-001	1.5814329+000	1.1713315-001
26	1.1111111+000	9.8569458-001	1.0856850+000	2.0930707-001	9.9209798-001	2.6626614+000	9.9990386-002
27	1.1111111+000	9.8585416-001	1.0654040+000	5.0029706-001	9.9209798-001	6.5277813+000	7.9549841-002
28	1.1111111+000	9.8565324-001	1.0373751+000	2.9016638+000	9.9209798-001	4.0315298+001	5.1721857-002
29	1.1111111+000	9.7210734-001	1.0091386+000	4.5960884-002	9.9209798-001	1.0000000+000	3.7031253-002
30	1.1111111+000	9.7278098-001	1.0087735+000	4.5498928-002	9.9209798-001	1.0000000+000	3.5992495-002
31	1.1111111+000	9.7343539-001	1.0084304+000	4.5041483-002	9.9209798-001	1.0000000+000	3.4994972-002
32	1.1111111+000	9.7407545-001	1.0081076+000	4.5355247-002	9.9209798-001	1.0171931+000	3.4032156-002
33	1.1111111+000	9.7471402-001	1.0077985+000	5.1634303-002	9.9209798-001	1.1699866+000	3.3084516-002
34	1.1111111+000	9.7540860-001	1.0074642+000	6.8970440-002	9.9209798-001	1.5814329+000	3.2055625-002

```
AN ERROR WAS ENCOUNTERED IN SUBROUTINE  KEFFCALC  AT STATEMENT NUMBER    692
TIME EXCEEDED
I=    1 G=1 J=1 FLUX=  8.4982643-004
I=    2 G=1 J=1 FLUX=  1.2232943-003
I=    3 G=1 J=1 FLUX=  1.7465989-003
I=    4 G=1 J=1 FLUX=  1.8362845-003
I=    5 G=1 J=1 FLUX=  1.8994976-003
I=    6 G=1 J=1 FLUX=  1.9451367-003
I=    7 G=1 J=1 FLUX=  1.9722676-003
I=    8 G=1 J=1 FLUX=  1.9815773-003
I=    9 G=1 J=1 FLUX=  1.9738310-003
I=   10 G=1 J=1 FLUX=  1.9500125-003
I=   11 G=1 J=1 FLUX=  1.5779214-003
I=   12 G=1 J=1 FLUX=  2.5018939-003
I=   13 G=1 J=1 FLUX=  5.8135126-003
I=   14 G=1 J=1 FLUX=  8.6307246-003
I=   15 G=1 J=1 FLUX=  8.6598988-003
I=   16 G=1 J=1 FLUX=  8.5428021-003
I=   17 G=1 J=1 FLUX=  7.6346384-003
I=   18 G=1 J=1 FLUX=  3.9402336-003
I=   19 G=1 J=1 FLUX=  1.2860468-002
I=   20 G=1 J=1 FLUX=  5.2279473-002
I=   21 G=1 J=1 FLUX=  1.3782368-001
I=   22 G=1 J=1 FLUX=  1.3851501-001
I=   23 G=1 J=1 FLUX=  1.3750601-001
I=   24 G=1 J=1 FLUX=  1.0876293-001
I=   25 G=1 J=1 FLUX=  7.8882572-002
I=   26 G=1 J=1 FLUX=  5.5910969-003
I=   27 G=1 J=1 FLUX=  1.7944309-004
I=   28 G=1 J=1 FLUX=  6.9265856-006
I=   29 G=1 J=1 FLUX=  2.7270039-007
I=   30 G=1 J=1 FLUX=  1.1024579-008
I=   31 G=1 J=1 FLUX=  9.3650820-010
I=   32 G=1 J=1 FLUX=  1.1890924-011
I=   33 G=1 J=1 FLUX=  1.4219336-013

CANDID2D HAS COPIED FLUX FROM LUN    3 ONTO LUN   48
```

```
IMAXIN=    33 JMAXIN=     3 IMAXOUT=    33 JMAXOUT=     3
I=     1 G=1 J=1 FLUX=  2,5984634-003
I=     2 G=1 J=1 FLUX=  2,5984634-003
I=     3 G=1 J=1 FLUX=  2,5984634-003
I=     4 G=1 J=1 FLUX=  2,5984634-003
I=     5 G=1 J=1 FLUX=  2,5984634-003
I=     6 G=1 J=1 FLUX=  2,5984634-003
I=     7 G=1 J=1 FLUX=  2,5984634-003
I=     8 G=1 J=1 FLUX=  2,5984634-003
I=     9 G=1 J=1 FLUX=  2,5984634-003
I=    10 G=1 J=1 FLUX=  2,5984634-003
I=    11 G=1 J=1 FLUX=  2,5984634-003
I=    12 G=1 J=1 FLUX=  2,5984634-003
I=    13 G=1 J=1 FLUX=  2,5984634-003
I=    14 G=1 J=1 FLUX=  2,5984634-003
I=    15 G=1 J=1 FLUX=  2,5984634-003
I=    16 G=1 J=1 FLUX=  2,5984634-003
I=    17 G=1 J=1 FLUX=  2,5984634-003
I=    18 G=1 J=1 FLUX=  2,5984634-003
I=    19 G=1 J=1 FLUX=  2,5984634-003
I=    20 G=1 J=1 FLUX=  2,5984634-003
I=    21 G=1 J=1 FLUX=  2,5984634-003
I=    22 G=1 J=1 FLUX=  2,5984634-003
I=    23 G=1 J=1 FLUX=  2,5984634-003
I=    24 G=1 J=1 FLUX=  2,5984634-003
I=    25 G=1 J=1 FLUX=  2,5984634-003
I=    26 G=1 J=1 FLUX=  2,5984634-003
I=    27 G=1 J=1 FLUX=  2,5984634-003
I=    28 G=1 J=1 FLUX=  2,5984634-003
I=    29 G=1 J=1 FLUX=  2,5984634-003
I=    30 G=1 J=1 FLUX=  2,5984634-003
I=    31 G=1 J=1 FLUX=  2,5984634-003
I=    32 G=1 J=1 FLUX=  2,5984634-003
I=    33 G=1 J=1 FLUX=  2,5984634-003

CANDID2D HAS COPIED FLUX FROM LUN    49 ONTO LUN    48

IMAXIN=    33 JMAXIN=     3 IMAXOUT=    33 JMAXOUT=     3
```

PROB. NO. 5.00000+000 2DCANDID SOURCE CALC(W/ACC), RT, 16 GROUPS, 33 X 3 MESH PAGE NO. 143

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	1.1111111+000	9.7633586-001	1.0070435+000	4.2917830-002	1.0000000+000	1.0000000+000	3.0707613-002
10.017							
2	1.1111111+000	9.7690108-001	1.0067996+000	4.2484860-002	1.0000000+000	1.0000000+000	2.9898517-002
3	1.1111111+000	9.7745727-001	1.0065689+000	4.2055924-002	1.0000000+000	1.0000000+000	2.9111673-002
4	1.1111111+000	9.7800369-001	1.0063506+000	4.1630987-002	1.0000000+000	1.0000000+000	2.8346915-002
5	1.1111111+000	9.7853971-001	1.0061438+000	4.1210011-002	1.0000000+000	1.0000000+000	2.7604046-002
6	1.1111111+000	9.7906479-001	1.0059476+000	4.1492728-002	9.8988792-001	1.0171541+000	2.6882833-002
7	1.1111111+000	9.7958747-001	1.0057583+000	4.7217659-002	9.8988792-001	1.1695438+000	2.6170843-002
8	1.1111111+000	9.8017631-001	1.0055519+000	6.3008262-002	9.8988792-001	1.5793872+000	2.5375632-002
9	1.1111111+000	9.8095534-001	1.0052899+000	1.0413691-001	9.8988792-001	2.6528357+000	2.4334572-002
10	1.1111111+000	9.8223668-001	1.0048856+000	2.4631174-001	9.8988792-001	6.4483759+000	2.2648892-002
11	1.1111111+000	9.8421246-001	1.0043076+000	1.3231098+000	9.8988792-001	3.7068773+001	2.0095105-002
12	1.1111111+000	9.8583967-001	1.0119824+000	2.2323329-002	9.8988792-001	1.0000000+000	2.6142706-002
13	1.1111111+000	9.8620101-001	1.0107151+000	2.2082398-002	9.8988792-001	1.0000000+000	2.4514059-002
14	1.1111111+000	9.8655950-001	1.0095586+000	2.1844032-002	9.8988792-001	1.0000000+000	2.2999124-002
15	1.1111111+000	9.8691462-001	1.0085009+000	2.1978823-002	9.8988792-001	1.0171541+000	2.1586281-002
16	1.1111111+000	9.8727179-001	1.0075150+000	2.4994008-002	9.8988792-001	1.1695438+000	2.0243232-002
17	1.1111111+000	9.8767770-001	1.0064769+000	3.3326081-002	9.8988792-001	1.5793872+000	1.8799213-002
18	1.1111111+000	9.8821878-001	1.0052094+000	5.5020761-002	9.8988792-001	2.6528357+000	1.6990603-002
19	1.1111111+000	9.8911357-001	1.0033516+000	1.2990396-001	9.8988792-001	6.4483759+000	1.4238068-002
20	1.1111111+000	9.9120467-001	1.0020708+000	6.9463547-001	9.8988792-001	3.7068773+001	1.0866081-002
21	1.1111111+000	9.8816790-001	1.0051777+000	1.1237388-002	9.8988792-001	1.0000000+000	1.7009804-002
22	1.1111111+000	9.8856446-001	1.0047478+000	1.1110902-002	9.8988792-001	1.0000000+000	1.6183320-002
23	1.1111111+000	9.8894823-001	1.0043358+000	1.0985801-002	9.8988792-001	1.0000000+000	1.5387583-002
24	1.1111111+000	9.8931933-001	1.0039415+000	1.1048384-002	9.8988792-001	1.0171541+000	1.4622140-002
25	1.1111111+000	9.8968409-001	1.0035579+000	1.2558034-002	9.8988792-001	1.1695438+000	1.3873835-002
26	1.1111111+000	9.9008941-001	1.0031371+000	1.6735137-002	9.8988792-001	1.5793872+000	1.3047739-002
27	1.1111111+000	9.9061629-001	1.0025997+000	2.7608594-002	9.8988792-001	2.6528357+000	1.1983428-002
28	1.1111111+000	9.9145889-001	1.0017649+000	6.5100099-002	9.8988792-001	6.4483759+000	1.0305961-002
29	1.1111111+000	9.9336160-001	1.0009942+000	3.4696573-001	9.8988792-001	3.7068773+001	7.6325987-003
30	1.1111111+000	9.9219812-001	1.0034365+000	5.4378816-003	9.8988792-001	1.0000000+000	1.1238348-002
31	1.1111111+000	9.9246977-001	1.0031416+000	5.3743548-003	9.8988792-001	1.0000000+000	1.0671817-002
32	1.1111111+000	9.9273568-001	1.0028669+000	5.3115636-003	9.8988792-001	1.0000000+000	1.0131219-002
33	1.1111111+000	9.9299505-001	1.0026105+000	5.3395455-003	9.8988792-001	1.0171541+000	9.6154342-003
34	1.1111111+000	9.9325223-001	1.0023669+000	6.0665236-003	9.8988792-001	1.1695438+000	9.1146978-003
35	1.1111111+000	9.9354027-001	1.0021057+000	8.0804036-003	9.8988792-001	1.5793872+000	8.5654491-003
36	1.1111111+000	9.9391757-001	1.0017803+000	1.3321676-002	9.8988792-001	2.6528357+000	7.8626821-003
37	1.1111111+000	9.9445682-001	1.0012907+000	3.1376770-002	9.8988792-001	6.4483759+000	6.8339050-003
38	1.1111111+000	9.9554552-001	1.0004702+000	1.6675752-001	9.8988792-001	3.7068773+001	4.9247063-003
39	1.1111111+000	9.9697750-001	1.0028688+000	2.5458970-003	9.8988792-001	1.0000000+000	5.8912988-003

```
AN ERROR WAS ENCOUNTERED IN SUBROUTINE  KEFFCALC  AT STATEMENT NUMBER    692
TIME EXCEEDED
I=    1 G=1 J=1 FLUX=  3.1616556-004
I=    2 G=1 J=1 FLUX=  4.5423551-004
I=    3 G=1 J=1 FLUX=  6.5871745-004
I=    4 G=1 J=1 FLUX=  6.9780257-004
I=    5 G=1 J=1 FLUX=  7.3223929-004
I=    6 G=1 J=1 FLUX=  7.6566513-004
I=    7 G=1 J=1 FLUX=  7.9767686-004
I=    8 G=1 J=1 FLUX=  8.2844628-004
I=    9 G=1 J=1 FLUX=  8.5796261-004
I=   10 G=1 J=1 FLUX=  8.8638726-004
I=   11 G=1 J=1 FLUX=  1.2891480-003
I=   12 G=1 J=1 FLUX=  3.0260230-003
I=   13 G=1 J=1 FLUX=  7.4462101-003
I=   14 G=1 J=1 FLUX=  1.1416284-002
I=   15 G=1 J=1 FLUX=  1.1447993-002
I=   16 G=1 J=1 FLUX=  1.1254572-002
I=   17 G=1 J=1 FLUX=  9.9862737-003
I=   18 G=1 J=1 FLUX=  4.5816223-003
I=   19 G=1 J=1 FLUX=  1.3505362-002
I=   20 G=1 J=1 FLUX=  5.4520700-002
I=   21 G=1 J=1 FLUX=  1.4357860-001
I=   22 G=1 J=1 FLUX=  1.4426423-001
I=   23 G=1 J=1 FLUX=  1.4314772-001
I=   24 G=1 J=1 FLUX=  1.1325241-001
I=   25 G=1 J=1 FLUX=  8.1306272-002
I=   26 G=1 J=1 FLUX=  5.8219381-003
I=   27 G=1 J=1 FLUX=  1.8685208-004
I=   28 G=1 J=1 FLUX=  7.2125865-006
I=   29 G=1 J=1 FLUX=  2.8396069-007
I=   30 G=1 J=1 FLUX=  1.1479830-008
I=   31 G=1 J=1 FLUX=  9.7518121-010
I=   32 G=1 J=1 FLUX=  1.2381960-011
I=   33 G=1 J=1 FLUX=  1.4702394-013

CANDID2D HAS COPIED FLUX FROM LUN   42 ONTO LUN   48
```

```
IMAXIN=    33 JMAXIN=     3 IMAXOUT=    33 JMAXOUT=     3
I=     1 G=1 J=1 FLUX=  2,5984634-003
I=     2 G=1 J=1 FLUX=  2,5984634-003
I=     3 G=1 J=1 FLUX=  2.5984634-003
I=     4 G=1 J=1 FLUX=  2,5984634-003
I=     5 G=1 J=1 FLUX=  2,5984634-003
I=     6 G=1 J=1 FLUX=  2,5984634-003
I=     7 G=1 J=1 FLUX=  2,5984634-003
I=     8 G=1 J=1 FLUX=  2,5984634-003
I=     9 G=1 J=1 FLUX=  2.5984634-003
I=    10 G=1 J=1 FLUX=  2,5984634-003
I=    11 G=1 J=1 FLUX=  2,5984634-003
I=    12 G=1 J=1 FLUX=  2,5984634-003
I=    13 G=1 J=1 FLUX=  2,5984634-003
I=    14 G=1 J=1 FLUX=  2,5984634-003
I=    15 G=1 J=1 FLUX=  2,5984634-003
I=    16 G=1 J=1 FLUX=  2,5984634-003
I=    17 G=1 J=1 FLUX=  2,5984634-003
I=    18 G=1 J=1 FLUX=  2,5984634-003
I=    19 G=1 J=1 FLUX=  2,5984634-003
I=    20 G=1 J=1 FLUX=  2.5984634-003
I=    21 G=1 J=1 FLUX=  2,5984634-003
I=    22 G=1 J=1 FLUX=  2,5984634-003
I=    23 G=1 J=1 FLUX=  2,5984634-003
I=    24 G=1 J=1 FLUX=  2,5984634-003
I=    25 G=1 J=1 FLUX=  2,5984634-003
I=    26 G=1 J=1 FLUX=  2,5984634-003
I=    27 G=1 J=1 FLUX=  2,5984634-003
I=    28 G=1 J=1 FLUX=  2,5984634-003
I=    29 G=1 J=1 FLUX=  2,5984634-003
I=    30 G=1 J=1 FLUX=  2,5984634-003
I=    31 G=1 J=1 FLUX=  2,5984634-003
I=    32 G=1 J=1 FLUX=  2,5984634-003
I=    33 G=1 J=1 FLUX=  2,5984634-003

CANDID2D HAS COPIED FLUX FROM LUN    49 ONTO LUN    48

IMAXIN=    33 JMAXIN=     3 IMAXOUT=    33 JMAXOUT=     3
```

PROB. NO. 5.00000+000 2DCANDID SOURCE CALC(W/ACC), RT, 16 GROUPS, 33 X 3 MESH PAGE NO. 143

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	1.1111111+000	9.9710296-001	1.0026975+000	2.5154339-003	1.0000000+000	1.0000000+000	5.5944869-003
9.981							
2	1.1111111+000	9.9721976-001	1.0025326+000	2.4853205-003	1.0000000+000	1.0000000+000	5.3128525-003
3	1.1111111+000	9.9733158-001	1.0023747+000	2.4555556-003	1.0000000+000	1.0000000+000	5.0431601-003
4	1.1111111+000	9.9743823-001	1.0022236+000	2.4261393-003	1.0000000+000	1.0000000+000	4.7854159-003
5	1.1111111+000	9.9753996-001	1.0020791+000	2.3970677-003	1.0000000+000	1.0000000+000	4.5391230-003
6	1.1111111+000	9.9763702-001	1.0019409+000	2.4088864-003	9.8801733-001	1.0171211+000	4.3038653-003
7	1.1111111+000	9.9773121-001	1.0018066+000	2.7352229-003	9.8801733-001	1.1691692+000	4.0753992-003
8	1.1111111+000	9.9783445-001	1.0016594+000	3.6391227-003	9.8801733-001	1.5776599+000	3.8249751-003
9	1.1111111+000	9.9796637-001	1.0014716+000	5.9846926-003	9.8801733-001	2.6445757+000	3.5052630-003
10	1.1111111+000	9.9817184-001	1.0011805+000	1.3985631-002	9.8801733-001	6.3826612+000	3.0086683-003
11	1.1111111+000	9.9860986-001	1.0006622+000	7.0213880-002	9.8801733-001	3.4703412+001	2.0523857-003
12	1.1111111+000	9.9830579-001	1.0003507+000	1.1791858-003	9.8801733-001	1.0000000+000	2.0449494-003
13	1.1111111+000	9.9836104-001	1.0003173+000	1.1647682-003	9.8801733-001	1.0000000+000	1.9562945-003
14	1.1111111+000	9.9841525-001	1.0002859+000	1.1505259-003	9.8801733-001	1.0000000+000	1.8706935-003
15	1.1111111+000	9.9846832-001	1.0002565+000	1.1559151-003	9.8801733-001	1.0171211+000	1.7881408-003
16	1.1111111+000	9.9852110-001	1.0002283+000	1.3121851-003	9.8801733-001	1.1691692+000	1.7071930-003
17	1.1111111+000	9.9858033-001	1.0001979+000	1.7453262-003	9.8801733-001	1.5776599+000	1.6175935-003
18	1.1111111+000	9.9865798-001	1.0001599+000	2.8691731-003	9.8801733-001	2.6445757+000	1.5019068-003
19	1.1111111+000	9.9878290-001	1.0001093+000	6.7006828-003	9.8801733-001	6.3826612+000	1.3263957-003
20	1.1111111+000	9.9906317-001	1.0001008+000	3.3586550-002	9.8801733-001	3.4703412+001	1.0375962-003
21	1.1111111+000	9.9960404-001	1.0004242+000	5.5650581-004	9.8801733-001	1.0000000+000	8.2018253-004
22	1.1111111+000	9.9961894-001	1.0003912+000	5.4958999-004	9.8801733-001	1.0000000+000	7.7225119-004
23	1.1111111+000	9.9963313-001	1.0003601+000	5.4277242-004	9.8801733-001	1.0000000+000	7.2693973-004
24	1.1111111+000	9.9964661-001	1.0003308+000	5.4522171-004	9.8801733-001	1.0171211+000	6.8418423-004

```
AN ERROR WAS ENCOUNTERED IN SUBROUTINE  KEFFCALC  AT STATEMENT NUMBER    692
TIME EXCEEDED
I=     1 G=1 J=1 FLUX=  3.0487365-004
I=     2 G=1 J=1 FLUX=  4.3824139-004
I=     3 G=1 J=1 FLUX=  6.3590147-004
I=     4 G=1 J=1 FLUX=  6.7402481-004
I=     5 G=1 J=1 FLUX=  7.0799144-004
I=     6 G=1 J=1 FLUX=  7.4131780-004
I=     7 G=1 J=1 FLUX=  7.7359661-004
I=     8 G=1 J=1 FLUX=  8.0496992-004
I=     9 G=1 J=1 FLUX=  8.3540131-004
I=    10 G=1 J=1 FLUX=  8.6502767-004
I=    11 G=1 J=1 FLUX=  1.2847737-003
I=    12 G=1 J=1 FLUX=  3.0405397-003
I=    13 G=1 J=1 FLUX=  7.4902914-003
I=    14 G=1 J=1 FLUX=  1.1498606-002
I=    15 G=1 J=1 FLUX=  1.1530547-002
I=    16 G=1 J=1 FLUX=  1.1334790-002
I=    17 G=1 J=1 FLUX=  1.0055524-002
I=    18 G=1 J=1 FLUX=  4.5979689-003
I=    19 G=1 J=1 FLUX=  1.3509956-002
I=    20 G=1 J=1 FLUX=  5.4527890-002
I=    21 G=1 J=1 FLUX=  1.4359596-001
I=    22 G=1 J=1 FLUX=  1.4428157-001
I=    23 G=1 J=1 FLUX=  1.4316473-001
I=    24 G=1 J=1 FLUX=  1.1326595-001
I=    25 G=1 J=1 FLUX=  8.1315994-002
I=    26 G=1 J=1 FLUX=  5.8226343-003
I=    27 G=1 J=1 FLUX=  1.8687442-004
I=    28 G=1 J=1 FLUX=  7.2134490-006
I=    29 G=1 J=1 FLUX=  2.8399465-007
I=    30 G=1 J=1 FLUX=  1.1481203-008
I=    31 G=1 J=1 FLUX=  9.7529784-010
I=    32 G=1 J=1 FLUX=  1.2383441-011
I=    33 G=1 J=1 FLUX=  1.4704153-013

CANDIB2D HAS COPIED FLUX FROM LUN    3 ONTO LUN   48
```

```
IMAXIN=    33 JMAXIN=     3 IMAXOUT=   33 JMAXOUT=     3
I=     1 G=1 J=1 FLUX=  2.5984634-003
I=     2 G=1 J=1 FLUX=  2.5984634-003
I=     3 G=1 J=1 FLUX=  2.5984634-003
I=     4 G=1 J=1 FLUX=  2.5984634-003
I=     5 G=1 J=1 FLUX=  2.5984634-003
I=     6 G=1 J=1 FLUX=  2.5984634-003
I=     7 G=1 J=1 FLUX=  2.5984634-003
I=     8 G=1 J=1 FLUX=  2.5984634-003
I=     9 G=1 J=1 FLUX=  2.5984634-003
I=    10 G=1 J=1 FLUX=  2.5984634-003
I=    11 G=1 J=1 FLUX=  2.5984634-003
I=    12 G=1 J=1 FLUX=  2.5984634-003
I=    13 G=1 J=1 FLUX=  2.5984634-003
I=    14 G=1 J=1 FLUX=  2.5984634-003
I=    15 G=1 J=1 FLUX=  2.5984634-003
I=    16 G=1 J=1 FLUX=  2.5984634-003
I=    17 G=1 J=1 FLUX=  2.5984634-003
I=    18 G=1 J=1 FLUX=  2.5984634-003
I=    19 G=1 J=1 FLUX=  2.5984634-003
I=    20 G=1 J=1 FLUX=  2.5984634-003
I=    21 G=1 J=1 FLUX=  2.5984634-003
I=    22 G=1 J=1 FLUX=  2.5984634-003
I=    23 G=1 J=1 FLUX=  2.5984634-003
I=    24 G=1 J=1 FLUX=  2.5984634-003
I=    25 G=1 J=1 FLUX=  2.5984634-003
I=    26 G=1 J=1 FLUX=  2.5984634-003
I=    27 G=1 J=1 FLUX=  2.5984634-003
I=    28 G=1 J=1 FLUX=  2.5984634-003
I=    29 G=1 J=1 FLUX=  2.5984634-003
I=    30 G=1 J=1 FLUX=  2.5984634-003
I=    31 G=1 J=1 FLUX=  2.5984634-003
I=    32 G=1 J=1 FLUX=  2.5984634-003
I=    33 G=1 J=1 FLUX=  2.5984634-003

CANDID2D HAS COPIED FLUX FROM LUN    49 ONTO LUN    48

IMAXIN=    33 JMAXIN=     3 IMAXOUT=   33 JMAXOUT=     3
```

5. Sample Problem 5

a. Description

(1) Problem Type

Source calculation without Chebyshev acceleration and $\mu = 1/0.9$.

