COO-2262-3

MITNE-151

GAKIN II: A ONE-DIMENSIONAL MULTIGROUP DIFFUSION THEORY REACTOR KINETICS CODE

by

K.F. Hansen, J.H. Mason

August 1973

Department of Nuclear Engineering
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

AEC Research and Development Report
Contract AT(11-1)- 2262
U.S. Atomic Energy Commission

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DEPARTMENT OF NUCLEAR ENGINEERING

Cambridge, Massachusetts 02139

GAKIN II: A ONE-DIMENSIONAL MULTIGROUP DIFFUSION THEORY REACTOR KINETICS CODE

by

K.F. Hansen, J.H. Mason

August 1973

COO-2262-3

MITNE-151

AEC Research and Development Report

Contract AT(11-1)-2262

U. S. Atomic Energy Commission

GAKIN II: A One-dimensional Multigroup Diffusion Theory Reactor Kinetics Code

by

John Herbert Mason

Submitted to the Department of Nuclear Engineering, September, 1973 in partial fulfillment of the requirements for the degree of Master of Science.

ABSTRACT

GAKIN II is a time dependent neutron diffusion code. It solves the time dependent multigroup neutron diffusion equations in one space dimension using the usual finite difference approximation. Time integration is accomplished using an exponential transformation and semi-implicit differencing.

GAKIN II is a revision of the existing code GAKIN. The temporal treatment has been improved, a simplified and more implicit algorithm has been used, and the coding has been improved and simplified.

Table of Contents

Table of Contents Continued

1. INTRODUCTION

GAKIN II is a one-dimensional multigroup diffusion theory kinetics code. The code solves the time dependent multigroup diffusion equations in slab, cylindrical, or spherical geometry. An arbitrary number of space points, regions and energy groups may be used. Optionally, the effects of time dependent cross sections, external sources, and xenon poisoning may be included. Time step adjustment can be automatic. GAKIN II has been written for the IBM System 370, or System 360.

GAKIN II is a revision of GAKIN (Reference 1) designed to decrease the storage requirements and running time of the original code. The iterative frequency predictor in GAKIN has been replaced by an explicit scheme, the steady state initialization calculation has been streamlined, and a large number of programming improvements have been made. As a result, GAKIN II is substantially more economic to use than GAKIN. A complete summary of the changes made to GAKIN can be found in Section 7.

The theoretical basis for GAKIN II is presented in Sections 2 through 5. Section 6 describes some of the terms a user may need, defines the cross sections used, and explains how cross section variation is treated. Section 8 contains necessary user information and section 9 contains two sample problems. The code is listed in the appendix.

2. Algorithm Development

In this section the basic numerical scheme used in GAKIN II is derived. In 2.1 the time dependent multigroup diffusion equations are set forth. Discretization is accomplished by finite differencing of the spatial variable in 2.2 and by exponential transformation of time in 2.3. The resulting system of equations is proven consistent in 2.4 and numerically stable in 2.5.

2.1 The Time Dependent Multigroup Diffusion Equations

Considering only one fissionable isotope and assuming that the neutron energy group velocities are time independent, the time dependent diffusion equation for group g is

$$v_g \frac{\partial}{\partial t} \phi_g(\underline{r},t) = \underline{\nabla} \cdot D_g(\underline{r},t) \underline{\nabla} \phi_g(\underline{r},t) - \Sigma_{tg}(\underline{r},t) \phi_g(\underline{r},t) + \sum_{g'=1}^{G} \Sigma_{sgg'}(\underline{r},t) \phi_{g'}(\underline{r},t) \quad (1a)$$

$$+(1-\beta)\ \chi_g^p \sum_{g'=1}^{G} \nu\Sigma_{fg'}(\underline{r},t)\ \phi_{g'}(\underline{r},t)$$

$$+ \sum_{i=1}^{I} \chi_{ig}^d\ \lambda_i\ c_i(\underline{r},t) + S_g(\underline{r},t),$$

where,

v_g is the group speed of neutrons in group g,

$\phi_g(\underline{r},t)$ is the neutron flux in group g at location $\underline{r}$, and at time t,