(2) Configuration

Same as Sample Problem 4.

(3) Convergence Criteria

Same as Sample Problem 4.

b. Output Listing

PROB. NO. 6.00000+000 2DCANDID SOURCE CALC(NO ACC), RT, 16 GROUPS, 33 X 3 MESH PAGE NO. 143

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	1.1111111+000	1.9929286-004	3.1753250+001	1.0180383+000	1.0000000+000	1.0000000+000	3.1753051+001
10.057							
2	1.1111111+000	5.6964586-004	2.3552273+000	4.6202040-001	1.0000000+000	1.0000000+000	2.3546576+000
3	1.1111111+000	8.9369064-003	1.7115041+000	2.2663113-001	1.0000000+000	1.0000000+000	1.7025672+000
4	1.1111111+000	7.7442631-002	1.4046963+000	1.5997858-001	1.0000000+000	1.0000000+000	1.3272536+000
5	1.1111111+000	6.8717976-001	1.2997538+000	1.4676681-001	1.0000000+000	1.0000000+000	6.1257400-001
6	1.1111111+000	8.2964448-001	1.2296130+000	1.4355254-001	1.0000000+000	1.0000000+000	3.9996856-001
7	1.1111111+000	9.0963385-001	1.1823985+000	1.4171337-001	1.0000000+000	1.0000000+000	2.7276460-001
8	1.1111111+000	9.1073017-001	1.1505645+000	1.4009615-001	1.0000000+000	1.0000000+000	2.3983430-001
9	1.1111111+000	9.1223573-001	1.1279741+000	1.3858227-001	1.0000000+000	1.0000000+000	2.1573836-001
10	1.1111111+000	9.1393720-001	1.1110622+000	1.3713906-001	1.0000000+000	1.0000000+000	1.9712496-001
11	1.1111111+000	9.1571805-001	1.0979018+000	1.3573243-001	1.0000000+000	1.0000000+000	1.8218372-001
12	1.1111111+000	9.1755163-001	1.0873645+000	1.3436150-001	1.0000000+000	1.0000000+000	1.6981292-001
13	1.1111111+000	9.1943764-001	1.0787381+000	1.3302733-001	1.0000000+000	1.0000000+000	1.5930048-001
14	1.1111111+000	9.2138356-001	1.0715477+000	1.3172536-001	1.0000000+000	1.0000000+000	1.5016419-001
15	1.1111111+000	9.2339759-001	1.0654641+000	1.3044925-001	1.0000000+000	1.0000000+000	1.4206652-001
16	1.1111111+000	9.2548716-001	1.0602514+000	1.2919402-001	1.0000000+000	1.0000000+000	1.3476425-001
17	1.1111111+000	9.2765857-001	1.0558805+000	1.2795657-001	1.0000000+000	1.0000000+000	1.2822191-001
18	1.1111111+000	9.2991688-001	1.0529933+000	1.2673524-001	1.0000000+000	1.0000000+000	1.2307645-001
19	1.1111111+000	9.3226568-001	1.0503774+000	1.2552914-001	1.0000000+000	1.0000000+000	1.1811167-001
20	1.1111111+000	9.3470683-001	1.0479953+000	1.2433786-001	1.0000000+000	1.0000000+000	1.1328842-001
21	1.1111111+000	9.3724030-001	1.0458163+000	1.2316110-001	1.0000000+000	1.0000000+000	1.0857603-001
22	1.1111111+000	9.3986392-001	1.0438151+000	1.2199866-001	1.0000000+000	1.0000000+000	1.0395114-001
23	1.1111111+000	9.4257334-001	1.0419701+000	1.2085030-001	1.0000000+000	1.0000000+000	9.9396751-002
24	1.1111111+000	9.4536185-001	1.0402633+000	1.1971579-001	1.0000000+000	1.0000000+000	9.4901488-002

```
AN ERROR WAS ENCOUNTERED IN SUBROUTINE  KEFFCALC  AT STATEMENT NUMBER    692
TIME EXCEEDED
I=    1 G=1 J=1 FLUX=  2.1779449-003
I=    2 G=1 J=1 FLUX=  3.1647486-003
I=    3 G=1 J=1 FLUX=  4.6408515-003
I=    4 G=1 J=1 FLUX=  4.9629947-003
I=    5 G=1 J=1 FLUX=  5.2202963-003
I=    6 G=1 J=1 FLUX=  5.4432732-003
I=    7 G=1 J=1 FLUX=  5.6108950-003
I=    8 G=1 J=1 FLUX=  5.7131878-003
I=    9 G=1 J=1 FLUX=  5.7421807-003
I=   10 G=1 J=1 FLUX=  5.6916015-003
I=   11 G=1 J=1 FLUX=  3.8838293-003
I=   12 G=1 J=1 FLUX=  2.6289483-003
I=   13 G=1 J=1 FLUX=  4.1382346-003
I=   14 G=1 J=1 FLUX=  5.5573201-003
I=   15 G=1 J=1 FLUX=  5.5184937-003
I=   16 G=1 J=1 FLUX=  5.3563237-003
I=   17 G=1 J=1 FLUX=  4.7084280-003
I=   18 G=1 J=1 FLUX=  1.8297965-003
I=   19 G=1 J=1 FLUX=  4.6210722-003
I=   20 G=1 J=1 FLUX=  1.9115212-002
I=   21 G=1 J=1 FLUX=  5.2095601-002
I=   22 G=1 J=1 FLUX=  5.2868671-002
I=   23 G=1 J=1 FLUX=  5.3461097-002
I=   24 G=1 J=1 FLUX=  4.1882006-002
I=   25 G=1 J=1 FLUX=  3.0058323-002
I=   26 G=1 J=1 FLUX=  2.1521979-003
I=   27 G=1 J=1 FLUX=  6.9069514-005
I=   28 G=1 J=1 FLUX=  2.6659598-006
I=   29 G=1 J=1 FLUX=  1.0495294-007
I=   30 G=1 J=1 FLUX=  4.2425867-009
I=   31 G=1 J=1 FLUX=  3.6038656-010
I=   32 G=1 J=1 FLUX=  4.5758343-012
I=   33 G=1 J=1 FLUX=  5.4333658-014

CANDID2D HAS COPIED FLUX FROM LUN    3 ONTO LUN   48
```

```
IMAXIN=    33 JMAXIN=     3 IMAXOUT=    33 JMAXOUT=     3
I=     1 G=1 J=1 FLUX=  2.5984634-003
I=     2 G=1 J=1 FLUX=  2.5984634-003
I=     3 G=1 J=1 FLUX=  2.5984634-003
I=     4 G=1 J=1 FLUX=  2.5984634-003
I=     5 G=1 J=1 FLUX=  2.5984634-003
I=     6 G=1 J=1 FLUX=  2.5984634-003
I=     7 G=1 J=1 FLUX=  2.5984634-003
I=     8 G=1 J=1 FLUX=  2.5984634-003
I=     9 G=1 J=1 FLUX=  2.5984634-003
I=    10 G=1 J=1 FLUX=  2.5984634-003
I=    11 G=1 J=1 FLUX=  2.5984634-003
I=    12 G=1 J=1 FLUX=  2.5984634-003
I=    13 G=1 J=1 FLUX=  2.5984634-003
I=    14 G=1 J=1 FLUX=  2.5984634-003
I=    15 G=1 J=1 FLUX=  2.5984634-003
I=    16 G=1 J=1 FLUX=  2.5984634-003
I=    17 G=1 J=1 FLUX=  2.5984634-003
I=    18 G=1 J=1 FLUX=  2.5984634-003
I=    19 G=1 J=1 FLUX=  2.5984634-003
I=    20 G=1 J=1 FLUX=  2.5984634-003
I=    21 G=1 J=1 FLUX=  2.5984634-003
I=    22 G=1 J=1 FLUX=  2.5984634-003
I=    23 G=1 J=1 FLUX=  2.5984634-003
I=    24 G=1 J=1 FLUX=  2.5984634-003
I=    25 G=1 J=1 FLUX=  2.5984634-003
I=    26 G=1 J=1 FLUX=  2.5984634-003
I=    27 G=1 J=1 FLUX=  2.5984634-003
I=    28 G=1 J=1 FLUX=  2.5984634-003
I=    29 G=1 J=1 FLUX=  2.5984634-003
I=    30 G=1 J=1 FLUX=  2.5984634-003
I=    31 G=1 J=1 FLUX=  2.5984634-003
I=    32 G=1 J=1 FLUX=  2.5984634-003
I=    33 G=1 J=1 FLUX=  2.5984634-003

CANDID2D HAS COPIED FLUX FROM LUN    49 ONTO LUN    48

IMAXIN=    33 JMAXIN=     3 IMAXOUT=    33 JMAXOUT=     3
```

PROB. NO. 6.00000+000 2DCANDID SOURCE CALC(NO ACC), RT, 16 GROUPS, 33 X 3 MESH PAGE NO. 143

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	1.1111111+000	9.4822050-001	1.0386795+000	1.1859488-001	1.0000000+000	1.0000000+000	9.0458967-002
10.013							
2	1.1111111+000	9.5113814-001	1.0372054+000	1.1748730-001	1.0000000+000	1.0000000+000	8.6067209-002
3	1.1111111+000	9.5410161-001	1.0358297+000	1.1639278-001	1.0000000+000	1.0000000+000	8.1728064-002
4	1.1111111+000	9.5709601-001	1.0345426+000	1.1531102-001	1.0000000+000	1.0000000+000	7.7446629-002
5	1.1111111+000	9.6010510-001	1.0333357+000	1.1424176-001	1.0000000+000	1.0000000+000	7.3230649-002
6	1.1111111+000	9.6311165-001	1.0322015+000	1.1318472-001	1.0000000+000	1.0000000+000	6.9089891-002
7	1.1111111+000	9.6343697-001	1.0311335+000	1.1213961-001	1.0000000+000	1.0000000+000	6.7696514-002
8	1.1111111+000	9.6371265-001	1.0301258+000	1.1110620-001	1.0000000+000	1.0000000+000	6.6413163-002
9	1.1111111+000	9.6398414-001	1.0291734+000	1.1008420-001	1.0000000+000	1.0000000+000	6.5189272-002
10	1.1111111+000	9.6425167-001	1.0282718+000	1.0907338-001	1.0000000+000	1.0000000+000	6.4020086-002
11	1.1111111+000	9.6451544-001	1.0274168+000	1.0807351-001	1.0000000+000	1.0000000+000	6.2901354-002
12	1.1111111+000	9.6477565-001	1.0266049+000	1.0708434-001	1.0000000+000	1.0000000+000	6.1829258-002
13	1.1111111+000	9.6503248-001	1.0258328+000	1.0610565-001	1.0000000+000	1.0000000+000	6.0800362-002
14	1.1111111+000	9.6528536-001	1.0250977+000	1.0513725-001	1.0000000+000	1.0000000+000	5.9812322-002
15	1.1111111+000	9.6553354-001	1.0243968+000	1.0417891-001	1.0000000+000	1.0000000+000	5.8863233-002
16	1.1111111+000	9.6577887-001	1.0237277+000	1.0323044-001	1.0000000+000	1.0000000+000	5.7948875-002
17	1.1111111+000	9.6602151-001	1.0230884+000	1.0229165-001	1.0000000+000	1.0000000+000	5.7066900-002
18	1.1111111+000	9.6626165-001	1.0224768+000	1.0136237-001	1.0000000+000	1.0000000+000	5.6215167-002
19	1.1111111+000	9.6649943-001	1.0218911+000	1.0044241-001	1.0000000+000	1.0000000+000	5.5391716-002
20	1.1111111+000	9.6673502-001	1.0213298+000	9.9531601-002	1.0000000+000	1.0000000+000	5.4594749-002
21	1.1111111+000	9.6696856-001	1.0207912+000	9.8629785-002	1.0000000+000	1.0000000+000	5.3822618-002
22	1.1111111+000	9.6720019-001	1.0202740+000	9.7736802-002	1.0000000+000	1.0000000+000	5.3073802-002
23	1.1111111+000	9.6743005-001	1.0197769+000	9.6852502-002	1.0000000+000	1.0000000+000	5.2346900-002
24	1.1111111+000	9.6765825-001	1.0192989+000	9.5976737-002	1.0000000+000	1.0000000+000	5.1640617-002
25	1.1111111+000	9.6788493-001	1.0188387+000	9.5109366-002	1.0000000+000	1.0000000+000	5.0953756-002
26	1.1111111+000	9.6811019-001	1.0183954+000	9.4250253-002	1.0000000+000	1.0000000+000	5.0285207-002
27	1.1111111+000	9.6833415-001	1.0179989+000	9.3399264-002	1.0000000+000	1.0000000+000	4.9664796-002
28	1.1111111+000	9.6855691-001	1.0176187+000	9.2556273-002	1.0000000+000	1.0000000+000	4.9061789-002
29	1.1111111+000	9.6877856-001	1.0172518+000	9.1721155-002	1.0000000+000	1.0000000+000	4.8473285-002
30	1.1111111+000	9.6899920-001	1.0168977+000	9.0893792-002	1.0000000+000	1.0000000+000	4.7898477-002
31	1.1111111+000	9.6921891-001	1.0165555+000	9.0074067-002	1.0000000+000	1.0000000+000	4.7336615-002
32	1.1111111+000	9.6943778-001	1.0162248+000	8.9261868-002	1.0000000+000	1.0000000+000	4.6787000-002
33	1.1111111+000	9.6965588-001	1.0159049+000	8.8457088-002	1.0000000+000	1.0000000+000	4.6248979-002
34	1.1111111+000	9.6987327-001	1.0155952+000	8.7659620-002	1.0000000+000	1.0000000+000	4.5721947-002
35	1.1111111+000	9.7009004-001	1.0152954+000	8.6869363-002	1.0000000+000	1.0000000+000	4.5205335-002
36	1.1111111+000	9.7030623-001	1.0150048+000	8.6086218-002	1.0000000+000	1.0000000+000	4.4698616-002
37	1.1111111+000	9.7052190-001	1.0147232+000	8.5310089-002	1.0000000+000	1.0000000+000	4.4201296-002
38	1.1111111+000	9.7073710-001	1.0144500+000	8.4540883-002	1.0000000+000	1.0000000+000	4.3712912-002
39	1.1111111+000	9.7095187-001	1.0141849+000	8.3778509-002	1.0000000+000	1.0000000+000	4.3233035-002
40	1.1111111+000	9.7116627-001	1.0139275+000	8.3022880-002	1.0000000+000	1.0000000+000	4.2761262-002
41	1.1111111+000	9.7138031-001	1.0136775+000	8.2273911-002	1.0000000+000	1.0000000+000	4.2297217-002
42	1.1111111+000	9.7159403-001	1.0134346+000	8.1531518-002	1.0000000+000	1.0000000+000	4.1840548-002
43	1.1111111+000	9.7180746-001	1.0131984+000	8.0795621-002	1.0000000+000	1.0000000+000	4.1390927-002
44	1.1111111+000	9.7202062-001	1.0129687+000	8.0066142-002	1.0000000+000	1.0000000+000	4.0948049-002

```
AN ERROR WAS ENCOUNTERED IN SUBROUTINE  KEFFCALC  AT STATEMENT NUMBER    692
TIME EXCEEDED
I=    1 G=1 J=1 FLUX=  1.9742358-003
I=    2 G=1 J=1 FLUX=  2.8154469-003
I=    3 G=1 J=1 FLUX=  4.0481940-003
I=    4 G=1 J=1 FLUX=  4.2512811-003
I=    5 G=1 J=1 FLUX=  4.3834619-003
I=    6 G=1 J=1 FLUX=  4.4664057-003
I=    7 G=1 J=1 FLUX=  4.4973321-003
I=    8 G=1 J=1 FLUX=  4.4773948-003
I=    9 G=1 J=1 FLUX=  4.4079715-003
I=   10 G=1 J=1 FLUX=  4.2904761-003
I=   11 G=1 J=1 FLUX=  2.4253481-003
I=   12 G=1 J=1 FLUX=  1.9271870-003
I=   13 G=1 J=1 FLUX=  3.5582423-003
I=   14 G=1 J=1 FLUX=  5.1443232-003
I=   15 G=1 J=1 FLUX=  5.1649909-003
I=   16 G=1 J=1 FLUX=  5.1085710-003
I=   17 G=1 J=1 FLUX=  4.5997841-003
I=   18 G=1 J=1 FLUX=  2.6547004-003
I=   19 G=1 J=1 FLUX=  9.4336869-003
I=   20 G=1 J=1 FLUX=  3.8789963-002
I=   21 G=1 J=1 FLUX=  1.0298692-001
I=   22 G=1 J=1 FLUX=  1.0371165-001
I=   23 G=1 J=1 FLUX=  1.0335343-001
I=   24 G=1 J=1 FLUX=  8.1585164-002
I=   25 G=1 J=1 FLUX=  5.8567415-002
I=   26 G=1 J=1 FLUX=  4.1936642-003
I=   27 G=1 J=1 FLUX=  1.3459163-004
I=   28 G=1 J=1 FLUX=  5.1952357-006
I=   29 G=1 J=1 FLUX=  2.0453446-007
I=   30 G=1 J=1 FLUX=  8.2686452-009
I=   31 G=1 J=1 FLUX=  7.0239514-010
I=   32 G=1 J=1 FLUX=  8.9183608-012
I=   33 G=1 J=1 FLUX=  1.0589701-013

CANDID2D HAS COPIED FLUX FROM LUN    3 ONTO LUN   48
```

```
IMAXIN=    33 JMAXIN=     3 IMAXOUT=    33 JMAXOUT=     3
I=     1 G=1 J=1 FLUX=  2,5984634-003
I=     2 G=1 J=1 FLUX=  2,5984634-003
I=     3 G=1 J=1 FLUX=  2,5984634-003
I=     4 G=1 J=1 FLUX=  2,5984634-003
I=     5 G=1 J=1 FLUX=  2,5984634-003
I=     6 G=1 J=1 FLUX=  2,5984634-003
I=     7 G=1 J=1 FLUX=  2,5984634-003
I=     8 G=1 J=1 FLUX=  2,5984634-003
I=     9 G=1 J=1 FLUX=  2,5984634-003
I=    10 G=1 J=1 FLUX=  2,5984634-003
I=    11 G=1 J=1 FLUX=  2,5984634-003
I=    12 G=1 J=1 FLUX=  2,5984634-003
I=    13 G=1 J=1 FLUX=  2,5984634-003
I=    14 G=1 J=1 FLUX=  2,5984634-003
I=    15 G=1 J=1 FLUX=  2,5984634-003
I=    16 G=1 J=1 FLUX=  2,5984634-003
I=    17 G=1 J=1 FLUX=  2,5984634-003
I=    18 G=1 J=1 FLUX=  2,5984634-003
I=    19 G=1 J=1 FLUX=  2,5984634-003
I=    20 G=1 J=1 FLUX=  2,5984634-003
I=    21 G=1 J=1 FLUX=  2,5984634-003
I=    22 G=1 J=1 FLUX=  2,5984634-003
I=    23 G=1 J=1 FLUX=  2,5984634-003
I=    24 G=1 J=1 FLUX=  2,5984634-003
I=    25 G=1 J=1 FLUX=  2,5984634-003
I=    26 G=1 J=1 FLUX=  2,5984634-003
I=    27 G=1 J=1 FLUX=  2,5984634-003
I=    28 G=1 J=1 FLUX=  2,5984634-003
I=    29 G=1 J=1 FLUX=  2,5984634-003
I=    30 G=1 J=1 FLUX=  2,5984634-003
I=    31 G=1 J=1 FLUX=  2,5984634-003
I=    32 G=1 J=1 FLUX=  2,5984634-003
I=    33 G=1 J=1 FLUX=  2,5984634-003

CANDID2D HAS COPIED FLUX FROM LUN    49 ONTO LUN    48

IMAXIN=    33 JMAXIN=     3 IMAXOUT=    33 JMAXOUT=     3
```

PROB. NO. 6.00000+000 2DCANDID SOURCE CALC(NO ACC), RT. 16 GROUPS. 33 X 3 MESH PAGE NO. 143

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	1.1111111+000	9.7223353-001	1.0127452+000	7.9343005-002	1.0000000+000	1.0000000+000	4.0511626-002
10.006							
2	1.1111111+000	9.7244620-001	1.0125276+000	7.8626135-002	1.0000000+000	1.0000000+000	4.0081391-002
3	1.1111111+000	9.7265864-001	1.0123157+000	7.7915460-002	1.0000000+000	1.0000000+000	3.9657096-002
4	1.1111111+000	9.7287086-001	1.0121094+000	7.7210910-002	1.0000000+000	1.0000000+000	3.9238507-002
5	1.1111111+000	9.7308286-001	1.0119083+000	7.6512416-002	1.0000000+000	1.0000000+000	3.8825407-002
6	1.1111111+000	9.7329464-001	1.0117122+000	7.5819912-002	1.0000000+000	1.0000000+000	3.8417596-002
7	1.1111111+000	9.7350619-001	1.0115211+000	7.5133333-002	1.0000000+000	1.0000000+000	3.8014884-002
8	1.1111111+000	9.7371751-001	1.0113346+000	7.4452614-002	1.0000000+000	1.0000000+000	3.7617097-002
9	1.1111111+000	9.7392858-001	1.0111527+000	7.3777694-002	1.0000000+000	1.0000000+000	3.7224072-002
10	1.1111111+000	9.7413940-001	1.0109751+000	7.3108512-002	1.0000000+000	1.0000000+000	3.6835658-002
11	1.1111111+000	9.7434994-001	1.0108017+000	7.2445010-002	1.0000000+000	1.0000000+000	3.6451715-002
12	1.1111111+000	9.7456019-001	1.0106323+000	7.1787128-002	1.0000000+000	1.0000000+000	3.6072113-002
13	1.1111111+000	9.7477013-001	1.0104669+000	7.1134812-002	1.0000000+000	1.0000000+000	3.5696731-002
14	1.1111111+000	9.7497972-001	1.0103052+000	7.0488006-002	1.0000000+000	1.0000000+000	3.5325458-002
15	1.1111111+000	9.7518896-001	1.0101471+000	6.9846655-002	1.0000000+000	1.0000000+000	3.4958191-002
16	1.1111111+000	9.7539780-001	1.0099926+000	6.9210708-002	1.0000000+000	1.0000000+000	3.4594835-002
17	1.1111111+000	9.7560622-001	1.0098415+000	6.8580111-002	1.0000000+000	1.0000000+000	3.4235302-002
18	1.1111111+000	9.7581418-001	1.0096937+000	6.7954815-002	1.0000000+000	1.0000000+000	3.3879511-002
19	1.1111111+000	9.7602167-001	1.0095491+000	6.7334770-002	1.0000000+000	1.0000000+000	3.3527388-002
20	1.1111111+000	9.7622863-001	1.0094075+000	6.6719927-002	1.0000000+000	1.0000000+000	3.3178864-002
21	1.1111111+000	9.7643504-001	1.0092689+000	6.6110239-002	1.0000000+000	1.0000000+000	3.2833877-002
22	1.1111111+000	9.7664087-001	1.0091332+000	6.5505658-002	1.0000000+000	1.0000000+000	3.2492370-002
23	1.1111111+000	9.7684606-001	1.0090004+000	6.4906139-002	1.0000000+000	1.0000000+000	3.2154289-002
24	1.1111111+000	9.7705060-001	1.0088702+000	6.4311637-002	1.0000000+000	1.0000000+000	3.1819586-002
25	1.1111111+000	9.7725443-001	1.0087426+000	6.3722107-002	1.0000000+000	1.0000000+000	3.1488218-002
26	1.1111111+000	9.7745752-001	1.0086177+000	6.3137506-002	1.0000000+000	1.0000000+000	3.1160144-002
27	1.1111111+000	9.7765984-001	1.0084952+000	6.2557792-002	1.0000000+000	1.0000000+000	3.0835326-002
28	1.1111111+000	9.7786133-001	1.0083751+000	6.1982921-002	1.0000000+000	1.0000000+000	3.0513733-002
29	1.1111111+000	9.7806198-001	1.0082573+000	6.1412854-002	1.0000000+000	1.0000000+000	3.0195333-002
30	1.1111111+000	9.7826172-001	1.0081418+000	6.0847548-002	1.0000000+000	1.0000000+000	2.9880098-002
31	1.1111111+000	9.7846053-001	1.0080285+000	6.0286965-002	1.0000000+000	1.0000000+000	2.9568002-002
32	1.1111111+000	9.7865837-001	1.0079174+000	5.9731065-002	1.0000000+000	1.0000000+000	2.9259023-002
33	1.1111111+000	9.7885520-001	1.0078083+000	5.9179809-002	1.0000000+000	1.0000000+000	2.8953138-002
34	1.1111111+000	9.7905099-001	1.0077013+000	5.8633159-002	1.0000000+000	1.0000000+000	2.8650329-002
35	1.1111111+000	9.7924569-001	1.0075963+000	5.8091077-002	1.0000000+000	1.0000000+000	2.8350576-002
36	1.1111111+000	9.7943926-001	1.0074931+000	5.7553526-002	1.0000000+000	1.0000000+000	2.8053864-002
37	1.1111111+000	9.7963169-001	1.0073919+000	5.7020469-002	1.0000000+000	1.0000000+000	2.7760176-002
38	1.1111111+000	9.7982292-001	1.0072924+000	5.6491871-002	1.0000000+000	1.0000000+000	2.7469498-002
39	1.1111111+000	9.8001293-001	1.0071947+000	5.5967696-002	1.0000000+000	1.0000000+000	2.7181816-002
40	1.1111111+000	9.8020169-001	1.0070988+000	5.5447908-002	1.0000000+000	1.0000000+000	2.6897117-002
41	1.1111111+000	9.8038915-001	1.0070045+000	5.4932474-002	1.0000000+000	1.0000000+000	2.6615388-002
42	1.1111111+000	9.8057530-001	1.0069119+000	5.4421358-002	1.0000000+000	1.0000000+000	2.6336618-002

```
AN ERROR WAS ENCOUNTERED IN SUBROUTINE  KEFFCALC  AT STATEMENT NUMBER    692
TIME EXCEEDED
I=    1 G=1 J=1 FLUX=  1,3344075-003
I=    2 G=1 J=1 FLUX=  1,8994038-003
I=    3 G=1 J=1 FLUX=  2,7255508-003
I=    4 G=1 J=1 FLUX=  2,8568798-003
I=    5 G=1 J=1 FLUX=  2,9415885-003
I=    6 G=1 J=1 FLUX=  2,9936011-003
I=    7 G=1 J=1 FLUX=  3,0124909-003
I=    8 G=1 J=1 FLUX=  2,9999497-003
I=    9 G=1 J=1 FLUX=  2,9576755-003
I=   10 G=1 J=1 FLUX=  2,8873785-003
I=   11 G=1 J=1 FLUX=  1,8466718-003
I=   12 G=1 J=1 FLUX=  2,1984790-003
I=   13 G=1 J=1 FLUX=  4,7720329-003
I=   14 G=1 J=1 FLUX=  7,0858775-003
I=   15 G=1 J=1 FLUX=  7,1160619-003
I=   16 G=1 J=1 FLUX=  7,0317726-003
I=   17 G=1 J=1 FLUX=  6,3042746-003
I=   18 G=1 J=1 FLUX=  3,4157587-003
I=   19 G=1 J=1 FLUX=  1,1579608-002
I=   20 G=1 J=1 FLUX=  4,7270102-002
I=   21 G=1 J=1 FLUX=  1,2489058-001
I=   22 G=1 J=1 FLUX=  1,2559433-001
I=   23 G=1 J=1 FLUX=  1,2482694-001
I=   24 G=1 J=1 FLUX=  9,8673244-002
I=   25 G=1 J=1 FLUX=  7,0837613-002
I=   26 G=1 J=1 FLUX=  5,0723031-003
I=   27 G=1 J=1 FLUX=  1,6279208-004
I=   28 G=1 J=1 FLUX=  6,2838258-006
I=   29 G=1 J=1 FLUX=  2,4739394-007
I=   30 G=1 J=1 FLUX=  1,0001444-008
I=   31 G=1 J=1 FLUX=  8,4959424-010
I=   32 G=1 J=1 FLUX=  1,0787367-011
I=   33 G=1 J=1 FLUX=  1,2808967-013

CANDID2D HAS COPIED FLUX FROM LUN    3 ONTO LUN   48
```

```
IMAXIN=   33 JMAXIN=    3 IMAXOUT=   33 JMAXOUT=    3
I=    1 G=1 J=1 FLUX=  2.5984634-003
I=    2 G=1 J=1 FLUX=  2.5984634-003
I=    3 G=1 J=1 FLUX=  2.5984634-003
I=    4 G=1 J=1 FLUX=  2.5984634-003
I=    5 G=1 J=1 FLUX=  2.5984634-003
I=    6 G=1 J=1 FLUX=  2.5984634-003
I=    7 G=1 J=1 FLUX=  2.5984634-003
I=    8 G=1 J=1 FLUX=  2.5984634-003
I=    9 G=1 J=1 FLUX=  2.5984634-003
I=   10 G=1 J=1 FLUX=  2.5984634-003
I=   11 G=1 J=1 FLUX=  2.5984634-003
I=   12 G=1 J=1 FLUX=  2.5984634-003
I=   13 G=1 J=1 FLUX=  2.5984634-003
I=   14 G=1 J=1 FLUX=  2.5984634-003
I=   15 G=1 J=1 FLUX=  2.5984634-003
I=   16 G=1 J=1 FLUX=  2.5984634-003
I=   17 G=1 J=1 FLUX=  2.5984634-003
I=   18 G=1 J=1 FLUX=  2.5984634-003
I=   19 G=1 J=1 FLUX=  2.5984634-003
I=   20 G=1 J=1 FLUX=  2.5984634-003
I=   21 G=1 J=1 FLUX=  2.5984634-003
I=   22 G=1 J=1 FLUX=  2.5984634-003
I=   23 G=1 J=1 FLUX=  2.5984634-003
I=   24 G=1 J=1 FLUX=  2.5984634-003
I=   25 G=1 J=1 FLUX=  2.5984634-003
I=   26 G=1 J=1 FLUX=  2.5984634-003
I=   27 G=1 J=1 FLUX=  2.5984634-003
I=   28 G=1 J=1 FLUX=  2.5984634-003
I=   29 G=1 J=1 FLUX=  2.5984634-003
I=   30 G=1 J=1 FLUX=  2.5984634-003
I=   31 G=1 J=1 FLUX=  2.5984634-003
I=   32 G=1 J=1 FLUX=  2.5984634-003
I=   33 G=1 J=1 FLUX=  2.5984634-003

CANDID2D HAS COPIED FLUX FROM LUN   49 ONTO LUN   48
```

6. Sample Problem 6

a. Description

(1) Problem Type

Real k_{eff} calculation

(2) Configuration

(a) Geometry

$r\theta$ (full periodic)

(b) Region Definition

The reactor consists of a core region composed of uranium (U^{235} and U^{238}), iron, and aluminum.

(c) Mesh Definition

r direction: 20 points

θ direction: 20 points

(d) Boundary Conditions

Left: $\phi' = 0.$

Right: $\phi = 0.$

Bottom: periodic.

Top: periodic.

(e) Number of Energy Groups: 2.

(3) Convergence Criteria

k_{eff} difference $= 10^{-6}$.

k_{eff} bounds $= 10^{-3}$.

Sum of flux difference $= 10^{-3}$.

Periodic $= 10^{-7}$.

Maximum number of periodic iterations = 25.

b. Output Listing

```
PROB, NO,   1.01000+001   2DCANDID  RT FULL CIRCLE 2, 2 GROUPS, 20X20 MESH                    PAGE NO.    2
                                           REACTOR GEOMETRY

 GEOMETRY                        LEFT              RIGHT             BOTTOM             TOP
   TYPE                          BOUND             BOUNC              BOUND            BOUND

             2D - RO          0,0000+000        5,0000+001        0.0000+000        3.1416+000

                                           REGION BOUNDARIES

             REGION NO.          LEFT BDRY.        RIGHT BDRY.      BOTTOM BDRY.        TOP BDRY.

                      1       0,0000+000        5,0000+001        0,0000+000        3,1416+000


PROB, NO,   1.01000+001   2DCANDID  RT FULL CIRCLE 2, 2 GROUPS, 20X20 MESH                    PAGE NO.    3
                                           MESH DEFINITION


                         CONSTANT INTERVAL PER REGION METHOD - X(R) DIRECTON

                               X(R) LEFT    NO. MESH       X(R) RIGHT

                              0.0000+000          20       5.0000+001

IMAX =    20


                          X(R) PLUS DELTA X(R) FROM LEFT  TO RIGHT OF REACTOR

MESH NO.            1          2          3          4          5          6          7          8          9         10
ABSCISSA   2.5000+000 5.0000+000 7.5000+000 1.0000+001 1.2500+001 1.5000+001 1.7500+001 2.0000+001 2.2500+001 2.5000+001

MESH NO.           11         12         13         14         15         16         17         18         19         20
ABSCISSA   2.7500+001 3.0000+001 3.2500+001 3.5000+001 3.7500+001 4.0000+001 4.2500+001 4.5000+001 4.7500+001 5.0000+001
```

MESH DEFINITION

CONSTANT INTERVAL PER REGION METHOD - Y(Z) DIRECTION

Y(Z) BOTTOM	NO. MESH	Y(Z) TOP
0.0000+000	20	3.1416+000

JMAX = 20

Y(Z) PLUS DELTA Y(Z) FROM BOTTOM TO TOP OF REACTOR

Y(Z) MESH NO.	1	2	3	4	5	6	7	8	9	10
ORDINATE	1.5708-001	3.1416-001	4.7124-001	6.2832-001	7.8540-001	9.4248-001	1.0996+000	1.2566+000	1.4137+000	1.5708+000

Y(Z) MESH NO.	11	12	13	14	15	16	17	18	19	20
ORDINATE	1.7279+000	1.8850+000	2.0420+000	2.1991+000	2.3562+000	2.5133+000	2.6704+000	2.8274+000	2.9845+000	3.1416+000

REGION MAP

(REGION NUMBER BY MESH POINT)

R MESH POINTS

Z MESH POINTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Z MESH POINTS
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20
19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	13
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	12
11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	11
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	9
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8
7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	6
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5
4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	