$D_g(\underline{r},t)$ is the group g diffusion coefficient,

$\beta = \sum_{i=1}^{I} \beta_i$, where β_i is the fraction of all neutrons produced due to decay of delayed neutron emitters in group i(i=1,2, ..., I),

χ_g^p is the fractional yield of prompt neutrons into group g,

ν is the number of neutrons emitted per fission,

$\Sigma_{fg}(\underline{r},t)$ is the macroscopic fission cross section for neutrons in group g,

χ_{ig}^{d} is the fractional yield of delayed neutrons into group g from emitters in group i,

λ_i is the decay constant for emitters in group i,

$c_i(\underline{r},t)$ is the concentration of delayed neutron emitters in group i,

$S_g(\underline{r},t)$ is the rate at which neutrons are introduced into group g from extraneous sources,

$\Sigma_{sgg'}(\underline{r},t)$ is the macroscopic cross section for scattering from group g' to group g, and

Σ_{tg} is the total macroscopic cross section for interaction of neutrons in group g. The associated equations for the delayed neutron emitter concentrations are:

$$\frac{\partial c_i(\underline{r},t)}{\partial t} = \beta_i \sum_{g=1}^{G} \nu\Sigma_{fg}(\underline{r},t)\ \phi_g(\underline{r},t) - \lambda_i\ c_i(\underline{r},t) \qquad (2)$$

for i = 1,2, ... I.

By defining the vectors

$\underline{\phi}(\underline{r},t)$ = Column $[\phi_1(\underline{r},t), \ldots, \phi_G(\underline{r},t)]$,

$\underline{S}(\underline{r},t)$ = Column $[S_1(\underline{r},t), \ldots, S_G(\underline{r},t)]$,

$$\underline{\nu\Sigma_f}(\underline{r},t) = \text{Column } [\nu\Sigma_{f1}(\underline{r},t),\ \ldots,\ \nu\Sigma_{fG}(\underline{r},t)],$$

$$\underline{\chi}^p = \text{Column } [\chi_1^p,\ \ldots,\ \chi_G^p], \text{ and}$$

$$\underline{\chi}_i^d = \text{Column } [\chi_{i1}^d, \ldots,\ \chi_{iG}^d]$$

and the matrices

$$[v] = \text{Diagonal } [v_1,\ \ldots,\ v_G],$$

$$[D(\underline{r},t)] = \text{Diagonal } [D_1(\underline{r},t),\ \ldots,\ D_G(\underline{r},t)], \text{ and}$$

$$[A(\underline{r},t)] = \begin{bmatrix} \Sigma_{t1}-\Sigma_{s11} & -\Sigma_{s12} & \cdots & -\Sigma_{s1G} \\ -\Sigma_{s21} & & & \\ \vdots & & & \vdots \\ -\Sigma_{sG1} & \cdots & & \Sigma_{tG}-\Sigma_{sGG} \end{bmatrix}$$

where $\Sigma_{tg} = \Sigma_{tg}(\underline{r},t)$ and $\Sigma_{sgg'} = \Sigma_{sgg'}(\underline{r},t)$, it is possible to write the time dependent multigroup diffusion equations in matrix form (Reference 2):

$$[v]^{-1} \frac{\partial}{\partial t} \underline{\phi}(\underline{r},t) = \underline{\nabla} \cdot [D(\underline{r},t)] \underline{\nabla} \underline{\phi}(\underline{r},t)$$

$$-[A(\underline{r},t)] \underline{\phi}(\underline{r},t) + (1-\beta) \underline{\chi}^{p} \underline{\nu\Sigma_f}(\underline{r},t)^{T} \underline{\phi}(\underline{r},t)$$

$$+ \sum_{i=1}^{I} \lambda_i c_i(\underline{r},t) \underline{\chi}_i^{d} + \underline{S}(\underline{r},t) . \qquad (1b)$$

2.2 Spatial Dependence

The simplest and most commonly applied method of discretizing the space coordinate in the diffusion equations is to replace (formally) the derivative in the leakage term, $\underline{\nabla} \cdot [D] \underline{\nabla}$ with a finite difference expression and to replace the continuous functions $\phi_g(\underline{r},t)$ with discrete values $\phi_{gp}(t) = \phi_g(\underline{r}_p,t)$. As a result, the elements of $\underline{\phi}$ must be expanded into vectors.