R MESH POINTS

```
PROB, NO,   1,01000+001  2DCANDID  RT FULL CIRCLE 2, 2 GROUPS, 20X20 MESH                    PAGE NO,   16
   ITERATION HISTORY
ITERATION    K-EFFECTIVE        K-LOWER          K-UPPER  CHANGE IN PHI         SIGMA          ALPHA        ERRLAM
***** I=     1 G=     1 TEST=  3,8949474-006 *****
***** I=     1 G=     2 TEST= -9,8656537-006 *****
          1  1,0577970+000  3,1892435-001  1,1759743+000  1,8323686-001  1,0000000+000  1,0000000+000  8,5704997-001
     4,610
***** I=     1 G=     1 TEST=  4,9665855-006 *****
***** I=     1 G=     2 TEST= -1,2262625-005 *****
          2  1,1145811+000  6,1438095-001  1,1362174+000  1,2648776-001  1,0000000+000  1,0000000+000  5,2183643-001
***** I=     1 G=     1 TEST=  5,0932263-006 *****
***** I=     1 G=     2 TEST= -1,2513913-005 *****
          3  1,1701205+000  7,4071431-001  1,1090072+000  1,0301649-001  1,0000000+000  1,0000000+000  3,6829291-001
***** I=     1 G=     1 TEST=  4,9614216-006 *****
***** I=     1 G=     2 TEST= -1,2162839-005 *****
          4  1,2228898+000  8,0331654-001  1,0892549+000  8,9050481-002  1,0000000+000  1,0000000+000  2,8593831-001
***** I=     1 G=     1 TEST=  4,7283315-006 *****
***** I=     1 G=     2 TEST= -1,1576486-005 *****
          5  1,2719657+000  8,4026287-001  1,0764826+000  7,8539607-002  1,0000000+000  1,0000000+000  2,3621975-001
***** I=     1 G=     1 TEST=  4,4505998-006 *****
***** I=     1 G=     2 TEST= -1,0895356-005 *****
          6  1,3169289+000  8,6473834-001  1,0668683+000  6,9835569-002  1,0000000+000  1,0000000+000  2,0213001-001
***** I=     1 G=     1 TEST=  4,1542189-006 *****
***** I=     1 G=     2 TEST= -1,0185465-005 *****
          7  1,3576745+000  8,8231791-001  1,0585935+000  6,2358116-002  1,0000000+000  1,0000000+000  1,7627562-001
***** I=     1 G=     1 TEST=  1,1852974-006 *****
***** I=     1 G=     2 TEST= -9,4811885-006 *****
          8  1,3942831+000  8,9580962-001  1,0515231+000  5,5835605-002  1,0000000+000  1,0000000+000  1,5571352-001
***** I=     1 G=     1 TEST=  3,5548205-006 *****
***** I=     1 G=     2 TEST= -8,8012061-006 *****
          9  1,4269406+000  9,0660857-001  1,0454845+000  5,0107598-002  1,0000000+000  1,0000000+000  1,3887591-001
***** I=     1 G=     1 TEST=  3,2646590-006 *****
***** I=     1 G=     2 TEST= -8,1557400-006 *****
         10  1,4558893+000  9,1553015-001  1,0403151+000  4,5062839-002  1,0000000+000  1,0000000+000  1,2478498-001
***** I=     1 G=     1 TEST=  2,9854823-006 *****
***** I=     1 G=     2 TEST= -7,5501389-006 *****
         11  1,4813979+000  9,2308049-001  1,0358750+000  4,0615840-002  1,0000000+000  1,0000000+000  1,1279453-001
***** I=     1 G=     1 TEST=  2,7191209-006 *****
***** I=     1 G=     2 TEST= -6,9865373-006 *****
         12  1,5037426+000  9,2958969-001  1,0320475+000  3,6696665-002  1,0000000+000  1,0000000+000  1,0245777-001
***** I=     1 G=     1 TEST=  2,4665394-006 *****
***** I=     1 G=     2 TEST= -6,4655355-006 *****
         13  1,5231960+000  9,3528228-001  1,0287368+000  3,3245709-002  1,0000000+000  1,0000000+000  9,3454519-002
***** I=     1 G=     1 TEST=  2,2282129-006 *****
***** I=     1 G=     2 TEST= -5,9864660-006 *****
         14  1,5400202+000  9,4031661-001  1,0258642+000  3,0210848-002  1,0000000+000  1,0000000+000  8,5547547-002
***** I=     1 G=     1 TEST=  2,0041934-006 *****
```

```
***** I=    1 G=    2 TEST= -5.5478667-006 *****
      15  1.5544624+000  9.4480808-001  1.0233649+000  2.7545690-002  1.0000000+000  1.0000000+000  7.8556791-002
***** I=    1 G=    1 TEST=  1.7942671-006 *****
***** I=    1 G=    2 TEST= -5.1479210-006 *****
      16  1.5667531+000  9.4884330-001  1.0211855+000  2.5606177-002  9.1178142-001  1.0157792+000  7.2342240-002
***** I=    1 G=    1 TEST=  1.5942987-006 *****
***** I=    1 G=    2 TEST= -4.7794470-006 *****
      17  1.5770801+000  9.5257004-001  1.0192547+000  2.6695502-002  9.1178142-001  1.1541344+000  6.6684649-002
***** I=    1 G=    1 TEST=  1.3779102-006 *****
***** I=    1 G=    2 TEST= -4.4053236-006 *****
      18  1.5854442+000  9.5657598-001  1.0173618+000  3.1846270-002  9.1178142-001  1.5103402+000  6.0785866-002
***** I=    1 G=    1 TEST=  1.1078462-006 *****
***** I=    1 G=    2 TEST= -3.9807501-006 *****
      19  1.5916165+000  9.6148072-001  1.0152876+000  4.4186528-002  9.1178142-001  2.3467783+000  5.3806868-002
***** I=    1 G=    1 TEST=  7.2228931-007 *****
***** I=    1 G=    2 TEST= -3.4337095-006 *****
      20  1.5950008+000  9.6844973-001  1.0127300+000  7.2437320-002  9.1178142-001  4.5096667+000  4.4280292-002
***** I=    1 G=    1 TEST=  1.2915234-007 *****
***** I=    1 G=    2 TEST= -2.6016673-006 *****
      21  1.5942932+000  9.7916873-001  1.0091217+000  1.2125279-001  9.1178142-001  9.6383354+000  2.9952941-002
***** I=    1 G=    1 TEST= -3.6624147-007 *****
***** I=    1 G=    2 TEST= -9.4350389-007 *****
      22  1.5877235+000  9.8852542-001  1.0040265+000  9.7251767-003  9.1178142-001  1.0000000+000  1.5531104-002
***** I=    1 G=    1 TEST= -2.9664488-007 *****
***** I=    1 G=    2 TEST= -6.3037942-007 *****
      23  1.5810375+000  9.8899382-001  1.0032507+000  9.2307707-003  9.1178142-001  1.0000000+000  1.4256923-002
***** I=    1 G=    1 TEST= -2.4607971-007 *****
***** I=    1 G=    2 TEST= -3.6473239-007 *****
      24  1.5742972+000  9.8943986-001  1.0026859+000  8.8030827-003  9.1178142-001  1.0000000+000  1.3246089-002
***** I=    1 G=    1 TEST= -2.0709990-007 *****
***** I=    1 G=    2 TEST= -1.4476336-007 *****
      25  1.5675583+000  9.8987952-001  1.0022546+000  8.5562204-003  9.1178142-001  1.0157792+000  1.2375033-002
***** I=    1 G=    1 TEST= -1.7602156-007 *****
      26  1.5608647+000  9.9031894-001  1.0019117+000  9.3188972-003  9.1178142-001  1.1541344+000  1.1592723-002
***** I=    1 G=    1 TEST= -1.4429702-007 *****
***** I=    1 G=    2 TEST=  2.0693642-007 *****
      27  1.5542334+000  9.9078427-001  1.0015637+000  1.1680312-002  9.1178142-001  1.5103402+000  1.0779456-002
***** I=    1 G=    1 TEST= -1.0177041-007 *****
***** I=    1 G=    2 TEST=  3.8679127-007 *****
      28  1.5476588+000  9.9131646-001  1.0011002+000  1.7323220-002  9.1178142-001  2.3467783+000  9.7837851-003
***** I=    1 G=    2 TEST=  6.0440379-007 *****
      29  1.5411102+000  9.9199434-001  1.0003182+000  3.1578584-002  9.1178142-001  4.5096667+000  8.3238335-003
***** I=    1 G=    1 TEST=  1.1480256-007 *****
***** I=    1 G=    2 TEST=  8.9047853-007 *****
      30  1.5345186+000  9.9299205-001  9.9876411-001  6.3574260-002  9.1178142-001  9.6383354+000  5.7720605-003
***** I=    1 G=    1 TEST=  3.5097719-007 *****
***** I=    1 G=    2 TEST=  1.1691072-006 *****
      31  1.5277979+000  9.9436235-001  9.9618255-001  6.2475266-003  9.1178142-001  1.0000000+000  1.8231916-003
```

```
***** I=    1 G=    1 TEST=  3,2983030-007 *****
***** I=    1 G=    2 TEST=  1,1548473-006 *****
      32  1,5213056+000  9,9474935-001  9,9646419-001  6,0309751-003  9,1178142-001  1,0000000+000  1,7148403-003
***** I=    1 G=    1 TEST=  2,9907642-007 *****
***** I=    1 G=    2 TEST=  1,1301549-006 *****
      33  1,5150552+000  9,9500473-001  9,9680128-001  5,8041562-003  9,1178142-001  1,0000000+000  1,7965441-003
***** I=    1 G=    1 TEST=  2,7022270-007 *****
***** I=    1 G=    2 TEST=  1,1014467-006 *****
      34  1,5090538+000  9,9526337-001  9,9713409-001  5,5723076-003  9,1178142-001  1,0000000+000  1,8707129-003
***** I=    1 G=    1 TEST=  2,4255110-007 *****
***** I=    1 G=    2 TEST=  1,0694544-006 *****
      35  1,5033056+000  9,9551273-001  9,9744169-001  5,4264489-003  9,6005474-001  1,0166285+000  1,9289601-003
***** I=    1 G=    1 TEST=  2,1658184-007 *****
***** I=    1 G=    2 TEST=  1,0349113-006 *****
      36  1,4978129+000  9,9576049-001  9,9772544-001  5,9359571-003  9,6005474-001  1,1635981+000  1,9649565-003
***** I=    1 G=    1 TEST=  1,9240974-007 *****
***** I=    1 G=    2 TEST=  9,9659155-007 *****
      37  1,4925816+000  9,9601383-001  9,9797206-001  7,5392143-003  9,6005474-001  1,5522820+000  1,9582275-003
***** I=    1 G=    1 TEST=  1,7154298-007 *****
***** I=    1 G=    2 TEST=  9,5130827-007 *****
      38  1,4876287+000  9,9628711-001  9,9814323-001  1,1597475-002  9,6005474-001  2,5269601+000  1,8561115-003
***** I=    1 G=    1 TEST=  1,5964565-007 *****
***** I=    1 G=    2 TEST=  8,9193418-007 *****
      39  1,4829978+000  9,9661699-001  9,9821180-001  2,3628934-002  9,6005474-001  5,5388767+000  1,5948026-003
***** I=    1 G=    1 TEST=  1,7984257-007 *****
***** I=    1 G=    2 TEST=  8,0066502-007 *****
      40  1,4788019+000  9,9707527-001  9,9796801-001  6,7512637-002  9,6005474-001  1,7761422+001  8,9273452-004
***** I=    1 G=    1 TEST=  2,7098508-007 *****
***** I=    1 G=    2 TEST=  6,5333415-007 *****
      41  1,4751917+000  9,9675750-001  9,9766290-001  3,1164338-003  9,6005474-001  1,0000000+000  9,0540141-004
***** I=    1 G=    1 TEST=  2,5639429-007 *****
***** I=    1 G=    2 TEST=  6,4649021-007 *****
      42  1,4716917+000  9,9698100-001  9,9787431-001  3,0186846-003  9,6005474-001  1,0000000+000  8,9331610-004
***** I=    1 G=    1 TEST=  2,3218809-007 *****
***** I=    1 G=    2 TEST=  6,3307789-007 *****
      43  1,4683136+000  9,9725787-001  9,9824292-001  2,9125716-003  9,6005474-001  1,0000000+000  9,8505919-004
***** I=    1 G=    1 TEST=  2,0871494-007 *****
***** I=    1 G=    2 TEST=  6,1722767-007 *****
      44  1,4650640+000  9,9752829-001  9,9853769-001  2,8484522-003  9,6005474-001  1,0166285+000  1,0094074-003
***** I=    1 G=    1 TEST=  1,8702781-007 *****
***** I=    1 G=    2 TEST=  5,9933745-007 *****
      45  1,4619478+000  9,9775777-001  9,9878729-001  3,1275136-003  9,6005474-001  1,1635981+000  1,0295260-003
***** I=    1 G=    1 TEST=  1,6610670-007 *****
***** I=    1 G=    2 TEST=  5,7868328-007 *****
      46  1,4589707+000  9,9782933-001  9,9896819-001  3,9870434-003  9,6005474-001  1,5522820+000  1,1388566-003
***** I=    1 G=    1 TEST=  1,4536613-007 *****
***** I=    1 G=    2 TEST=  5,5300870-007 *****
      47  1,4561442+000  9,9791859-001  9,9904831-001  6,1595312-003  9,6005474-001  2,5269601+000  1,1297189-003
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***** I=    1 G=    1 TEST=  1,2609667-007 *****
***** I=    1 G=    2 TEST=  5,1738016-007 *****
     48  1,4534958+000  9,9804254-001  9,9899238-001  1,2617995-002  9,6005474-001  5,5388767+000  9,4983671-004
***** I=    1 G=    1 TEST=  1,1518409-007 *****
***** I=    1 G=    2 TEST=  4,5840397-007 *****
     49  1,4511005+000  9,9824663-001  9,9878003-001  3,6262501-002  9,6005474-001  1,7761422+001  5,334 601-004
***** I=    1 G=    1 TEST=  1,4002626-007 *****
***** I=    1 G=    2 TEST=  3,3027618-007 *****
     50  1,4491233+000  9,9826363-001  9,9869626-001  1,6376998-003  9,6005474-001  1,0000000+000  4,3262463-004
***** I=    1 G=    1 TEST=  1,2519740-007 *****
***** I=    1 G=    2 TEST=  3,3871584-007 *****
     51  1,4472030+000  9,9843785-001  9,9884197-001  1,5893366-003  9,6005474-001  1,0000000+000  4,0411700-004
***** I=    1 G=    1 TEST=  1,1508428-007 *****
***** I=    1 G=    2 TEST=  3,3073820-007 *****
     52  1,4453510+000  9,9856829-001  9,9904635-001  1,5326160-003  9,6005474-001  1,0000000+000  4,7805130-004
***** I=    1 G=    1 TEST=  1,0326175-007 *****
***** I=    1 G=    2 TEST=  3,2313756-007 *****
     53  1,4435707+000  9,9871256-001  9,9920912-001  1,4981770-003  9,6005474-001  1,0166285+000  4,9655714-004
***** I=    1 G=    2 TEST=  3,1403351-007 *****
     54  1,4418647+000  9,9875366-001  9,9934651-001  1,6440615-003  9,6005474-001  1,1635981+000  5,9285248-004
***** I=    1 G=    2 TEST=  3,0370848-007 *****
     55  1,4402361+000  9,9879281-001  9,9944523-001  2,0947541-003  9,6005474-001  1,5522820+000  6,5242476-004
***** I=    1 G=    2 TEST=  2,9055263-007 *****
     56  1,4386921+000  9,9884295-001  9,9948735-001  3,2335267-003  9,6005474-001  2,5269601+000  6,444 345-004
***** I=    1 G=    2 TEST=  2,7097212-007 *****
     57  1,4372493+000  9,9891798-001  9,9945356-001  6,6141463-003  9,6005474-001  5,5388767+000  5,3558621-004
***** I=    1 G=    2 TEST=  2,3888379-007 *****
     58  1,4359500+000  9,9904036-001  9,9933286-001  1,8992879-002  9,6005474-001  1,7761422+001  2,925 192-004
***** I=    1 G=    2 TEST=  1,9430126-007 *****
     59  1,4348695+000  9,9894757-001  9,9928779-001  8,7551752-004  9,6005474-001  1,0000000+000  3,4021826-004
***** I=    1 G=    2 TEST=  1,7407274-007 *****
     60  1,4338334+000  9,9915942-001  9,9936805-001  8,3856759-004  9,6005474-001  1,0000000+000  2,0863004-004
***** I=    1 G=    2 TEST=  1,7288494-007 *****
     61  1,4328316+000  9,9922566-001  9,9947919-001  8,1077705-004  9,6005474-001  1,0000000+000  2,5353144-004
***** I=    1 G=    2 TEST=  1,7081766-007 *****
     62  1,4318670+000  9,9928922-001  9,9956826-001  7,9382358-004  9,6005474-001  1,0166285+000  2,7904387-004
***** I=    1 G=    2 TEST=  1,6625063-007 *****
     63  1,4309423+000  9,9931848-001  9,9964360-001  8,7146062-004  9,6005474-001  1,1635981+000  3,2511869-004
***** I=    1 G=    2 TEST=  1,6089598-007 *****
     64  1,4300593+000  9,9933993-001  9,9969770-001  1,1107598-003  9,6005474-001  1,5522820+000  3,5776588-004
***** I=    1 G=    2 TEST=  1,5405112-007 *****
     65  1,4292220+000  9,9936740-001  9,9972079-001  1,7155489-003  9,6005474-001  2,5269601+000  3,5339731-004
***** I=    1 G=    2 TEST=  1,4381430-007 *****
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***** I=    1 G=    2 TEST=  1,2709097-007 *****
     67  1,4277344+000  9,9947565-001  9,9963662-001  1,0109801-002  9,6005474-001  1,7761422+001  1,6096745-004
***** I=    1 G=    2 TEST=  1,0421036-007 *****
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69	1.4265857+000	9,9954243-001	9,9965633-001	4.4974496-004	9,6005474-001	1.0000000+000	1.1389966-004
70	1.4260420+000	9,9957562-001	9,9971707-001	4.3473920-004	9.6005474-001	1.0000000+000	1.4145524-004
71	1.4255184+000	9,9961451-001	9,9976569-001	4,2567035-004	9,6005474-001	1.0166285+000	1.5117916-004
72	1.4250165+000	9,9962817-001	9,9981247-001	4,6729309-004	9,6005474-001	1.1635981+000	1,843 589-004
73	1.4245373+000	9,9963992-001	9,9983623-001	5,9562812-004	9,6005474-001	1.5522820+000	1,9631525-004
74	1.4240829+000	9,9965504-001	9,9984886-001	9,2000923-004	9,6005474-001	2.5269601+000	1,9381179-004
75	1.4236582+000	9,9967757-001	9,9983923-001	1,8841731-003	9,6005474-001	5.5388767+000	1,6165474-004
76	1.4232759+000	9,9971469-001	9,9980258-001	5,4260203-003	9,6005474-001	1.7761422+001	8,7891880-005
77	1.4229572+000	9,9967343-001	9,9981528-001	2.5356379-004	9,6005474-001	1.0000000+000	1,4184861-004
78	1.4226525+000	9,9974973-001	9,9981805-001	2,4204831-004	9,6005474-001	1.0000000+000	6,8317400-005
79	1.4223577+000	9,9976959-001	9,9984642-001	2,3416698-004	9,6005474-001	1.0000000+000	7,6829776-005
80	1.4220737+000	9,9979118-001	9,9987288-001	2,2931768-004	9,6005474-001	1.0166285+000	8,1697915-005
81	1.4218016+000	9,9979782-001	9,9989523-001	2,5169974-004	9,6005474-001	1.1635981+000	9,7403637-005
82	1.4215418+000	9,9980420-001	9,9991123-001	3,2083415-004	9,6005474-001	1.5522820+000	1,0703165-004
83	1.4212954+000	9,9981256-001	9,9991802-001	4,9554595-004	9,6005474-001	2.5269601+000	1,0546207-004
84	1.4210652+000	9,9982453-001	9,9991248-001	1,0152584-003	9,6005474-001	5.5388767+000	8,7955850-005
85	1.4208580+000	9,9984517-001	9,9989284-001	2,9237914-003	9,6005474-001	1.7761422+001	4,767 372-005
86	1.4206836+000	9,9967709-001	9,9993249-001	1,3879969-004	9,6005474-001	1.0000000+000	2,554 883-004
87	1.4205186+000	9,9986026-001	9,9989903-001	1,3056352-004	9,6005474-001	1.0000000+000	3,8769154-005
88	1.4203589+000	9,9987423-001	9,9991684-001	1,2641867-004	9,6005474-001	1.0000000+000	4,2609419-005
89	1.4202050+000	9,9988567-001	9,9993118-001	1,2381980-004	9,6005474-001	1.0166285+000	4,5513938-005
90	1.4200576+000	9,9989036-001	9,9994539-001	1,3586878-004	9,6005474-001	1.1635981+000	5,5025317-005
91	1.4199168+000	9,9989379-001	9,9995203-001	1,7322225-004	9,6005474-001	1.5522820+000	5,8235921-005
92	1.4197833+000	9,9989823-001	9,9995564-001	2,6761273-004	9,6005474-001	2,5269601+000	5,7407509-005
93	1.4196586+000	9,9990493-001	9,9995283-001	5.4823954-004	9,6005474-001	5,5388767+000	4,7895883-005
94	1.4195463+000	9,9991581-001	9,9994376-001	1,5800426-003	9,6005474-001	1.7761422+001	2,7951421-005
95	1.4194528+000	9,9974712-001	1,0000429+000	7,4036345-005	9,6005474-001	1.0000000+000	2,9574678-004
96	1.4193633+000	9,9992270-001	9,9995905-001	7,0718834-005	9,6005474-001	1.0000000+000	3,6353347-005
97	1.4192767+000	9,9993186-001	9,9995486-001	6,8397847-005	9,6005474-001	1.0000000+000	2,2995140-005
98	1.4191933+000	9,9993703-001	9,9996265-001	6,8384810-005	9,6005474-001	1.0379257+000	2,5626010-005
99	1.4191134+000	9,9994042-001	9,9996944-001	8,9779939-005	9,6005474-001	1.4211184+000	2,9021321-005
100	1.4190372+000	9,9994259-001	9,9997211-001	1,7914929-004	9,6005474-001	2.9737645+000	2,952 845-005
101	1.4189659+000	9,9994592-001	9,9996957-001	7,3730196-004	9,6005474-001	1.3074430+001	2,3643079-005
102	1.4189064+000	9,9993867-001	9,9996776-001	4,7009896-005	9,6005474-001	1.0000000+000	2,9089570-005
103	1.4188487+000	9,9995564-001	9,9996343-001	4,5593970-005	9,6005474-001	1.0000000+000	7,7892182-006
104	1.4187931+000	9,9995902-001	9,9996956-001	4,3898106-005	9,6005474-001	1.0000000+000	1,0541757-005
105	1.4187398+000	9,9996023-001	9,9997552-001	4,4975925-005	9,6005474-001	1,0687317+000	1,5283687-005
106	1.4186890+000	9,9996158-001	9,9998027-001	7,7370678-005	9,6005474-001	1,9231781+000	1,8686842-005
107	1.4186409+000	9,9996353-001	9,9998108-001	3,6478240-004	9,6005474-001	9,5917065+000	1,7543658-005
108	1.4185994+000	9,9996564-001	9,9997591-001	3,2761109-005	9,6005474-001	1,0000000+000	1,0275209-005
109	1.4185595+000	9,9997007-001	9,9997802-001	3,1516602-005	9,6005474-001	1,0000000+000	7,9524470-006
110	1.4185213+000	9,9997082-001	9,9998242-001	3,0200335-005	9,6005474-001	1.0000000+000	1,1593773-005
111	1.4184848+000	9,9997187-001	9,9998651-001	3,0821755-005	9,6005474-001	1.0687317+000	1,4631369-005
112	1.4184502+000	9,9997299-001	9,9998951-001	5,2808395-005	9,6005474-001	1.9231781+000	1,6523045-005
113	1.4184176+000	9,9997468-001	9,9998962-001	2,4711880-004	9,6005474-001	9.5917065+000	1,4936813-005
114	1.4183905+000	9,9997379-001	9,9998555-001	2,1417564-005	9,6005474-001	1,0000000+000	1,1756201-005
115	1.4183644+000	9,9998052-001	9,9998525-001	2,0604513-005	9,6005474-001	1,0000000+000	4,7339126-006
116	1.4183395+000	9,9998105-001	9,9998824-001	1,9754603-005	9,6005474-001	1.0000000+000	7,1935501-006

117	1,4183156+000	9,9998169-001	9.9999101-001	2.1964572-005	9.6005474-001	1.1635981+000	9.3244162-006
118	1,4182929+000	9,9998232-001	9.9999288-001	9.9574750-005	9.6005474-001	5.5388767+000	1.0563177-005
119	1,4182726+000	9,9998459-001	9.9999103-001	1.6042433-005	9.6005474-001	1.0000000+000	6.4377818-006
120	1,4182532+000	9,9998496-001	9.9999219-001	1.5347305-005	9.6005474-001	1.0000000+000	7.2275579-006
121	1,4182348+000	9,9998552-001	9.9999446-001	1.4625305-005	9.6005474-001	1.0000000+000	8.9381501-006
122	1,4182173+000	9,9998615-001	9.9999604-001	1.6152955-005	9.6005474-001	1.1635981+000	9.8915480-006
123	1,4182007+000	9,9998673-001	9.9999699-001	7.2808889-005	9.6005474-001	5.5388767+000	1.0256583-005
124	1,4181864+000	9,9998879-001	9.9999443-001	1.1373005-005	9.6005474-001	1.0000000+000	5.6473655-006
125	1,4181727+000	9,9998930-001	9.9999515-001	1.0843978-005	9.6005474-001	1.0000000+000	5.8592850-006
126	1,4181597+000	9,9998960-001	9.9999660-001	1.0333076-005	9.6005474-001	1.0000000+000	7.0007663-006
127	1,4181473+000	9,9999000-001	9.9999770-001	1.1413483-005	9.6005474-001	1.1635981+000	7.7010482-006
128	1,4181357+000	9,9999048-001	9.9999836-001	5.1292011-005	9.6005474-001	5.5388767+000	7.8834710-006
129	1,4181258+000	9,9999225-001	9.9999633-001	7.8773123-006	9.6005474-001	1.0000000+000	4.0813320-006
130	1,4181163+000	9,9999246-001	9.9999690-001	7.5251852-006	9.6005474-001	1.0000000+000	4.4341868-006
131	1,4181073+000	9,9999271-001	9.9999791-001	7.1599257-006	9.6005474-001	1.0000000+000	5.1935640-006
132	1,4180988+000	9,9999299-001	9.9999867-001	7.8978028-006	9.6005474-001	1.1635981+000	5.6725985-006
133	1,4180907+000	9,9999333-001	9.9999911-001	3.5478085-005	9.6005474-001	5.5388767+000	5.7819707-006
134	1,4180839+000	9,9999289-001	9.9999785-001	5.4207764-006	9.6005474-001	1.0000000+000	4.9601949-006
135	1,4180774+000	9,9999471-001	9.9999801-001	5.1744791-006	9.6005474-001	1.0000000+000	3.3082470-006
136	1,4180712+000	9,9999496-001	9.9999871-001	4.9092900-006	9.6005474-001	1.0000000+000	3.7457066-006
137	1,4180654+000	9,9999516-001	9.9999922-001	5.4187060-006	9.6005474-001	1.1635981+000	4.0649320-006
138	1,4180599+000	9,9999545-001	9.9999952-001	2.4171238-005	9.6005474-001	5.5388767+000	4.0666491-006
139	1,4180553+000	9,9999393-001	9.9999950-001	3.7037964-006	9.6005474-001	1.0000000+000	5.5688433-006
140	1,4180508+000	9,9999616-001	9.9999873-001	3.5490765-006	9.6005474-001	1.0000000+000	2.5723857-006
141	1,4180466+000	9,9999639-001	9.9999920-001	3.3622529-006	9.6005474-001	1.0000000+000	2.8082286-006
142	1,4180427+000	9,9999668-001	9.9999955-001	3.6813238-006	9.6005474-001	1.1635981+000	2.8670765-006
143	1,4180389+000	9,9999682-001	9.9999974-001	1.6542171-005	9.6005474-001	5.5388767+000	2.9219664-006
144	1,4180357+000	9,9999738-001	9.9999900-001	2.5288873-006	9.6005474-001	1.0000000+000	1.6185222-006
145	1,4180328+000	9,9999754-001	9.9999918-001	2.3881211-006	9.6005474-001	1.0000000+000	1.6382837-006
146	1,4180299+000	9,9999762-001	9.9999951-001	2.2751716-006	9.6005474-001	1.0000000+000	1.8830178-006
147	1,4180272+000	9,9999770-001	9.9999974-001	2.4843960-006	9.6005474-001	1.1635981+000	2.0426087-006
148	1,4180247+000	9,9999777-001	9.9999987-001	1.1175483-005	9.6005474-001	5.5388767+000	2.1034066-006
149	1,4180226+000	9,9999688-001	9.9999955-001	1.7027758-006	9.6005474-001	1.0000000+000	2.6763300-006
150	1,4180205+000	9,9999794-001	9.9999946-001	1.6516429-006	9.6005474-001	1.0000000+000	1.5244877-006
151	1,4180186+000	9,9999837-001	9.9999970-001	1.5263562-006	9.6005474-001	1.0000000+000	1.3337412-006
152	1,4180168+000	9,9999846-001	9.9999985-001	1.6858843-006	9.6005474-001	1.1635981+000	1.3963581-006
153	1,4180151+000	9,9999852-001	9.9999994-001	7.5804368-006	9.6005474-001	5.5388767+000	1.4198595-006
154	1,4180137+000	9,9999759-001	9.9999978-001	1.1316722-006	9.6005474-001	1.0000000+000	2.1856104-006
155	1,4180123+000	9,9999872-001	9.9999965-001	1.0867702-006	9.6005474-001	1.0000000+000	9.3577546-007
156	1,4180110+000	9,9999887-001	9.9999981-001	1.0284952-006	9.6005474-001	1.0000000+000	9.4161078-007
157	1,4180098+000	9,9999896-001	9.9999992-001	1.1305025-006	9.6005474-001	1.1635981+000	9.5956784-007
158	1,4180087+000	9,9999900-001	9.9999997-001	5.0860235-006	9.6005474-001	5.5388767+000	9.6963777-007
159	1,4180077+000	9,9999886-001	9.9999971-001	7.6758066-007	9.6005474-001	1.0000000+000	8.5154898-007

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I= 2 G=1 J=1 FLUX= 1,6691894-002
I= 3 G=1 J=1 FLUX= 1,6450294-002
I= 4 G=1 J=1 FLUX= 1,6091181-002

```
I=    5 G=1 J=1 FLUX=  1,5618439-002
I=    6 G=1 J=1 FLUX=  1,5037175-002
I=    7 G=1 J=1 FLUX=  1,4353654-002
I=    8 G=1 J=1 FLUX=  1,3575229-002
I=    9 G=1 J=1 FLUX=  1,2710249-002
I=   10 G=1 J=1 FLUX=  1,1767960-002
I=   11 G=1 J=1 FLUX=  1,0758395-002
I=   12 G=1 J=1 FLUX=  9,6922528-003
I=   13 G=1 J=1 FLUX=  8,5807714-003
I=   14 G=1 J=1 FLUX=  7,4355953-003
I=   15 G=1 J=1 FLUX=  6,2686366-003
I=   16 G=1 J=1 FLUX=  5,0919350-003
I=   17 G=1 J=1 FLUX=  3,9175166-003
I=   18 G=1 J=1 FLUX=  2,7572525-003
I=   19 G=1 J=1 FLUX=  1,6227221-003
I=   20 G=1 J=1 FLUX=  5,2507853-004

CANDID2D HAS COPIED FLUX FROM LUN   42 ONTO LUN   48

IMAXIN=   20 JMAXIN=   20 IMAXOUT=   20 JMAXOUT=   20
I=    1 G=1 J=1 FLUX=  3,5355339-002
I=    2 G=1 J=1 FLUX=  3,5355339-002
I=    3 G=1 J=1 FLUX=  3,5355339-002
I=    4 G=1 J=1 FLUX=  3,5355339-002
I=    5 G=1 J=1 FLUX=  3,5355339-002
I=    6 G=1 J=1 FLUX=  3,5355339-002
I=    7 G=1 J=1 FLUX=  3,5355339-002
I=    8 G=1 J=1 FLUX=  3,5355339-002
I=    9 G=1 J=1 FLUX=  3,5355339-002
I=   10 G=1 J=1 FLUX=  3,5355339-002
I=   11 G=1 J=1 FLUX=  3,5355339-002
I=   12 G=1 J=1 FLUX=  3,5355339-002
I=   13 G=1 J=1 FLUX=  3,5355339-002
I=   14 G=1 J=1 FLUX=  3,5355339-002
I=   15 G=1 J=1 FLUX=  3,5355339-002
I=   16 G=1 J=1 FLUX=  3,5355339-002
I=   17 G=1 J=1 FLUX=  3,5355339-002
I=   18 G=1 J=1 FLUX=  3,5355339-002
I=   19 G=1 J=1 FLUX=  3,5355339-002
I=   20 G=1 J=1 FLUX=  3,5355339-002

CANDID2D HAS COPIED FLUX FROM LUN   49 ONTO LUN   48

IMAXIN=   20 JMAXIN=   20 IMAXOUT=   20 JMAXOUT=   20

CANDID2D IS PREPARING X SECTIONS ONLY ON LUN   48
```

PROB. NO. 1.01000+001 2DCANDID RT FULL CIRCLE 2, 2 GROUPS, 20X20 MESH PAGE NO. 17

FLUXES IN CHANNEL NO. 1 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	1.68134-002	7.94191-002	1
2	1.68134-002	7.94191-002	2
3	1.68134-002	7.94191-002	3
4	1.68134-002	7.94191-002	4
5	1.68133-002	7.94191-002	5
6	1.68133-002	7.94191-002	6
7	1.68133-002	7.94191-002	7
8	1.68133-002	7.94191-002	8
9	1.68133-002	7.94191-002	9
10	1.68133-002	7.94191-002	10
11	1.68133-002	7.94191-002	11
12	1.68133-002	7.94191-002	12
13	1.68133-002	7.94191-002	13
14	1.68133-002	7.94191-002	14
15	1.68133-002	7.94191-002	15
16	1.68133-002	7.94191-002	16
17	1.68134-002	7.94191-002	17
18	1.68134-002	7.94191-002	18
19	1.68134-002	7.94191-002	19
20	1.68134-002	7.94192-002	20

PROB. NO. 1.01000+001 2DCANDID RT FULL CIRCLE 2, 2 GROUPS, 20X20 MESH PAGE NO. 26

FLUXES IN CHANNEL NO. 10 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	1.17680-002	5.55869-002	1
2	1.17680-002	5.55869-002	2
3	1.17680-002	5.55869-002	3
4	1.17680-002	5.55869-002	4
5	1.17679-002	5.55869-002	5
6	1.17679-002	5.55869-002	6
7	1.17679-002	5.55868-002	7
8	1.17679-002	5.55868-002	8
9	1.17679-002	5.55868-002	9
10	1.17679-002	5.55868-002	10
11	1.17679-002	5.55868-002	11
12	1.17679-002	5.55868-002	12
13	1.17679-002	5.55868-002	13
14	1.17679-002	5.55868-002	14
15	1.17679-002	5.55869-002	15
16	1.17680-002	5.55869-002	16
17	1.17680-002	5.55869-002	17
18	1.17680-002	5.55869-002	18
19	1.17680-002	5.55869-002	19
20	1.17680-002	5.55869-002	20

FLUXES IN CHANNEL NO. 20 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	5,25079-004	2,48025-003	1
2	5,25078-004	2,48025-003	2
3	5,25078-004	2,48025-003	3
4	5,25078-004	2,48025-003	4
5	5,25078-004	2,48025-003	5
6	5,25078-004	2,48025-003	6
7	5,25078-004	2,48025-003	7
8	5,25078-004	2,48025-003	8
9	5,25078-004	2,48025-003	9
10	5,25078-004	2,48025-003	10
11	5,25078-004	2,48025-003	11
12	5,25078-004	2,48025-003	12
13	5,25078-004	2,48025-003	13
14	5,25078-004	2,48025-003	14
15	5,25078-004	2,48025-003	15
16	5,25078-004	2,48025-003	16
17	5,25078-004	2,48025-003	17
18	5,25078-004	2,48025-003	18
19	5,25078-004	2,48025-003	19
20	5,25079-004	2,48025-003	20

FLUX NORMALIZATION FACTOR IS 5.84356-001

7. Sample Problem 7

a. Description

(1) Problem Type

Real k_{eff} calculation

(2) Configuration

Same as Sample Problem 6

(3) Convergence Criteria

k_{eff} difference = 10^{-6}.

k_{eff} bounds = 10^{-3}.

Sum of flux difference = 10^{-3}.

Periodic = 10^{-4}.

Maximum number of periodic iterations = 5.

b. Output Listing

```
PROB. NO.   1.02000+001  2DCANDID  RT FULL CIRCLE 1, 2 GROUPS, 20X20 MESH                     PAGE NO.   16
    ITERATION HISTORY
ITERATION     K=EFFECTIVE          K=LOWER          K=UPPER   CHANGE IN PHI         SIGMA          ALPHA         ERRLAM
***** I=    1 G=    1 TEST=  7.8223789-004 *****
***** I=    1 G=    2 TEST= -1.7901878-003 *****
***** I=    2 G=    1 TEST=  2.5252598-004 *****
***** I=    2 G=    2 TEST= -5.9478709-004 *****
***** I=    3 G=    2 TEST= -1.5022675-004 *****
          1  1.0572093+000  8.1892435-001  1.1759743+000  1.8283174-001  1.0000000+000  1.0000000+000  8.5704996-001
    3.485
***** I=    1 G=    1 TEST=  1.1518030-003 *****
***** I=    1 G=    2 TEST= -2.5637999-003 *****
***** I=    2 G=    1 TEST=  2.7143803-004 *****
***** I=    2 G=    2 TEST= -6.2448533-004 *****
***** I=    3 G=    2 TEST= -1.4340434-004 *****
          2  1.1133531+000  6.1443016-001  1.1362627+000  1.2587037-001  1.0000000+000  1.0000000+000  5.2183255-001
***** I=    1 G=    1 TEST=  1.2848729-003 *****
***** I=    1 G=    2 TEST= -2.8392027-003 *****
***** I=    2 G=    1 TEST=  2.7117629-004 *****
***** I=    2 G=    2 TEST= -6.1943403-004 *****
***** I=    3 G=    2 TEST= -1.3575101-004 *****
          3  1.1683575+000  7.4081900-001  1.1090855+000  1.0246606-001  1.0000000+000  1.0000000-000  3.6826649-001
***** I=    1 G=    1 TEST=  1.3067079-003 *****
***** I=    1 G=    2 TEST= -2.8826818-003 *****
***** I=    2 G=    1 TEST=  2.6284161-004 *****
***** I=    2 G=    2 TEST= -5.9816032-004 *****
***** I=    3 G=    2 TEST= -1.2760969-004 *****
          4  1.2207146+000  8.0346143-001  1.0893509+000  8.8634227-002  1.0000000+000  1.0000000+000  2.8588947-001
***** I=    1 G=    1 TEST=  1.2762726-003 *****
***** I=    1 G=    2 TEST= -2.8163229-003 *****
***** I=    2 G=    1 TEST=  2.5051635-004 *****
***** I=    2 G=    2 TEST= -5.6896800-004 *****
***** I=    3 G=    2 TEST= -1.1926783-004 *****
          5  1.2694885+000  8.4043239-001  1.0784045+000  7.8258799-002  1.0000000+000  1.0000000+000  2.3797212-001
***** I=    1 G=    1 TEST=  1.2203436-003 *****
***** I=    1 G=    2 TEST= -2.6967430-003 *****
***** I=    2 G=    1 TEST=  2.3609236-004 *****
***** I=    2 G=    2 TEST= -5.3606527-004 *****
***** I=    3 G=    2 TEST= -1.1088911-004 *****
          6  1.3142499+000  8.6491673-001  1.0696473+000  6.9666595-002  1.0000000+000  1.0000000+000  2.0473057-001
***** I=    1 G=    1 TEST=  1.1517111-003 *****
***** I=    1 G=    2 TEST= -2.5518961-003 *****
***** I=    2 G=    1 TEST=  2.2068230-004 *****
***** I=    2 G=    2 TEST= -5.0167092-004 *****
***** I=    3 G=    2 TEST= -1.0306800-004 *****
          7  1.3548767+000  8.8250171-001  1.0616311+000  6.2284657-002  1.0000000+000  1.0000000+000  1.7912934-001
***** I=    1 G=    1 TEST=  1.0771454-003 *****
***** I=    1 G=    2 TEST= -2.3963335-003 *****
```

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***** I=   2 G=   1 TEST=  2.0495918-004 *****
***** I=   2 G=   2 TEST= -4.6800188-004 *****
    8  1,3914345+000  8,9599167-001  1,0545237+000  5,5838204-002  1,0000000+000  1,0000000+000  1,5853201-001
***** I=   1 G=   1 TEST=  1.0005196-003 *****
***** I=   1 G=   2 TEST= -2.2399812-003 *****
***** I=   2 G=   1 TEST=  1.8931621-004 *****
***** I=   2 G=   2 TEST= -4.3538648-004 *****
    9  1,4240935+000  9,0678371-001  1,0483359+000  5,0166725-002  1,0000000+000  1,0000000+000  1,4155216-001
***** I=   1 G=   1 TEST=  9.2407921-004 *****
***** I=   1 G=   2 TEST= -2,0873468-003 *****
***** I=   2 G=   1 TEST=  1.7402150-004 *****
***** I=   2 G=   2 TEST= -4,0431100-004 *****
   10  1,4530907+000  9,1569500-001  1,0429684+000  4,5169742-002  1,0000000+000  1,0000000+000  1,2727339-001
***** I=   1 G=   1 TEST=  8,4924290-004 *****
***** I=   1 G=   2 TEST= -1,9411309-003 *****
***** I=   2 G=   1 TEST=  1,5851945-004 *****
***** I=   2 G=   2 TEST= -3,7510155-004 *****
   11  1,4786775+000  9,2323223-001  1,0383140+000  4,0754857-002  1,0000000+000  1,0000000+000  1,1508181-001
***** I=   1 G=   1 TEST=  7.7550220-004 *****
***** I=   1 G=   2 TEST= -1.8030679-003 *****
***** I=   2 G=   1 TEST=  1.4484497-004 *****
***** I=   2 G=   2 TEST= -3.4778726-004 *****
   12  1,5011280+000  9,2972721-001  1,0342766+000  3,6864886-002  1,0000000+000  1,0000000+000  1,0454936-001
***** I=   1 G=   1 TEST=  7,0653759-004 *****
***** I=   1 G=   2 TEST= -1,6737403-003 *****
***** I=   2 G=   1 TEST=  1,3129008-004 *****
***** I=   2 G=   2 TEST= -3,2247858-004 *****
   13  1,5207020+000  9,3540410-001  1,0307640+000  3,3430397-002  1,0000000+000  1,0000000+000  9,5359912-002
***** I=   1 G=   1 TEST=  6,4050797-004 *****
***** I=   1 G=   2 TEST= -1,5535850-003 *****
***** I=   2 G=   1 TEST=  1,1879379-004 *****
***** I=   2 G=   2 TEST= -2,9896168-004 *****
   14  1,5376618+000  9,4042365-001  1,0277033+000  3,0409942-002  1,0000000+000  1,0000000+000  8,7279626-002
***** I=   1 G=   1 TEST=  5,7854615-004 *****
***** I=   1 G=   2 TEST= -1,4422112-003 *****
***** I=   2 G=   1 TEST=  1,0700701-004 *****
***** I=   2 G=   2 TEST= -2,7751538-004 *****
   15  1,5522494+000  9,4489979-001  1,0250240+000  2,7753551-002  1,0000000+000  1,0000000+000  8,0124196-002
***** I=   1 G=   1 TEST=  5,2037209-004 *****
***** I=   1 G=   2 TEST= -1,3399796-003 *****
***** I=   2 G=   2 TEST= -2,5791474-004 *****
   16  1,5646895+000  9,4891995-001  1,0226821+000  2,5821855-002  9,1264730-001  1,0157944+000  7,3762138-002
***** I=   1 G=   1 TEST=  4,6480772-004 *****
***** I=   1 G=   2 TEST= -1,2451247-003 *****
***** I=   2 G=   2 TEST= -2,3981587-004 *****
   17  1,5751703+000  9,5262728-001  1,0206012+000  2,6942641-002  9,1264730-001  1,1542734+000  6,7973898-002
***** I=   1 G=   1 TEST=  4,0477779-004 *****
***** I=   1 G=   2 TEST= -1,1478766-003 *****
```

```
***** I=    2 G=    2 TEST= =2,2145981=004 *****
     18  1,5836799+000  9,5660889=001  1,0185500+000  3,2166642=002  9,1264730=001  1,5110725+000  6,1941075=002
***** I=    1 G=    1 TEST=  3,2968317=004 *****
***** I=    1 G=    2 TEST= =1,0361908=003 *****
***** I=    2 G=    2 TEST= =2,0046139=004 *****
     19  1,5899962+000  9,6151950=001  1,0162867+000  4,4688758=002  9,1264730=001  2,3497836+000  5,4767198=002
***** I=    1 G=    1 TEST=  2,2192633=004 *****
***** I=    1 G=    2 TEST= =8,9070944=004 *****
***** I=    2 G=    2 TEST= =1,7287618=004 *****
     20  1,5935080+000  9,6848229=001  1,0134816+000  7,3372137=002  9,1264730=001  4,5247475+000  4,4999282=002
***** I=    1 G=    2 TEST= =6,7471235=004 *****
***** I=    2 G=    2 TEST= =1,2459181=004 *****
     21  1,5929066+000  9,7582942=001  1,0096231+000  1,2312748=001  9,1264730=001  9,7180260+000  3,3793709=002
***** I=    1 G=    1 TEST=  2,2878701=004 *****
***** I=    1 G=    2 TEST= =2,0985024=004 *****
     22  1,5863823+000  9,5378957=001  1,0206593+000  9,8555345=003  9,1264730=001  1,0000000+000  6,6869731=002
***** I=    1 G=    2 TEST= =2,4645124=004 *****
     23  1,5798546+000  9,8218288=001  1,0032082+000  9,2482908=003  9,1264730=001  1,0000000+000  2,1025347=002
***** I=    1 G=    2 TEST= =1,1621131=004 *****
     24  1,5732503+000  9,8951015=001  1,0024887+000  8,7673968=003  9,1264730=001  1,0000000+000  1,2978542=002
     25  1,5666735+000  9,8994324=001  1,0019057+000  8,5113225=003  9,1264730=001  1,0157944+000  1,1962474=002
     26  1,5601267+000  9,9037519=001  1,0016986+000  9,2536661=003  9,1264730=001  1,1542734+000  1,1323372=002
     27  1,5536685+000  9,9083309=001  1,0015613+000  1,1589469=002  9,1264730=001  1,5110725+000  1,0728165=002
     28  1,5472505+000  9,9135633=001  1,0010588+000  1,7176642=002  9,1264730=001  2,3497836+000  9,7024855=003
***** I=    1 G=    2 TEST=  1,3569644=004 *****
     29  1,5408156+000  9,9202445=001  1,0006403+000  3,1370929=002  9,1264730=001  4,5247475+000  8,6158827=003
***** I=    1 G=    2 TEST=  2,0108044=004 *****
     30  1,5343526+000  9,9074816=001  1,0003635+000  6,3286102=002  9,1264730=001  9,7180260+000  9,6153242=003
***** I=    1 G=    1 TEST=  1,6569548=004 *****
***** I=    1 G=    2 TEST=  3,7059514=004 *****
     31  1,5277659+000  9,5963826=001  1,0431383+000  6,4688746=003  9,1264730=001  1,0000000+000  8,3499986=002
***** I=    1 G=    1 TEST=  1,4179050=004 *****
***** I=    1 G=    2 TEST=  1,8569717=004 *****
     32  1,5214871+000  9,8448256=001  1,0072321+000  5,9170824=003  9,1264730=001  1,0000000+000  2,2749583=002
***** I=    1 G=    2 TEST=  3,0130014=004 *****
     33  1,5152830+000  9,9280266=001  9,9864103=001  5,7738714=003  9,1264730=001  1,0000000+000  5,8383679=003
***** I=    1 G=    2 TEST=  2,8335859=004 *****
     34  1,5093312+000  9,9515667=001  9,9788370=001  5,5367083=003  9,1264730=001  1,0000000+000  2,7270293=003
***** I=    1 G=    2 TEST=  2,7137821=004 *****
     35  1,5036462+000  9,9544044=001  9,9806475=001  5,3778854=003  9,5900781=001  1,0166101+000  2,6243043=003
***** I=    1 G=    2 TEST=  2,5722116=004 *****
     36  1,4982202+000  9,9577142=001  9,9844204=001  5,8755096=003  9,5900781=001  1,1633906+000  2,6706107=003
***** I=    1 G=    2 TEST=  2,4791829=004 *****
     37  1,4930489+000  9,9602559=001  9,9877734=001  7,4643647=003  9,5900781=001  1,5513477+000  2,7517508=003
***** I=    1 G=    2 TEST=  2,3654666=004 *****
     38  1,4881516+000  9,9629116=001  9,9905889=001  1,1475232=002  9,5900781=001  2,5227594+000  2,7677339=003
***** I=    1 G=    2 TEST=  2,2200091=004 *****
     39  1,4835652+000  9,9656870=001  9,9934015=001  2,3336183=002  9,5900781=001  5,5115966+000  2,7714493=003
```

```
***** I=    1 G=    2 TEST=  2,0114057-004 *****
   40  1,4794157+000  9,9122504-001  1,0031632+000  6,5917200-002  9,5900781-001  1,7442605+001  1,1938159-002
***** I=    1 G=    1 TEST=  2,4932646-004 *****
***** I=    2 G=    1 TEST=  2,8040680-004 *****
   41  1,4759384+000  9,2369434-001  1,1363508+000  5,7492100-003  9,5900781-001  1,0000000+000  2,1265644-001
***** I=    1 G=    1 TEST=  6,1958531-004 *****
***** I=    1 G=    2 TEST=  1,9636501-004 *****
   42  1,4723224+000  9,7343919-001  1,0233502+000  3,6995102-003  9,5900781-001  1,0000000+000  4,9911045-002
***** I=    1 G=    2 TEST=  1,6092075-004 *****
   43  1,4689550+000  9,9564611-001  1,0008422+000  2,9249081-003  9,5900781-001  1,0000000+000  5,1961128-003
***** I=    1 G=    2 TEST=  1,5627488-004 *****
   44  1,4657268+000  9,9702909-001  9,9918101-001  2,7972014-003  9,5900781-001  1,0000000+000  2,1519208-003
***** I=    1 G=    2 TEST=  1,5037825-004 *****
   45  1,4626296+000  9,9767140-001  9,9883236-001  2,6830751-003  9,5900781-001  1,0000000+000  1,1609664-003
***** I=    1 G=    2 TEST=  1,4586054-004 *****
   46  1,4596666+000  9,9780692-001  9,9904808-001  2,5685133-003  9,5900781-001  1,0000000+000  1,2411545-003
***** I=    1 G=    2 TEST=  1,4135622-004 *****
   47  1,4568365+000  9,9786984-001  9,9923686-001  3,5112302-003  9,5730206-001  1,4300000+000  1,3670241-003
***** I=    1 G=    2 TEST=  1,3532877-004 *****
   48  1,4541541+000  9,9795448-001  9,9928208-001  3,3282589-003  9,5730206-001  1,4300000+000  1,3276032-003
***** I=    1 G=    2 TEST=  1,2889303-004 *****
   49  1,4516444+000  9,9804581-001  9,9939309-001  3,1139198-003  9,5730206-001  1,4300000+000  1,3472793-003
***** I=    1 G=    2 TEST=  1,1746841-004 *****
   50  1,4492722+000  9,9804515-001  9,9947947-001  2,0584175-003  9,5730206-001  1,0000000+000  1,4343287-003
***** I=    1 G=    2 TEST=  1,1305426-004 *****
   51  1,4470316+000  9,9824886-001  9,9965182-001  1,9464904-003  9,5730206-001  1,0000000+000  1,4029584-003
***** I=    1 G=    2 TEST=  1,1082419-004 *****
   52  1,4449100+000  9,9831012-001  9,9977319-001  1,8462891-003  9,5730206-001  1,0000000+000  1,4630793-003
***** I=    1 G=    2 TEST=  1,0507172-004 *****
   53  1,4429052+000  9,9839328-001  9,9987319-001  1,7470336-003  9,5730206-001  1,0000000+000  1,4799112-003
***** I=    1 G=    2 TEST=  1,0026808-004 *****
   54  1,4410122+000  9,9846468-001  9,9995738-001  1,6793550-003  9,4624057-001  1,0163853+000  1,4927011-003
   55  1,4392332+000  9,9853453-001  1,0000254+000  1,8067458-003  9,4624057-001  1,1608654+000  1,4908167-003
   56  1,4375626+000  9,9860644-001  1,0000517+000  2,2527726-003  9,4624057-001  1,5400436+000  1,4452332-003
   57  1,4360142+000  9,9869546-001  1,0000106+000  3,3549978-003  9,4624057-001  2,4726331+000  1,3151678-003
   58  1,4346347+000  9,9887849-001  9,9988340-001  6,2628925-003  9,4624057-001  5,1993116+000  1,0049126-003
   59  1,4334356+000  9,9842589-001  9,9991542-001  1,5015903-002  9,4624057-001  1,4310121+001  1,4895292-003
***** I=    1 G=    2 TEST= -2,3423068-004 *****
   60  1,4327338+000  9,8737030-001  1,0084559+000  1,8816470-003  9,4624057-001  1,0000000+000  2,1085620-002
   61  1,4319057+000  9,9650765-001  1,0010751+000  8,4026171-004  9,4624057-001  1,0000000+000  4,5674005-003
   62  1,4311227+000  9,9880181-001  1,0000941+000  6,8726105-004  9,4624057-001  1,0000000+000  1,2922658-003
   63  1,4303503+000  9,9927825-001  9,9988870-001  6,5869054-004  9,4624057-001  1,0000000+000  6,1045610-004
   64  1,4296121+000  9,9937309-001  9,9974820-001  6,2783131-004  9,4624057-001  1,0000000+000  3,7511783-004
   65  1,4288875+000  9,9939550-001  9,9976478-001  6,1635443-004  9,4624057-001  1,0000000+000  3,6927266-004
   66  1,4281845+000  9,9933442-001  9,9981493-001  8,5554451-004  9,8171981-001  1,4300000+000  4,8051147-004
   67  1,4275392+000  9,9947452-001  9,9983007-001  7,8524929-004  9,8171981-001  1,4300000+000  3,5555140-004
   68  1,4268973+000  9,9929813-001  9,9985590-001  7,8410629-004  9,8171981-001  1,4300000+000  5,5777033-004
   69  1,4263128+000  9,9948778-001  9,9988291-001  4,9815141-004  9,8171981-001  1,0000000+000  3,9512606-004
```