Let ϕ_{gp} (g=1, ..., G; p=1, ..., P) be the neutron flux in group g at spatial mesh point p. And similarly, let c_{ip} (i=1, ..., I; p=1, ...,P) be the concentration of delayed neutron precursors in group i at point p.

We may now define the following.

$$\underline{\psi} = \begin{bmatrix} \phi_{1,1} \\ \phi_{1,2} \\ \cdot \\ \cdot \\ \cdot \\ \phi_{1,P} \\ \phi_{2,1} \\ \cdot \\ \cdot \\ \cdot \\ \phi_{G,P} \\ c_{1,1} \\ c_{1,2} \\ \cdot \\ \cdot \\ \cdot \\ c_{1,P} \\ \cdot \\ \cdot \\ \cdot \\ c_{I,P} \end{bmatrix} \qquad (3)$$

$$[\Gamma] = \text{Diagonal } [\Gamma_i], \; i=1,2 \ldots, G+I \tag{4}$$

where,

$$[\Gamma_i] = v_i\{\Sigma_{sii}+(1-\beta)\chi_i^p \; \nu\Sigma_{fi}-\Sigma_{ti}\}[I]$$

for $i \leq G$

$$[\Gamma_i] = -\lambda_i \; [I]$$

for $G < i \leq G+I$.

$[I]$ is the P by P identity matrix.

$$[H] = \text{Diagonal } [H_i] \; i=1,2,\ldots, G+I$$

where, for a homogeneous reactor,

$$[H_i] = v_i D_i \begin{bmatrix} -a & b & & & & 0 \\ b & -a & b & & & \\ & b & -a & & & \\ & & & \cdot & & \\ & & & & \cdot & \\ & & & & & \cdot \\ 0 & & & & -a & b \\ & & & & b & -a \end{bmatrix},$$

$$a = \frac{2r^n}{\Delta r^2} \; ,$$

$$b = \frac{r^n}{\Delta r^2} \; ,$$

n = 0 for plane geometry,

1 for cylindrical geometry,

2 for spherical geometry,

and Δr is the mesh spacing.

$$[H_i] = [0] \text{ for } G < i \leq G + I.$$

Note that $[\Gamma] = [\Gamma(t)]$ is diagonal and $[H] = [H(t)]$ is tridiagonal.

$$[L] = \begin{bmatrix} [L_{11}] & \cdots & [L_{1,G+I}] \\ \vdots & & \vdots \\ [L_{G+I,1}] & \cdots & [L_{G+I,G+I}] \end{bmatrix}$$

where

$[L_{ij}] = [0]$

for $i \leq j$

and for $G < j < i$,

$$[L_{ij}] = v_i \quad \{\Sigma_{sij} + (1-\beta) \; \chi_i^p \; \nu\Sigma_{fj}\} \quad [I]$$

for $j < i \leq G$, and

$$[L_{ij}] = (\nu\Sigma_{fj} \; \beta_{i-G}) \; [I]$$

for $j \leq G < i$.

$$[U] = \begin{bmatrix} [U_{11}] & , \cdots & [U_{1,G+I}] \\ \vdots & & \vdots \\ [U_{G+1,1}] & \cdots & [U_{G+I,G+I}] \end{bmatrix} \qquad (7)$$

where,

$$[U_{ij}] = [0]$$

for $j \leq i$,

and for $G < i < j$,

$$[U_{ij}] = v_i \; \{\Sigma_{sij} + (1-\beta) \; \chi_i^p \; \nu\Sigma_{fj}\} \, [I]$$

for $i < j \leq G$, and

$$[U_{ij}] = (\chi^d_{i,j-G} \quad \lambda_{j-G}) \quad [I]$$

for $i \leq G < j$.