70	1,4257653+000	9,9956970-001	9,9992504-001	4,6686425-004	9,8171981-001	1,0000000+000	3,5534290-004
71	1,4252359+000	9,9947969-001	9,9995427-001	4,5190272-004	9,8171981-001	1,0000000+000	4,7457310-004
72	1,4247396+000	9,9959814-001	9,9998016-001	4,3132814-004	9,8171981-001	1,0170102+000	3,8202407-004
73	1,4242593+000	9,9948457-001	9,9999985-001	4,8098750-004	9,8171981-001	1,1679099+000	5,1527885-004
74	1,4238111+000	9,9960956-001	1,0000101+000	6,0470024-004	9,8171981-001	1,5718723+000	4,0054266-004
75	1,4233836+000	9,9945687-001	9,9999965-001	9,6445573-004	9,8171981-001	2,6171420+000	5,4277734-004
76	1,4229883+000	9,9957523-001	9,9996477-001	2,1149193-003	9,8171981-001	6,1709454+000	3,8954000-004
77	1,4226636+000	9,9824684-001	1,0001966+000	9,5691209-003	9,8171981-001	2,8566669+001	1,9437486-003
***** I=	1 G=	2 TEST=	6,8637176-004 *****				
***** I=	2 G=	2 TEST=	-2,7848911-004 *****				
78	1,4216070+000	9,8263406-001	1,0399164+000	5,5429497-003	9,8171981-001	1,0000000+000	5,7282319-002
79	1,4215118+000	9,9937867-001	1,0023387+000	4,7597861-004	9,8171981-001	1,0000000+000	2,9600482-003
80	1,4213619+000	9,9969095-001	1,0003852+000	1,8482635-004	9,8171981-001	1,0000000+000	6,9424920-004
81	1,4212024+000	9,9974048-001	1,0001385+000	1,5345622-004	9,8171981-001	1,0000000+000	3,9797317-004
82	1,4210480+000	9,9977126-001	1,0000936+000	2,0562867-004	8,3027242-001	1,4300000+000	3,2228776-004
83	1,4208975+000	9,9979647-001	1,0000527+000	1,9387591-004	8,3027242-001	1,4300000+000	2,5618958-004
84	1,4207502+000	9,9981110-001	1,0000125+000	1,8541942-004	8,3027242-001	1,4300000+000	2,0137124-004
85	1,4206061+000	9,9982944-001	9,9999055-001	1,2485432-004	8,3027242-001	1,0000000+000	1,6110556-004
86	1,4204660+000	9,9983791-001	9,9997410-001	1,2043511-004	8,3027242-001	1,0000000+000	1,3618819-004
87	1,4203300+000	9,9984842-001	9,9996417-001	1,1620696-004	8,3027242-001	1,0000000+000	1,1574627-004
88	1,4201983+000	9,9985769-001	9,9996182-001	1,1203444-004	8,3027242-001	1,0000000+000	1,0412520-004
89	1,4200710+000	9,9986691-001	9,9996872-001	1,0973643-004	9,6409409-001	1,0166997+000	1,0180163-004
90	1,4199482+000	9,9987582-001	9,9997472-001	1,2095021-004	9,6409409-001	1,1643996+000	9,8896868-005
91	1,4198301+000	9,9988544-001	9,9997815-001	1,5523895-004	9,6409409-001	1,5558974+000	9,2717863-005
92	1,4197169+000	9,9989699-001	9,9997716-001	2,4276916-004	9,6409409-001	2,5432997+000	8,0167039-005
93	1,4196096+000	9,9991266-001	9,9997019-001	5,1086547-004	9,6409409-001	5,6467117+000	5,7524259-005
94	1,4195105+000	9,9992182-001	9,9995366-001	1,5945322-003	9,6409409-001	1,9109036+001	3,1833464-005
95	1,4194268+000	9,9992336-001	9,9994789-001	7,0364680-005	9,6409409-001	1,0000000+000	2,4536115-005
96	1,4193457+000	9,9993286-001	9,9995330-001	6,8154809-005	9,6409409-001	1,0000000+000	2,0438150-005
97	1,4192672+000	9,9993581-001	9,9996218-001	6,5991922-005	9,6409409-001	1,0000000+000	2,6367372-005
98	1,4191915+000	9,9993675-001	9,9996927-001	6,5277434-005	9,6409409-001	1,0241631+000	3,2519180-005
99	1,4191185+000	9,9993801-001	9,9997523-001	7,6703840-005	9,6409409-001	1,2479828+000	3,7216319-005
100	1,4190484+000	9,9993942-001	9,9997906-001	1,1407207-004	9,6409409-001	1,9306773+000	3,9633058-005
101	1,4189816+000	9,9994168-001	9,9997920-001	2,4032787-004	9,6409409-001	4,2623419+000	3,7518970-005
102	1,4189194+000	9,9994611-001	9,9997474-001	8,8244153-004	9,6409409-001	1,6807014+001	2,8633120-005
103	1,4188675+000	9,9995428-001	9,9996953-001	4,3603973-005	9,6409409-001	1,0000000+000	1,5246638-005
104	1,4188174+000	9,9996032-001	9,9997186-001	4,2118775-005	9,6409409-001	1,0000000+000	1,1545722-005
105	1,4187688+000	9,9996126-001	9,9997680-001	4,0772978-005	9,6409409-001	1,0000000+000	1,5546408-005
106	1,4187220+000	9,9996194-001	9,9998133-001	4,0849286-005	9,6409409-001	1,0380914+000	1,9389365-005
107	1,4186770+000	9,9996261-001	9,9998517-001	5,3988798-005	9,6409409-001	1,4236408+000	2,2566004-005
108	1,4186339+000	9,9996335-001	9,9998713-001	1,0910633-004	9,6409409-001	2,9986668+000	2,3788103-005
109	1,4185931+000	9,9996510-001	9,9998565-001	4,7340477-004	9,6409409-001	1,3774189+001	2,0550564-005
110	1,4185586+000	9,9997044-001	9,9998093-001	2,9035659-005	9,6409409-001	1,0000000+000	1,0490316-005
111	1,4185252+000	9,9997167-001	9,9998155-001	2,8103502-005	9,6409409-001	1,0000000+000	9,8777236-006
112	1,4184930+000	9,9997265-001	9,9998518-001	2,7100176-005	9,6409409-001	1,0000000+000	1,2528239-005
113	1,4184620+000	9,9997334-001	9,9998855-001	2,7922447-005	9,6409409-001	1,0690409+000	1,5215643-005
114	1,4184322+000	9,9997381-001	9,9999123-001	4,8475126-005	9,6409409-001	1,9306773+000	1,7416751-005
115	1,4184039+000	9,9997484-001	9,9999157-001	2,3795727-004	9,6409409-001	9,9514403+000	1,6726903-005

116	1,4183792+000	9,9997907-001	9,9998703-001	2,0840117-005	9,6409409-001	1,0000000+000	7,9580641-006
117	1,4183554+000	9,9997962-001	9,9998850-001	2,0086463-005	9,6409409-001	1,0000000+000	8,8813977-006
118	1,4183325+000	9,9998000-001	9,9999163-001	1,9310906-005	9,6409409-001	1,0000000+000	1,1626733-005
119	1,4183106+000	9,9998041-001	9,9999407-001	1,9830190-005	9,6409409-001	1,0690409+000	1,3658020-005
120	1,4182896+000	9,9998080-001	9,9999586-001	3,4325533-005	9,6409409-001	1,9306773+000	1,5054116-005
121	1,4182698+000	9,9998158-001	9,9999587-001	1,6753490-004	9,6409409-001	9,9514403+000	1,4289748-005
122	1,4182529+000	9,9998521-001	9,9999186-001	1,4225115-005	9,6409409-001	1,0000000+000	6,6426292-006
123	1,4182367+000	9,9998562-001	9,9999235-001	1,3698489-005	9,6409409-001	1,0000000+000	6,7342044-006
124	1,4182212+000	9,9998586-001	9,9999456-001	1,3168657-005	9,6409409-001	1,0000000+000	8,6988293-006
125	1,4182063+000	9,9998618-001	9,9999626-001	1,4725678-005	9,6409409-001	1,1643996+000	1,0077027-005
126	1,4181920+000	9,9998654-001	9,9999740-001	6,8359486-005	9,6409409-001	5,6467117+000	1,0857519-005
127	1,4181792+000	9,9998824-001	9,9999566-001	1,0897734-005	9,6409409-001	1,0000000+000	7,4159907-006
128	1,4181669+000	9,9998844-001	9,9999669-001	1,0455873-005	9,6409409-001	1,0000000+000	8,2500337-006
129	1,4181551+000	9,9998872-001	9,9999814-001	1,0019058-005	9,6409409-001	1,0000000+000	9,4210263-006
130	1,4181439+000	9,9998899-001	9,9999912-001	1,1165201-005	9,6409409-001	1,1643996+000	1,0129210-005
131	1,4181332+000	9,9998933-001	9,9999971-001	5,1624754-005	9,6409409-001	5,6467117+000	1,0380492-005
132	1,4181239+000	9,9999086-001	9,9999744-001	8,0297801-006	9,6409409-001	1,0000000+000	6,5759086-006
133	1,4181149+000	9,9999107-001	9,9999816-001	7,6902885-006	9,6409409-001	1,0000000+000	7,0908427-006
134	1,4181063+000	9,9999131-001	9,9999923-001	7,3550307-006	9,6409409-001	1,0000000+000	7,9191232-006
135	1,4180982+000	9,9999155-001	9,9999994-001	8,1815214-006	9,6409409-001	1,1643996+000	8,3906925-006
136	1,4180904+000	9,9999184-001	1,0000004+000	3,7743982-005	9,6409409-001	5,6467117+000	8,5183128-006
137	1,4180837+000	9,9999315-001	9,9999862-001	5,7782335-006	9,6409409-001	1,0000000+000	5,4714765-006
138	1,4180773+000	9,9999332-001	9,9999912-001	5,5269561-006	9,6409409-001	1,0000000+000	5,7976140-006
139	1,4180713+000	9,9999352-001	9,9999987-001	5,2798290-006	9,6409409-001	1,0000000+000	6,3471525-006
140	1,4180655+000	9,9999371-001	1,0000004+000	5,8665836-006	9,6409409-001	1,1643996+000	6,6435896-006
141	1,4180600+000	9,9999394-001	1,0000006+000	2,7026203-005	9,6409409-001	5,6467117+000	6,6903885-006
142	1,4180553+000	9,9999499-001	9,9999932-001	4,0899595-006	9,6409409-001	1,0000000+000	4,3266919-006
143	1,4180508+000	9,9999513-001	9,9999966-001	3,9081764-006	9,6409409-001	1,0000000+000	4,5337802-006
144	1,4180465+000	9,9999528-001	1,0000002+000	3,7298913-006	9,6409409-001	1,0000000+000	4,8974180-006
145	1,4180425+000	9,9999543-001	1,0000005+000	4,1407069-006	9,6409409-001	1,1643996+000	5,0827803-006
146	1,4180387+000	9,9999560-001	1,0000007+000	1,9053848-005	9,6409409-001	5,6467117+000	5,0899398-006
147	1,4180354+000	9,9999640-001	9,9999972-001	2,8552233-006	9,6409409-001	1,0000000+000	3,3164397-006
148	1,4180323+000	9,9999651-001	9,9999995-001	2,7262197-006	9,6409409-001	1,0000000+000	3,4455588-006
149	1,4180294+000	9,9999662-001	1,0000003+000	2,5998604-006	9,6409409-001	1,0000000+000	3,6824495-006
150	1,4180266+000	9,9999673-001	1,0000005+000	2,8841361-006	9,6409409-001	1,1643996+000	3,7956634-006
151	1,4180239+000	9,9999686-001	1,0000006+000	1,3258921-005	9,6409409-001	5,6467117+000	3,7839927-006
152	1,4180217+000	9,9999746-001	9,9999994-001	1,9690136-006	9,6409409-001	1,0000000+000	2,4822075-006
153	1,4180196+000	9,9999753-001	1,0000001+000	1,8786638-006	9,6409409-001	1,0000000+000	2,5616027-006
154	1,4180176+000	9,9999762-001	1,0000003+000	1,7903603-006	9,6409409-001	1,0000000+000	2,7136703-006
155	1,4180157+000	9,9999770-001	1,0000005+000	1,9848053-006	9,6409409-001	1,1643996+000	2,7810165-006
156	1,4180139+000	9,9999779-001	1,0000006+000	9,1164308-006	9,6409409-001	5,6467117+000	2,7619535-006
157	1,4180124+000	9,9999822-001	1,0000000+000	1,3420615-006	9,6409409-001	1,0000000+000	1,8226565-006
158	1,4180110+000	9,9999828-001	1,0000002+000	1,2795962-006	9,6409409-001	1,0000000+000	1,8704159-006
159	1,4180096+000	9,9999834-001	1,0000003+000	1,2186548-006	9,6409409-001	1,0000000+000	1,9662839-006
160	1,4180083+000	9,9999840-001	1,0000004+000	1,3501412-006	9,6409409-001	1,1643996+000	2,0050502-006
161	1,4180071+000	9,9999847-001	1,0000005+000	6,1962233-006	9,6409409-001	5,6467117+000	1,9845611-006
162	1,4180061+000	9,9999878-001	1,0000001+000	9,0420486-007	9,6409409-001	1,0000000+000	1,3173558-006
163	1,4180052+000	9,9999882-001	1,0000002+000	8,6154555-007	9,6409409-001	1,0000000+000	1,3445097-006

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I=   1 G=1 J=1 FLUX=  1,7852171-002
I=   2 G=1 J=1 FLUX=  1,7723179-002
I=   3 G=1 J=1 FLUX=  1,7466637-002
I=   4 G=1 J=1 FLUX=  1,7085321-002
I=   5 G=1 J=1 FLUX=  1,6583358-002
I=   6 G=1 J=1 FLUX=  1,5966168-002
I=   7 G=1 J=1 FLUX=  1,5240407-002
I=   8 G=1 J=1 FLUX=  1,4413881-002
I=   9 G=1 J=1 FLUX=  1,3495454-002
I=  10 G=1 J=1 FLUX=  1,2494945-002
I=  11 G=1 J=1 FLUX=  1,1423006-002
I=  12 G=1 J=1 FLUX=  1,0290996-002
I=  13 G=1 J=1 FLUX=  9,1108484-003
I=  14 G=1 J=1 FLUX=  7,8949261-003
I=  15 G=1 J=1 FLUX=  6,6558771-003
I=  16 G=1 J=1 FLUX=  5,4064845-003
I=  17 G=1 J=1 FLUX=  4,1595168-003
I=  18 G=1 J=1 FLUX=  2,9275785-003
I=  19 G=1 J=1 FLUX=  1,7229637-003
I=  20 G=1 J=1 FLUX=  5,5751462-004

CANDID2D HAS COPIED FLUX FROM LUN   42 ONTO LUN   48

IMAXIN=   20 JMAXIN=   20 IMAXOUT=   20 JMAXOUT=   20
I=   1 G=1 J=1 FLUX=  3,5355339-002
I=   2 G=1 J=1 FLUX=  3,5355339-002
I=   3 G=1 J=1 FLUX=  3,5355339-002
I=   4 G=1 J=1 FLUX=  3,5355339-002
I=   5 G=1 J=1 FLUX=  3,5355339-002
I=   6 G=1 J=1 FLUX=  3,5355339-002
I=   7 G=1 J=1 FLUX=  3,5355339-002
I=   8 G=1 J=1 FLUX=  3,5355339-002
I=   9 G=1 J=1 FLUX=  3,5355339-002
I=  10 G=1 J=1 FLUX=  3,5355339-002
I=  11 G=1 J=1 FLUX=  3,5355339-002
I=  12 G=1 J=1 FLUX=  3,5355339-002
I=  13 G=1 J=1 FLUX=  3,5355339-002
I=  14 G=1 J=1 FLUX=  3,5355339-002
I=  15 G=1 J=1 FLUX=  3,5355339-002
I=  16 G=1 J=1 FLUX=  3,5355339-002
I=  17 G=1 J=1 FLUX=  3,5355339-002
I=  18 G=1 J=1 FLUX=  3,5355339-002
I=  19 G=1 J=1 FLUX=  3,5355339-002
I=  20 G=1 J=1 FLUX=  3,5355339-002
CANDID2D HAS COPIED FLUX FROM LUN   49 ONTO LUN   48

IMAXIN=   20 JMAXIN=   20 IMAXOUT=   20 JMAXOUT=   20
CANDID2D IS PREPARING X SECTIONS ONLY ON LUN   48
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PROB, NO, 1,02000+001 2DCANDID RT FULL CIRCLE 1, 2 GROUPS, 20X20 MESH PAGE NO, 17

FLUXES IN CHANNEL NO, 1 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	1,78522-002	8,43264-002	1
2	1,78522-002	8,43263-002	2
3	1,78522-002	8,43263-002	3
4	1,78522-002	8,43262-002	4
5	1,78521-002	8,43262-002	5
6	1,78521-002	8,43262-002	6
7	1,78521-002	8,43261-002	7
8	1,78521-002	8,43261-002	8
9	1,78521-002	8,43261-002	9
10	1,78521-002	8,43261-002	10
11	1,78521-002	8,43261-002	11
12	1,78521-002	8,43261-002	12
13	1,78521-002	8,43261-002	13
14	1,78521-002	8,43261-002	14
15	1,78521-002	8,43261-002	15
16	1,78521-002	8,43262-002	16
17	1,78522-002	8,43262-002	17
18	1,78522-002	8,43263-002	18
19	1,78522-002	8,43263-002	19
20	1,78522-002	8,43264-002	20

PROB, NO, 1,02000+001 2DCANDID RT FULL CIRCLE 1, 2 GROUPS, 20X20 MESH PAGE NO, 26

FLUXES IN CHANNEL NO, 10 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	1,24949-002	5,90209-002	1
2	1,24949-002	5,90208-002	2
3	1,24949-002	5,90208-002	3
4	1,24949-002	5,90208-002	4
5	1,24949-002	5,90207-002	5
6	1,24949-002	5,90207-002	6
7	1,24949-002	5,90207-002	7
8	1,24949-002	5,90206-002	8
9	1,24949-002	5,90206-002	9
10	1,24949-002	5,90206-002	10
11	1,24949-002	5,90206-002	11
12	1,24949-002	5,90206-002	12
13	1,24949-002	5,90206-002	13
14	1,24949-002	5,90207-002	14
15	1,24949-002	5,90207-002	15
16	1,24949-002	5,90207-002	16
17	1,24949-002	5,90208-002	17
18	1,24949-002	5,90208-002	18
19	1,24949-002	5,90208-002	19
20	1,24949-002	5,90209-002	20

FLUXES IN CHANNEL NO, 20 ARE

ZMESH	GROUP 1	GROUP 2	ZMESH
1	5,57515-004	2,63346-003	1
2	5,57514-004	2,63346-003	2
3	5,57514-004	2,63346-003	3
4	5,57514-004	2,63346-003	4
5	5,57513-004	2,63346-003	5
6	5,57513-004	2,63345-003	6
7	5,57512-004	2,63345-003	7
8	5,57512-004	2,63345-003	8
9	5,57512-004	2,63345-003	9
10	5,57512-004	2,63345-003	10
11	5,57512-004	2,63345-003	11
12	5,57512-004	2,63345-003	12
13	5,57512-004	2,63345-003	13
14	5,57512-004	2,63345-003	14
15	5,57513-004	2,63345-003	15
16	5,57513-004	2,63346-003	16
17	5,57514-004	2,63346-003	17
18	5,57514-004	2,63346-003	18
19	5,57515-004	2,63346-003	19
20	5,57515-004	2,63346-003	20

FLUX NORMALIZATION FACTOR IS 5,50358-001

8. Sample Problem 8

a. Description

(1) Problem Type

Real k_{eff} calculation

(2) Configuration

(a) Geometry

xy

(b) Region Definition

The reactor consists of three regions as follows:

Region No. 1: Internal thermal column (water).

Region No. 1: Core region composed of enriched uranium, stainless steel, and water.

Region No. 3: Reflector composed of beryllium and water.

(c) Mesh Definition

x direction: nine points

y direction: nine points

Buckling (B^2) = 0.0027416

(d) Boundary Conditions

Left: $\phi' = 0.$

Right: $\phi = 0.$

Bottom: $\phi' = 0.$

Top: $\phi = 0.$

(e) Number of Energy Groups: 18.

(3) Convergence Criteria

k_{eff} difference = 10^{-5}.

k_{eff} bounds = 10^{-5}.

Sum of flux difference = 10^{-5}.

Up-scattering = 10^{-3}.

Maximum number of up-scattering iterations = 0.

b. Output Listing

```
PROB. NO,    7,10000+000   2DCANDID   K CALC(UPSCAT-NO INNERS),XY,18 GROUPS,9x9MESH           PAGE NO,    3
                                        REACTOR GEOMETRY

     GEOMETRY                      LEFT              RIGHT            BOTTOM             TOP
       TYPE                        BOUND             BOUND             BOUND            BOUND

 2D-XY WITH NO SYMMETRY          0,0000+000        3,6000+001        0,0000+000        3,6000+001



                                        REGION BOUNDARIES

                REGION NO,       LEFT BDRY,        RIGHT BDRY,       BOTTOM BDRY,       TOP BDRY.

                        1        0,0000+000        3.6000+001        0,0000+000        3.6000+001
                        2        0,0000+000        2,1000+001        0,0000+000        2,1000+001
                        3        0,0000+000        6,0000+000        0.0000+000        6,0000+000


 PROB. NO,    7,10000+000   2DCANDID   K CALC(UPSCAT-NO INNERS),XY,18 GROUPS,9x9MESH           PAGE NO,    4
                                        MESH DEFINITION


                              INCREMENT METHOD - X(R) DIRECTION

         X(R)  INCREMENTS         X(R)  INCREMENTS         X(R)  INCREMENTS         X(R)  INCREMENT         X(R)

     0,0000+000     3         6,0000+000     3         2.1000+001     3         3.6000+001

 IMAX =      9


                          X(R) PLUS DELTA X(R) FROM LEFT  TO RIGHT OF REACTOR

MESH NO,           1          2          3          4          5          6          7          8          9
ABSCISSA  2.0000+000 4,0000+000 6,0000+000 1,1000+001 1,6000+001 2.1000+001 2.6000+001 3.1000+001 3,6000+001
```

```
PROB. NO.   7.10000+000   2DCANDID   K CALC(UPSCAT=NO INNERS),XY,18 GROUPS,9x9MESH            PAGE NO.    6
  Z                                            REGION MAP                                                          Z
 MESH                                   (REGION NUMBER BY MESH POINT)                                             MESH
POINTS                                         R MESH POINTS                                                      POINTS
          1    2    3    4    5    6    7    8    9
       *************************************
       9*  1    1    1    1    1    1    1    1    1*  9
        *                                         *
       8*  1    1    1    1    1    1    1    1    1*  8
        *                                         *
       7*  1    1    1    1    1    1    1    1    1*  7
        *************************                 *
       6*  2    2    2    2    2    2*   1    1    1*  6
        *                             *           *
       5*  2    2    2    2    2    2*   1    1    1*  5
        *                             *           *
       4*  2    2    2    2    2    2*   1    1    1*  4
        *************                 *           *
       3*  3    3    3*   2    2    2*   1    1    1*  3
        *             *               *           *
       2*  3    3    3*   2    2    2*   1    1    1*  2
        *             *               *           *
       1*  3    3    3*   2    2    2*   1    1    1*  1
        *************************************
          1    2    3    4    5    6    7    8    9
                                                   R MESH POINTS
```

```
PROB. NO.   7.10000+000   2DCANDID   K CALC(UPSCAT=NO INNERS),XY,18 GROUPS,9x9MESH            PAGE NO.    5
                                              MESH DEFINITION

                                    INCREMENT METHOD - Y(Z) DIRECTION

       Y(Z)  INCREMENTS        Y(Z)  INCREMENTS        Y(Z)  INCREMENTS        Y(Z)  INCREMENTS        Y(Z)

  0.0000+000     3        6.0000+000     3        2.1000+001     3        3.6000+001

JMAX =    9

                          Y(Z) PLUS DELTA Y(Z) FROM BOTTOM TO TOP OF REACTOR

Y(Z) MESH NO.     1          2          3          4          5          6          7          8          9
 ORDINATE 2.0000+000 4.0000+000 6.0000+000 1.1000+001 1.6000+001 2.1000+001 2.6000+001 3.1000+001 3.6000+001
```

PROB. NO, 7,10000+000 2DCANDID K CALC(UPSCAT-NO INNERS),XY,18 GROUPS,9x9MESH PAGE NO. 35

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	8,0551883+000	3,2283639-002	1,2558345+002	4,2704011+000	1,0000000+000	1,0000000+000	1,2555116+002
5,803							
2	5,9538542+000	1,7672015-001	3,2618348+000	2,1411204+000	1,0000000+000	1,0000000+000	3,0851146+000
3	4,7115020+000	4,4604123-001	2,1563654+000	1,1766309+000	1,0000000+000	1,0000000+000	1,7103242+000
4	4,2618539+000	5,4015625-001	1,8993805+000	6,5130688-001	1,0000000+000	1,0000000+000	1,3592242+000
5	4,0241743+000	6,1243324-001	1,6706014+000	3,8707505-001	1,0000000+000	1,0000000+000	1,0581681+000
6	3,8575030+000	6,5825446-001	1,4524148+000	2,7163750-001	1,0000000+000	1,0000000+000	7,9416038-001
7	3,7160165+000	7,0705650-001	1,2889248+000	2,1451338-001	1,0000000+000	1,0000000+000	5,8186827-001
8	3,5907815+000	7,5137861-001	1,2251130+000	1,7486507-001	1,0000000+000	1,0000000+000	4,7373440-001
9	3,4743711+000	7,8866298-001	1,1687512+000	1,4414567-001	1,0000000+000	1,0000000+000	3,8008818-001
10	3,3617026+000	8,1853468-001	1,1241578+000	1,2031145-001	1,0000000+000	1,0000000+000	3,0562309-001
11	3,2498830+000	8,2285771-001	1,0898438+000	1,0216737-001	1,0000000+000	1,0000000+000	2,6698611-001
12	3,1375842+000	8,2516623-001	1,0661315+000	8,8664797-002	1,0000000+000	1,0000000+000	2,4096523-001
13	3,0244739+000	8,2940678-001	1,0475794+000	7,8814235-002	1,0000000+000	1,0000000+000	2,1817262-001
14	2,9107982+000	8,3475462-001	1,0326010+000	7,1699842-002	1,0000000+000	1,0000000+000	1,9784638-001
15	2,7971010+000	8,4074458-001	1,0205099+000	6,6522623-002	1,0000000+000	1,0000000+000	1,7976533-001
16	2,6840447+000	8,4715053-001	1,0107150+000	6,3644525-002	9,2779316-001	1,0160608+000	1,6356448-001
17	2,5722388+000	8,4886438-001	1,0026094+000	6,8892877-002	9,2779316-001	1,1572362+000	1,5374505-001
18	2,4618579+000	8,5063166-001	9,9506735-001	8,6328140-002	9,2779316-001	1,5239983+000	1,4443569-001
19	2,3526481+000	8,5522401-001	9,8710456-001	1,2841227-001	9,2779316-001	2,4036257+000	1,3188055-001
20	2,2438493+000	8,6957999-001	9,7757420-001	2,3469570-001	9,2779316-001	4,8058668+000	1,0799421-001
21	2,1340925+000	9,3361620-001	9,6530931-001	4,5177697-001	9,2779316-001	1,1361863+001	3,1693109-002
22	2,0247988+000	7,5932594-001	1,1068620+000	1,8633186-002	9,2779316-001	1,0000000+000	3,4753610-001
23	1,9209214+000	8,6182989-001	1,0476705+000	1,7669340-002	9,2779316-001	1,0000000+000	1,8584058-001
24	1,8228106+000	8,8044344-001	1,0382255+000	1,6698628-002	9,2779316-001	1,0000000+000	1,5778209-001
25	1,7303012+000	8,9623935-001	1,0411134+000	1,6014333-002	9,2779316-001	1,0160608+000	1,4487407-001
26	1,6432201+000	9,1499654-001	1,0445956+000	1,7180673-002	9,2779316-001	1,1572362+000	1,2959901-001
27	1,5614720+000	9,4038160-001	1,0458302+000	2,1104156-002	9,2779316-001	1,5239983+000	1,0544862-001
28	1,4851944+000	9,4728368-001	1,0420236+000	3,0275172-002	9,2779316-001	2,4036257+000	9,4739945-002
29	1,4151771+000	9,4883687-001	1,0280506+000	5,1695215-002	9,2779316-001	4,8058668+000	7,9213745-002
30	1,3547195+000	9,5304036-001	1,0317040+000	8,5922151-002	9,2779316-001	1,1361863+001	7,8663685-002
31	1,3165220+000	9,1634075-001	1,0016153+000	2,5834059-003	9,2779316-001	1,0000000+000	8,5274500-002
32	1,2805365+000	9,5547080-001	9,9938135-001	2,4448271-003	9,2779316-001	1,0000000+000	4,3910549-002
33	1,2467132+000	9,6766341-001	1,0083426+000	2,3366075-003	9,2779316-001	1,0000000+000	4,0679201-002
34	1,2150167+000	9,6831762-001	1,0160443+000	2,2756156-003	9,2779316-001	1,0160608+000	4,7726729-002
35	1,1855687+000	9,6906845-001	1,0226849+000	2,4807272-003	9,2779316-001	1,1572362+000	5,3616415-002
36	1,1585613+000	9,6999782-001	1,0268248+000	3,0991304-003	9,2779316-001	1,5239983+000	5,6827006-002
37	1,1344588+000	9,7053065-001	1,0273433+000	4,5160331-003	9,2779316-001	2,4036257+000	5,6812614-002

38	1,1144818+000	9,7161557-001	1,0240860+000	7,7646061-003	9,2779316-001	4,8058668+000	5.2470464-002
39	1,1022009+000	9,7487736-001	1,0157558+000	1.2362035-002	9,2779316-001	1.1361863+001	4.0878474-002
40	1,1041487+000	9,8533320-001	1,0193509+000	2,4708213-004	9,2779316-001	1,0000000+000	3.4017724-002
41	1,1063391+000	9,9075131-001	1,0101893+000	2,2751953-004	9,2779316-001	1,0000000+000	1.9438036-002
42	1,1085791+000	9,9146095-001	1,0092406+000	2,0999467-004	9,2779316-001	1,0000000+000	1.7779692-002
43	1,1108022+000	9,9210637-001	1,0079155+000	1,9485209-004	9,2779316-001	1,0160608+000	1.5809110-002
44	1,1130016+000	9,9274993-001	1,0072807+000	2,0521813-004	9,2779316-001	1,1572362+000	1.4530751-002
45	1,1151726+000	9,9347542-001	1,0066783+000	2,5001413-004	9,2779316-001	1,5239983+000	1.3202855-002
46	1,1173271+000	9,9440654-001	1,0059781+000	3,6330453-004	9,2779316-001	2,4036257+000	1.1571603-002
47	1,1194827+000	9,9578287-001	1,0054918+000	6,6293409-004	9,2779316-001	4,8058668+000	9.7089145-003
48	1,1216120+000	9,9809375-001	1,0028819+000	1,4121325-003	9,2779316-001	1,1361863+001	4,7881186-003
49	1,1234704+000	9,9795280-001	1,0031631+000	1,0549344-004	9,2779316-001	1,0000000+000	5.2103328-003
50	1,1251111+000	9,9997893-001	1,0022096+000	9,7222208-005	9,2779316-001	1,0000000+000	2,2306894-003
51	1,1265837+000	9,9947235-001	1,0021195+000	9,3191822-005	9,2779316-001	1,0000000+000	2.6471622-003
52	1,1279047+000	9,9911898-001	1,0020644+000	9,2016599-005	9,2779316-001	1,0160608+000	2,9454448-003
53	1,1290780+000	9,9885759-001	1,0020006+000	1,0205300-004	9,2779316-001	1,1572362+000	3,1430401-003
54	1,1301062+000	9,9871388-001	1,0019173+000	1,2960859-004	9,2779316-001	1,5239983+000	3,2033749-003
55	1,1309790+000	9,9874133-001	1,0017912+000	1,9103510-004	9,2779316-001	2,4036257+000	3,0498807-003
56	1,1316518+000	9,9889067-001	1,0015639+000	3,2914127-004	9,2779316-001	4,8058668+000	2,6732010-003
57	1,1319850+000	9,9919470-001	1,0010593+000	5,1537593-004	9,2779316-001	1,1361863+001	1,8646090-003
58	1,1317404+000	9,9909311-001	1,0007637+000	1,6407636-005	9,2779316-001	1,0000000+000	1,6705683-003
59	1,1315004+000	9,9936739-001	1,0000279+000	1,5132078-005	9,2779316-001	1,0000000+000	6,6052310-004
60	1,1312740+000	9,9943649-001	9,9994424-001	1,3981907-005	9,2779316-001	1,0000000+000	5,0775032-004
61	1,1310615+000	9,9948931-001	9,9998940-001	1,3280158-005	9,2779316-001	1,0160608+000	5,0009735-004
62	1,1308623+000	9,9952910-001	1,0000372+000	1,4306425-005	9,2779316-001	1,1572362+000	5,0810198-004
63	1,1306765+000	9,9958599-001	1,0000658+000	1,7840723-005	9,2779316-001	1,5239983+000	4,7983453-004
64	1,1305040+000	9,9962055-001	1,0000690+000	2,6340819-005	9,2779316-001	2,4036257+000	4,4841820-004
65	1,1303472+000	9,9967309-001	1,0000423+000	4,7480806-005	9,2779316-001	4,8058668+000	3,6918401-004
66	1,1302167+000	9,9972846-001	9,9998768-001	9,0885885-005	9,2779316-001	1,1361863+001	2,5922222-004
67	1,1301366+000	9,9977146-001	1,0001424+000	4,7046659-006	9,2779316-001	1,0000000+000	3,7098155-004
68	1,1300665+000	9,9982028-001	9,9999771-001	4,2296730-006	9,2779316-001	1,0000000+000	1,7742848-004
69	1,1300034+000	9,9982780-001	1,0000154+000	4,0431574-006	9,2779316-001	1,0000000+000	1,8763443-004
70	1,1299466+000	9,9983428-001	1,0000324+000	3,9841931-006	9,2779316-001	1,0160608+000	1,9815544-004
71	1,1298960+000	9,9984071-001	1,0000456+000	4,4093420-006	9,2779316-001	1,1572362+000	2,0490994-004
72	1,1298516+000	9,9984798-001	1,0000530+000	5,5898948-006	9,2779316-001	1,5239983+000	2,0502400-004
73	1,1298138+000	9,9985765-001	1,0000533+000	8,2267058-006	9,2779316-001	2,4036257+000	1,9569759-004
74	1,1297846+000	9,9987314-001	1,0000470+000	1,4150440-005	9,2779316-001	4,8058668+000	1,7381235-004
75	1,1297699+000	9,9990446-001	1,0000349+000	2,2070168-005	9,2779316-001	1,1361863+001	1,3039802-004
76	1,1297793+000	9,9996682-001	1,0000284+000	6,8823385-007	9,2779316-001	1,0000000+000	6,1575149-005
77	1,1297885+000	9,9997659-001	1,0000215+000	6,3207015-007	9,2779316-001	1,0000000+000	4,4933928-005
78	1,1297971+000	9,9997839-001	1,0000187+000	5,8993759-007	9,2779316-001	1,0000000+000	4,0354440-005

```
AN ERROR WAS ENCOUNTERED IN SUBROUTINE  KEFFCALC  AT STATEMENT NUMBER    692
TIME EXCEEDED
I=    1 G=1 J=1 FLUX=  8,3225438-004
I=    2 G=1 J=1 FLUX=  8,8126803-004
I=    3 G=1 J=1 FLUX=  9,8950568-004
I=    4 G=1 J=1 FLUX=  1,4354737-003
I=    5 G=1 J=1 FLUX=  1,3915868-003
I=    6 G=1 J=1 FLUX=  1,1296118-003
I=    7 G=1 J=1 FLUX=  3,0583440-004
I=    8 G=1 J=1 FLUX=  7,5277754-005
I=    9 G=1 J=1 FLUX=  1,4321493-005

CANDID2D HAS COPIED FLUX FROM LUN    3 ONTO LUN   48

IMAXIN=    9 JMAXIN=    9 IMAXOUT=    9 JMAXOUT=    9
I=    1 G=1 J=1 FLUX=  4,7814609-002
I=    2 G=1 J=1 FLUX=  4,7814609-002
I=    3 G=1 J=1 FLUX=  4,7814609-002
I=    4 G=1 J=1 FLUX=  3,5860957-002
I=    5 G=1 J=1 FLUX=  3,5860957-002
I=    6 G=1 J=1 FLUX=  3,5860957-002
I=    7 G=1 J=1 FLUX=  2,3907305-003
I=    8 G=1 J=1 FLUX=  2,3907305-003
I=    9 G=1 J=1 FLUX=  2,3907305-003

CANDID2D HAS COPIED FLUX FROM LUN   49 ONTO LUN   48

IMAXIN=    9 JMAXIN=    9 IMAXOUT=    9 JMAXOUT=    9
```

```
       ITERATION HISTORY
ITERATION    K-EFFECTIVE        K-LOWER          K-UPPER      CHANGE IN PHI          SIGMA            ALPHA           ERRLAM
       1   1.1298051+000   9.9998009-001   1.0000165+000   5.5654417-007   1.0000000+000   1.0000000+000   3.6408281-005
   5,809
       2   1.1298124+000   9.9998177-001   1.0000149+000   5.3004385-007   1.0000000+000   1.0000000+000   3.3132441-005
       3   1.1298192+000   9.9998341-001   1.0000130+000   5.0633887-007   1.0000000+000   1.0000000+000   2.9627845-005
       4   1.1298254+000   9.9998498-001   1.0000115+000   4.8469138-007   1.0000000+000   1.0000000+000   2.6504917-005
       5   1.1298309+000   9.9998644-001   1.0000106+000   4.6455021-007   1.0000000+000   1.0000000+000   2.4171110-005
       6   1.1298359+000   9.9998778-001   1.0000098+000   4.5278993-007   9.5844538-001   1.0166002+000   2.1971733-005
       7   1.1298403+000   9.9998900-001   1.0000091+000   4.9584549-007   9.5844538-001   1.1632791+000   2.0101201-005
       8   1.1298441+000   9.9999025-001   1.0000085+000   6.2409496-007   9.5844538-001   1.5508462+000   1.8283841-005
       9   1.1298473+000   9.9999166-001   1.0000077+000   9.2425284-007   9.5844538-001   2.5205084+000   1.6042788-005
      10   1.1298495+000   9.9999349-001   1.0000064+000   1.6800244-006   9.5844538-001   5.4970518+000   1.2874109-005
      11   1.1298502+000   9.9999545-001   1.0000040+000   3.2595392-006   9.5844538-001   1.7276010+001   8.5781503-006
I=    1 G=1 J=1 FLUX=  8.3225721-004
I=    2 G=1 J=1 FLUX=  8.8126457-004
I=    3 G=1 J=1 FLUX=  9.8948148-004
I=    4 G=1 J=1 FLUX=  1.4353849-003
I=    5 G=1 J=1 FLUX=  1.3914267-003
I=    6 G=1 J=1 FLUX=  1.1294603-003
I=    7 G=1 J=1 FLUX=  3.0579342-004
I=    8 G=1 J=1 FLUX=  7.5267668-005
I=    9 G=1 J=1 FLUX=  1.4319571-005

CANDID2D HAS COPIED FLUX FROM LUN    42 ONTO LUN    48

IMAXIN=     9 JMAXIN=     9 IMAXOUT=     9 JMAXOUT=     9
I=    1 G=1 J=1 FLUX=  4.7814609-002
I=    2 G=1 J=1 FLUX=  4.7814609-002
I=    3 G=1 J=1 FLUX=  4.7814609-002
I=    4 G=1 J=1 FLUX=  3.5860957-002
I=    5 G=1 J=1 FLUX=  3.5860957-002
I=    6 G=1 J=1 FLUX=  3.5860957-002
I=    7 G=1 J=1 FLUX=  2.3907305-003
I=    8 G=1 J=1 FLUX=  2.3907305-003
I=    9 G=1 J=1 FLUX=  2.3907305-003

CANDID2D HAS COPIED FLUX FROM LUN    49 ONTO LUN    48

IMAXIN=     9 JMAXIN=     9 IMAXOUT=     9 JMAXOUT=     9

CANDID2D IS PREPARING X SECTIONS ONLY ON LUN    48
```

9. Sample Problem 9

a. Description

(1) Problem Type

Real k_{eff} calculation

(2) Configuration

Same as Sample Problem 8

(3) Convergence Criteria

k_{eff} difference = 10^{-5}.

k_{eff} bounds = 10^{-5}.