Note that $[L] = [L(t)]$ is lower triangular, $[U] = [U(t)]$ is upper triangular, and $[U_{ij}]$ and $[L_{ij}]$ are diagonal (if non-zero).

For a reactor composed of more than one region, each with different properties, the non-zero elements of $[H_i]$, $[\Gamma_i]$, $[U_{ij}]$, and $[L_{ij}]$ are no longer identical but depend on the properties at that mesh point. For region interfaces, a more rigorous development yields the proper volume weighting of properties for that point. The band structure of the matrices involved is unchanged.

Finally, using the above definitions, the time dependent multigroup diffusion equations may be written

$$\frac{d}{dt} \underline{\psi}(t) = [B(t)]\, \underline{\psi}(t) + \underline{S}(t) \qquad (8)$$

where

$$[B(t)] = [L(t)] + [U(t)] + [H(t)] + [\Gamma(t)].$$

2.3 Time Dependence

In this section, the temporal variable is discretized by approximating the neutron flux time dependence with an exponential. This approximation is exact when the flux behavior is asymptotic and is expected to be accurate in other cases.

Integration of equation (8) over the interval $h = t_{j+1} - t_j$ and rearranging yields:

$$\underline{\psi}^{j+1} - \int_{t_j}^{t_{j+1}} [\Gamma(t)]\, \underline{\psi}(t)\, dt - \int_{t_j}^{t_{j+1}} [H(t)]\, \underline{\psi}(t)\, dt$$

$$= \underline{\psi}^j + \int_{t_j}^{t_{j+1}} [L(t)]\, \underline{\psi}(t)\, dt + \int_{t_j}^{t_{j+1}} [U(t)]\, \underline{\psi}(t)\, dt \qquad (9)$$

$$+ \int_{t_j}^{t_{j+1}} \underline{S}(t)\, dt$$

where,

$$\underline{\psi}^j = \underline{\psi}(t_j) = \text{Column}\, [\psi_{11}^j, \ldots, \psi_{GP}^j]$$

It is reasonably accurate to approximate,

$$\psi_{gp}(t) \simeq e^{\omega_{gp}(t-t_j)}\, \psi_{gp}^j \qquad (10)$$

in the interval h.

Numerically, a more manageable approach is to use energy independent frequencies, ω_p, such that

$$\psi_{gp}(t) \simeq e^{\omega_p(t-t_j)} \psi_{gp}^j \quad \text{for } g=1, \ldots, G. \qquad (11)$$

This approximation is physically justifiable if the test energy group for determination of the point dependent frequencies is judiciously chosen (e.g., for a thermal reactor, the behavior of the faster flux groups would be expected to closely follow that of a thermal energy group).

Then substitute

$$\underline{\psi}(t) = e^{(t-t_j) \cdot [\Omega]} \quad \underline{\psi}^j, \tag{12a}$$

where

$$[\Omega] = \text{Diagonal } [\omega_1,..,\omega_p,...,\omega_1,...,\omega_p],$$

into the second integral on the right hand side of equation (9) and

$$\underline{\psi}(t) = e^{(t-t_{j+1}) \cdot [\Omega]} \quad \underline{\psi}^{j+1} \tag{12b}$$

into all other integrals involving $\underline{\psi}(t)$ in (9). These substitutions are performed to produce a stable numerical scheme implicit in all terms except the term involving [U]. Finally, approximation of [L], [U], [Γ], [H], and [Ω] by constants in the interval h yields the algorithm used in GAKIN II:

$$\{[I] - [H+\Gamma][FF2]\}\ \underline{\psi}^{j+1} =$$

$$[L][FF2]\ \underline{\psi}^{j+1} + \{[I]+[U][FF1]\}\ \underline{\psi}^{j} + \int_{t_j}^{t_{j+1}} \underline{S}(t)\,dt \qquad (13)$$

The elements of the diagonal matrices [FF1] and [FF2] are given by

$$FF1_p = \frac{e^{\omega_p \cdot h} - 1}{\omega_p} \qquad \text{for all } g \qquad (14a)$$

$$FF2p = \frac{1 - e^{-\omega_p \cdot h}}{\omega_p} \qquad \text{for all } g \qquad (14b)$$

The fact that matrix factorization is performed one group at a time has been used to account for the slowing down source, $[L]\ \underline{\psi}$ implicity. Since the external source term, $\underline{S}(t)$ is a known (in GAKIN II, linear) function of time, the final term in equation (13) is easily determined.