Sum of flux difference = 10^{-5}.

Up-scattering = 10^{-3}.

Maximum number of up-scattering iterations = 4.

b. Output Listing

PROB, NO, 7,40000+000 2DCANDID K CALC(UPSCAT=4 INNERS),XY,18 GROUPS,9x9MESH PAGE NO, 35

ITERATION HISTORY

ITERATION	K-EFFECTIVE	K-LOWER	K-UPPER	CHANGE IN PHI	SIGMA	ALPHA	ERRLAM
1	8,3038143+000	9,5068875-003	1,2558345+002	4,3654464+000	1,0000000+000	1.0000000+000	1.2557394+002
11,522							
2	6,2631728+000	2,5176762-001	3,2459383+000	2,2831032+000	1,0000000+000	1.0000000+000	2.9941707+000
3	5,4393983+000	4,2170893-001	2,1480156+000	1,1803486+000	1,0000000+000	1.0000000+000	1,7263067+000
4	5,3612331+000	5,2219240-001	1,8938318+000	6,7305079-001	1,0000000+000	1.0000000+000	1.3716394+000
5	5,3882127+000	5,8890472-001	1,6586894+000	4,4066188-001	1,0000000+000	1.0000000+000	1,0697847+000
6	5,3329679+000	6,3182750-001	1,5267534+000	3,1511913-001	1,0000000+000	1.0000000+000	8,9492586-001
7	5,1414289+000	6,7979081-001	1,3791054+000	2,4523168-001	1,0000000+000	1.0000000+000	6.9931457-001
8	4,8401090+000	7,2671541-001	1,2529651+000	2,1837922-001	1,0000000+000	1.0000000+000	5,2624971-001
9	4,4695024+000	7,6962049-001	1,1587620+000	2,1303869-001	1,0000000+000	1.0000000+000	3,8914151-001
10	4,0658863+000	8,0211793-001	1,0915385+000	2,1092755-001	1,0000000+000	1.0000000+000	2,8942062-001
11	3,6566499+000	8,0460113-001	1,0429081+000	2,0493433-001	1,0000000+000	1.0000000+000	2,3830701-001
12	3,2605305+000	8,0731056-001	1,0068928+000	1,9421047-001	1,0000000+000	1.0000000+000	1,9958227-001
13	2,8892950+000	8,1348032-001	9,7966078-001	1,7993827-001	1,0000000+000	1.0000000+000	1,6618046-001
14	2,5495610+000	8,2260274-001	9,5875197-001	1,6360260-001	1,0000000+000	1,0000000+000	1,3614923-001
15	2,2443466+000	8,3419074-001	9,7687034-001	1,4645363-001	1,0000000+000	1,0000000+000	1,4267960-001
16	1,9742723+000	8,3680301-001	9,9834623-001	1,3140674-001	8,9517911-001	1,0154874+000	1,6154322-001
17	1,7384542+000	8,3949307-001	1,0186389+000	1,2983286-001	8,9517911-001	1,1508751+000	1,7914588-001
18	1,5356010+000	8,4476962-001	1,0330864+000	1,4265885-001	8,9517911-001	1,4964344+000	1,8831675-001
19	1,3661121+000	8,5755470-001	1,0366544+000	1,7166436-001	8,9517911-001	2,2906058+000	1,7909970-001
20	1,2371086+000	8,9033539-001	1,0268595+000	2,0676628-001	8,9517911-001	4,2387819+000	1,3652409-001
21	1,1812599+000	9,0258330-001	1,0064553+000	1,2653688-001	8,9517911-001	8,3283273+000	1,0387196-001
22	1,1905983+000	8,8636850-001	1,2287559+000	5,7700904-003	8,9517911-001	1,0000000+000	3,4238744-001
23	1,1934157+000	9,3431022-001	1,1451811+000	3,5280497-003	8,9517911-001	1,0000000+000	2,1087092-001
24	1,1934611+000	9,4681090-001	1,0930245+000	2,6458479-003	8,9517911-001	1,0000000+000	1,4621365-001
25	1,1911389+000	9,5364743-001	1,0598116+000	2,0981404-003	8,9517911-001	1,0000000+000	1,0616416-001
26	1,1869251+000	9,5940398-001	1,0382765+000	1,7227147-003	8,9517911-001	1,0000000+000	7,8872538-002
27	1,1812530+000	9,6581581-001	1,0239937+000	1,4922435-003	8,9517911-001	1,0000000+000	5,8177849-002
28	1,1745891+000	9,7173442-001	1,0143129+000	1,3688287-003	8,9517911-001	1,0000000+000	4,2578492-002
29	1,1673815+000	9,7649582-001	1,0076165+000	1,3078767-003	8,9517911-001	1,0000000+000	3,1120692-002
30	1,1600268+000	9,8008421-001	1,0028986+000	1,2721646-003	8,9517911-001	1,0000000+000	2,2814378-002
31	1,1528564+000	9,8276021-001	9,9976644-001	1,2380113-003	8,9517911-001	1,0000000+000	1,7006228-002
32	1,1461332+000	9,8483546-001	1,0017720+000	1,1936027-003	8,9517911-001	1,0000000+000	1,6936550-002
33	1,1400524+000	9,8656552-001	1,0034291+000	1,1525128-003	8,9517911-001	1,0154874+000	1,6863543-002
34	1,1347484+000	9,8814512-001	1,0046759+000	1,2213406-003	8,9517911-001	1,1508751+000	1,6530793-002
35	1,1303427+000	9,8984319-001	1,0052510+000	1,4387388-003	8,9517911-001	1,4964344+000	1,5407840-002
36	1,1270362+000	9,9198381-001	1,0049974+000	1,8539977-003	8,9517911-001	2,2906058+000	1,3013641-002
37	1,1252417+000	9,9323351-001	1,0039839+000	2,3693536-003	8,9517911-001	4,2387819+000	1,0750440-002
38	1,1256701+000	9,9567048-001	1,0032277+000	1,8496889-003	8,9517911-001	8,3283273+000	7,5572486-003
39	1,1274371+000	9,9800849-001	1,0031026+000	3,3268429-004	8,9517911-001	1,0000000+000	5,0941444-003
40	1,1288147+000	9,9943827-001	1,0027452+000	2,6878689-004	8,9517911-001	1,0000000+000	3,3069147-003

41	1,1299127+000	9,9909672-001	1,0023037+000	2,3437485-004	8,9517911-001	1,0000000+000	3,2069448-003
42	1,1307741+000	9,9886956-001	1,0019252+000	2,1126879-004	8,9517911-001	1,0154874+000	3,0556264-003
43	1,1314194+000	9,9874990-001	1,0016286+000	2,1102182-004	8,9517911-001	1,1508751+000	2,8787031-003
44	1,1318499+000	9,9875954-001	1,0013688+000	2,3267640-004	8,9517911-001	1,4964344+000	2,6092692-003
45	1,1320453+000	9,9888784-001	1,0010993+000	2,7590498-004	8,9517911-001	2,2906058+000	2,2114944-003
46	1,1319526+000	9,9911761-001	1,0007504+000	3,3639090-004	8,9517911-001	4,2387819+000	1,6327762-003
47	1,1315069+000	9,9922560-001	1,0001502+000	6,3472385-004	8,9517911-001	8,3283273+000	9,2464429-004
48	1,1309944+000	9,9911703-001	1,0000807+000	8,8038822-005	8,9517911-001	1,0000000+000	9,6365315-004
49	1,1305617+000	9,9922264-001	1,0000515+000	7,7155991-005	8,9517911-001	1,0000000+000	8,2888786-004
50	1,1301952+000	9,9932596-001	1,0001800+000	7,0059867-005	8,9517911-001	1,0000000+000	8,5408051-004
51	1,1298895+000	9,9940738-001	1,0002712+000	6,4089705-005	8,9517911-001	1,0000000+000	8,6384261-004
52	1,1296431+000	9,9946888-001	1,0003317+000	5,9052465-005	9,1478485-001	1,0158320+000	8,6280538-004
53	1,1294542+000	9,9951861-001	1,0003636+000	5,9931683-005	9,1478485-001	1,1546906+000	8,4497704-004
54	1,1293239+000	9,9956824-001	1,0003594+000	6,7314543-005	9,1478485-001	1,5128835+000	7,9111580-004
55	1,1292594+000	9,9963069-001	1,0003193+000	8,1949894-005	9,1478485-001	2,3572358+000	6,8859101-004
56	1,1292780+000	9,9973143-001	1,0002493+000	1,0309717-004	9,1478485-001	4,5624124+000	5,1782397-004
57	1,1294040+000	9,9994022-001	1,0002168+000	2,1259751-004	9,1478485-001	9,9205939+000	2,7657722-004
58	1,1295379+000	9,9990194-001	1,0003169+000	2,3909836-005	9,1478485-001	1,0000000+000	4,1493753-004
59	1,1296504+000	9,9998503-001	1,0002629+000	2,0521706-005	9,1478485-001	1,0000000+000	2,7789274-004
60	1,1297453+000	9,9995178-001	1,0002168+000	1,8507498-005	9,1478485-001	1,0000000+000	2,6503729-004
61	1,1298243+000	9,9992793-001	1,0001829+000	1,7148504-005	9,1478485-001	1,0158320+000	2,5501792-004
62	1,1298876+000	9,9991283-001	1,0001584+000	1,7620939-005	9,1478485-001	1,1546906+000	2,4558589-004
63	1,1299349+000	9,9990877-001	1,0001377+000	2,0139285-005	9,1478485-001	1,5128835+000	2,2894613-004
64	1,1299639+000	9,9991654-001	1,0001163+000	2,5051853-005	9,1478485-001	2,3572358+000	1,9977705-004
65	1,1299692+000	9,9993334-001	1,0000873+000	3,1071750-005	9,1478485-001	4,5624124+000	1,5395039-004
66	1,1299421+000	9,9994249-001	1,0000310+000	4,8557506-005	9,1478485-001	9,9205939+000	8,8528264-005
67	1,1299067+000	9,9991329-001	1,0000365+000	6,5172700-006	9,1478485-001	1,0000000+000	1,2322664-004
68	1,1298777+000	9,9992749-001	1,0000073+000	5,4476171-006	9,1478485-001	1,0000000+000	7,9777819-005
69	1,1298536+000	9,9994063-001	1,0000149+000	4,8455701-006	9,1478485-001	1,0000000+000	7,4234529-005
70	1,1298340+000	9,9995064-001	1,0000206+000	4,4446257-006	9,1478485-001	1,0158320+000	6,9922098-005
71	1,1298185+000	9,9995801-001	1,0000240+000	4,5276195-006	9,1478485-001	1,1546906+000	6,5985892-005
72	1,1298073+000	9,9996422-001	1,0000246+000	5,1266791-006	9,1478485-001	1,5128835+000	6,0383987-005
73	1,1298009+000	9,9997050-001	1,0000222+000	6,3090554-006	9,1478485-001	2,3572358+000	5,1744195-005
74	1,1298007+000	9,9997862-001	1,0000177+000	7,8226787-006	9,1478485-001	4,5624124+000	3,9051665-005
75	1,1298085+000	9,9999339-001	1,0000153+000	1,3724914-005	9,1478485-001	9,9205939+000	2,1928339-005
76	1,1298180+000	9,9999153-001	1,0000228+000	1,7108544-006	9,1478485-001	1,0000000+000	3,1256408-005
77	1,1298258+000	9,9999837-001	1,0000191+000	1,4472486-006	9,1478485-001	1,0000000+000	2,0688254-005
78	1,1298323+000	9,9999627-001	1,0000157+000	1,2952500-006	9,1478485-001	1,0000000+000	1,9388855-005
79	1,1298377+000	9,9999468-001	1,0000131+000	1,1933961-006	9,1478485-001	1,0158320+000	1,8398132-005
80	1,1298419+000	9,9999371-001	1,0000112+000	1,2203299-006	9,1478485-001	1,1546906+000	1,7488142-005
81	1,1298451+000	9,9999350-001	1,0000096+000	1,3873963-006	9,1478485-001	1,5128835+000	1,6113307-005
82	1,1298469+000	9,9999409-001	1,0000080+000	1,7152460-006	9,1478485-001	2,3572358+000	1,3904093-005
83	1,1298471+000	9,9999530-001	1,0000059+000	2,1255766-006	9,1478485-001	4,5624124+000	1,0581891-005
84	1,1298451+000	9,9999593-001	1,0000019+000	3,5528437-006	9,1478485-001	9,9205939+000	6,0067105-006

```
I=     1 G=1  J=1  FLUX=   2,4542818-003
I=     2 G=1  J=1  FLUX=   2,5987917-003
I=     3 G=1  J=1  FLUX=   2,9179100-003
I=     4 G=1  J=1  FLUX=   4,2328369-003
I=     5 G=1  J=1  FLUX=   4,1032082-003
I=     6 G=1  J=1  FLUX=   3,3306827-003
I=     7 G=1  J=1  FLUX=   9,0175858-004
I=     8 G=1  J=1  FLUX=   2,2195784-004
I=     9 G=1  J=1  FLUX=   4,2227170-005

CANDID2D HAS COPIED FLUX FROM LUN     3 ONTO LUN    48

IMAXIN=     9 JMAXIN=     9 IMAXOUT=     9 JMAXOUT=     9
I=     1 G=1  J=1  FLUX=   4,7814609-002
I=     2 G=1  J=1  FLUX=   4,7814609-002
I=     3 G=1  J=1  FLUX=   4,7814609-002
I=     4 G=1  J=1  FLUX=   3,5860957-002
I=     5 G=1  J=1  FLUX=   3,5860957-002
I=     6 G=1  J=1  FLUX=   3,5860957-002
I=     7 G=1  J=1  FLUX=   2,3907305-003
I=     8 G=1  J=1  FLUX=   2,3907305-003
I=     9 G=1  J=1  FLUX=   2,3907305-003

CANDID2D HAS COPIED FLUX FROM LUN    49 ONTO LUN    48

IMAXIN=     9 JMAXIN=     9 IMAXOUT=     9 JMAXOUT=     9

CANDID2D IS PREPARING X SECTIONS ONLY ON LUN    48
```

APPENDIX B

LGOEDIT2

1. Identification

a. Title.	Load-and-go tape edit
b. Language.	FORTRAN-63, one COMPASS subroutine
c. Machine.	3600
d. Programming and Design.	Sanford Elkin,[†] D. B. Taylor, A. L. Rago, J. Zapatka, G. J. Duffy

2. Purpose

LGOEDIT2 provides a facility for editing and updating load-and-go tapes for the 3600 by means of deleting, replacing, and inserting binary decks and control cards at specified positions on the tape. LGOEDIT2 is expected to be useful primarily when the LGO tape contains MAIN, OVERLAY, and SEGMENT control cards, or when the order of loading is important.

3. Usage

LGOEDIT2 creates a new LGO tape by editing an old LGO tape with information from an edit tape (the edit tape can be the standard input unit). LGOEDIT2 first reads a card from standard input using the format 3I2. Colums 1 and 2 must contain the logical unit number of the old LGO tape, colums 3 and 4 the logical unit number of the new LGO tape, and columns 5 and 6 the logical unit number of the edit tape. (All must be numbers from 1 to 49, except that columns 5 and 6 can contain 60.) All further information is obtained from an edit tape.

LGOEDIT2 recognizes five control cards. These are:

Column	1-4	5-8	9-16
	$^{7}_{9}$DEL		NAME
	$^{7}_{9}$REP		NAME
	$^{7}_{9}$INS		NAME
	$^{7}_{9}$BYP		NAME
	$^{7}_{9}$DLC		NAME

[†] Control Data Corporation.

where NAME is the BCD name of the subroutine of the LGO tape, and it must be left justified beginning in column 9. Columns 5-8 are not used.

LGOEDIT2 reads a control card from the edit tape and copies the old LGO tape onto the new one until it finds subroutine NAME. It then does the operation required by the control card and returns to the edit tape to read another control card. When it finds an end of file on the edit tape, editing is completed, and the remainder of the old LGO tape is copied onto the new one.

The control cards cause LGOEDIT2 to perform the following actions:

$^{7}_{9}$DEL will delete subroutine NAME.

$^{7}_{9}$REP will replace subroutine NAME with binary decks from the edit tape, until another control card is read. Note that NAME may be replaced by many subroutines.

$^{7}_{9}$INS will insert binary decks from the edit tape onto the new LGO tape <u>after</u> subroutine NAME has been copied. Note that many decks may be inserted after NAME.

$^{7}_{9}$BYP will copy the old LGO tape onto the new LGO tape, up to and including NAME. The reason for this is that on an overlay tape, the same subroutine name may occur in several overlays or segments. If we desire to edit some of these subroutines, $^{7}_{9}$BYP allows us to bypass an earlier occurrence of NAME.

$^{7}_{9}$DLC will delete all cards between the IDC card of subprogram NAME and the final card of the subprogram preceding NAME.

This DLC card was installed mainly to remove or replace loader control cards (e.g., bank, main, overlay, segment) or octal corrector cards.

LGOEDIT2 never looks at the names of the subroutines on the edit tape, but only at the NAMES on the control cards.

4. <u>Restrictions</u>

The NAMEs referenced on the edit tape must appear in the same order as on the old LGO tape, because LGOEDIT2 will not backspace the tapes to search for missing names. Both the edit tape and the old LGO tape must be terminated by an end of file. We cannot follow a REP card with an INS card with the same NAME on both.

5. Timing

A large LGOEDIT2 job was timed with the following resulting statistics:

a. LGOEDIT2 portion of job:

Number of DLC control cards = 2

Number of DEL control cards = 5

Number of REP control cards = 8

Number of binary subroutines transferred = 143.

LGOEDIT2 time = 1 min 35 sec (22% of job time)

b. FORTRAN called nine times to compile 11 subroutines (1650 source cards).

FTN time = 2 min 50 sec (40% of job time)

c. Translation of LOAD/GO tape to Overlay tape.

Translation time = 2 min 44 sec (38% of job time)

Total time for all three runs in job = 7 min 9 sec

6. LGOEDIT2 Output Edit

LGOEDIT2 will produce lists of the subprogram names on old and new LGO tapes, along with a record of the edit procedures carried out and attempted.

7. Typical LGOEDIT Job

$^{7}_{9}$Job,999,204051,25

Acct. card.

$^{7}_{9}$/Mount Tapes L5882(44) and L8878(49)

$^{7}_{9}$EQUIP,20=60

$^{7}_{9}$EQUIP,21=61

$^{7}_{9}$EQUIP,29=(SNARG·OVERLAY·29,1),SV

$^{7}_{9}$EQUIP,39=(SNARG·OVERLAY·LOAD·AND·GO,1),SV

$^{7}_{9}$EQUIP,44=(SNARG·XLIBIT·DEBUG,6)RO,SV

$^{7}_{9}$EQUIP,49=(SNARG·OVERLAY·LOAD·AND·GO),RO,SV

$^{7}_{9}$FILE,14

$^{7}_{9}$REP····SNARG1D

$^{7}_{9}$FILE·END

$^{7}_{9}$FTN,L,A,X=14.

SNARG1D Source Deck

SCOPE

$^{7}_{9}$FILE,14

$^{7}_{9}$REP····INITILIZ

$^{7}_{9}$FILE·END

$^{7}_{9}$FTN,L,A,X=14

INITILIZ Source Deck

To place the following on LUN 14:

$^{7}_{9}$REP····SNARG1D

SNARG1D binary deck.

$^{7}_{9}$REP····INITILIZ

INITILIZ binary deck.

$^{7}_{8}$(EOF)

SCOPE

LGOEDIT2 Binary Deck

$^{7}_{9}$RUN,60,10000,7,

4 9 3 9 1 4

$^{7}_{8}$END·OF·FILE card for end of this run

$^{7}_{9}$LOAD,39

$^{7}_{9}$RUN,60,10000,7,

Data Deck

Blank Card

$^{7}_{8}$End of File card for this job.

Transfers all binary card records from 49 to 39 replacing only those belonging to SNARG1D and INITILIZ in the process. These two are transferred from 14 to 39 in lieu of their old versions. After the LGOEDIT2 run, LUN39 was loaded to run the program.

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