2.4 Proof of Consistency

A numerical scheme for solution of a properly posed set of equations must converge to the correct answer as successively smaller time steps are used. Assuming the time dependent multigroup diffusion equations are properly posed, consistency and stability imply convergence (Reference 3). In this section we will show that the GAKIN II algorithm is consistent and that the truncation error is of order h^2. The scheme will be proven stable in the next section. Note that these proofs are rigorous only for constant frequencies. However, experience has indicated that the scheme works provided the time step used is not too large.

Neglect the source term and rearrange equation (13) as follows,

$$\underline{\psi}^{j+1} - \underline{\psi}^{j} = [H+\Gamma+L][FF2]\, \underline{\psi}^{j+1} + [U][FF1]\, \underline{\psi}^{j} \qquad (15)$$

or

$$\underline{\psi}^{j+1} - \underline{\psi}^{j} = [H+\Gamma+L]\, \{h[I] - 0(h^2)\}\, \underline{\psi}^{j+1} + [U]\{h[I] + 0(h^2)\}\, \underline{\psi}^{j}. \qquad (16)$$

Further rearrangements gives,

$$\frac{1}{h}\{\underline{\psi}^{j+1} - \underline{\psi}^{j}\} = [H+\Gamma+L]\, \underline{\psi}^{j+1} + [U]\, \underline{\psi}^{j} + 0(h). \qquad (17)$$

Taking the limit of this equation as $h \to 0$,

$$\frac{d}{dt} \underline{\psi} = [B] \; \underline{\psi} \; . \tag{18}$$

The numerical scheme proposed for GAKIN II is therefore consistent with the time dependent multi-group diffusion equations (spatially discretized) for any fixed h.

Equation (16) also shows that the truncation error is of order h^2 by comparison with

$$\underline{\psi}^{j+1} = e^{h[B]} \; \underline{\psi}^{j}.$$

2.5 Proof of Stability

In this section the GAKIN II algorithm is proven numerically stable. Unstable error modes cannot dominate the solution and the method will provide convergent results (since it is also consistent).

By ignoring the external source term in equation (13) and rearranging other terms, the GAKIN II algorithm may be written

$$[G_1] \; \underline{\psi}^{j+1} = [G_2] \; \underline{\psi}^{j}$$

where,

$$[G_1] = [I] - \{[H]+[\Gamma]\} \; [FF2]$$

$$[G_2] = [I] + [U][FF1] + [L][FF2].$$

$[G_2]$ can be shown to be nonnegative for all fixed values of ω_p, h, [U], and [L].

For most physical problems

$$\Sigma_{tg} \geq (1-\beta)\chi_g^p \nu\Sigma_{fg} + \Sigma_{sgg} - 1/v_g \quad \text{for all } g.$$

Therefore, $[G_1]$ is a nonsingular matrix with positive diagonal elements and nonpositive off diagonal elements. Such a matrix can be shown to have a nonnegative inverse (Reference 4). Therefore, $[G_1]^{-1}$ $[G_2]$ is nonnegative and irreducible and by the Perron-Frobenius Theorem has a single largest eigenvalue whose associated eigenvector has positive components. Consequently, the algorithm can be proven numerically stable for all real ω_p and any h (Reference 5).

3. Frequency Prediction

In order to solve for $\underline{\psi}$, some means of predicting the frequencies, ω_p, p=1,2..., must be found. GAKIN II is in this sense a predictor-corrector type of algorithm. Three methods have been tested for use in GAKIN II. No completely satisfactory method universally applicable to all problems has been found. However, the method finally chosen provides acceptable results for most problems. In any case, use of a sufficiently small time step will always provide correct results.

The first predictor tried (Reference 6) uses an approximation to the factors [FF1] and [FF2] (equations (14)). Expansion of the exponential terms in these factors,

$$[FF1] = h[I] + \frac{h^2}{2} [\Omega] + \ldots \qquad (21a)$$

$$[FF2] = h[I] - \frac{h^2}{2} [\Omega] + \ldots , \qquad (21b)$$

shows that they may be approximated (with error of order h^2) by $h[I]$. The predictor step for this method then consists of applying this approximation to the GAKIN II algorithm in the test energy group, g'; solving for approximate flux values $\tilde{\psi}^{j+1}_{g'p}$; and computing frequencies, $\omega_p = \frac{1}{h} \ln(\tilde{\psi}^{j+1}_{g'p} / \psi^{j}_{g'p})$. These predicted frequencies are then substituted and the corrector step (full GAKIN II algorithm) is carried out. If the designated test energy group is other than group one, it is necessary to approximate the slowing down source at step j+1 by $[L] \cdot e^{h \cdot [\Omega]} \cdot \underline{\psi}^j$ (again with error of order h^2).

In the second predictor tried, the factors [FF1] and [FF2] are calculated explicitly using a frequency

$\omega_p = \frac{1}{h} \ln(\psi^{j}_{g',p}/\psi^{j-1}_{g',p})$ found from the results of the previous step. This predictor consists of using these values of [FF1] and [FF2] in the GAKIN II algorithm in test group, g'; solving for approximate flux values $\tilde{\psi}^{j+1}_{g',p}$; and computing predicted frequencies, ω_p, as in the first method. These ω_p are then used in the corrector step. Again, series expansions of [FF1] and [FF2] show that neglecting the change in [Ω] should result in errors of order h^2.

The third method tested and the one finally implemented in the current version of GAKIN II calculates frequencies, $\omega_p = \frac{1}{h} \ln(\psi^{j}_{g',p}/\psi^{j-1}_{g',p})$, from test energy groups, g', fluxes. These frequencies are then used directly in the full GAKIN II algorithm to calculate the flux and precursor values at the end of time step j+1. As before, approximation of [Ω] should mean that the error is of order h^2 for this scheme.

Testing of the above prediction methods has been conducted using American Nuclear Socity Benchmark Problems (Reference 7). Problem X-A3, a prompt supercritical excursion in a three region core and problem X-A2, a delayed supercritical transient in the same core have been solved using the various prediction schemes. In both problems, the initiating mechanism is a decrease in the absorption cross section in a non-central region of the reactor. Results obtained using the frequency predictor incorporated in the present version of GAKIN II are listed in section 9.

Results for the prompt supercritical problem using all of the frequency predictors demonstrate substantial gains in time step size. Difficulties appear when the methods are applied to the slower transient. Relatively small time steps are necessary for converged solutions with all three methods and numerical instabilities occur when the same time step size is used in the second method.

The third method has been chosen for use in GAKIN II because it is the simplest and the other two methods do not result in savings worth the added computational effort. GAKIN II is an excellent means of solving rapid or moderately slow kinetics problems. However, for very slow transients there are other existing codes which may enable use of larger time step sizes.

4. Automatic Time Step Adjustment

GAKIN II incorporates an option by which the time step size may be automatically adjusted. The method used for this adjustment is based largely on a number of years of code use. Basically, tests are made to determine how rapidly the frequencies are changing in space and time and the time step is increased or decreased accordingly. **Figure** 1 is a flow diagram of the time step adjustment logic.

For all space points, p, the maximum frequency $\overline{\omega}$ and the minimum frequency $\underline{\omega}$ are found. The ratio $R_s = \overline{\omega}/\underline{\omega}$ if $\overline{\omega}$ is greater than or equal to zero, or $R_s = \underline{\omega}/\overline{\omega}$ if $\overline{\omega}$ is less than zero is used to define

$$\varepsilon_s = \frac{\varepsilon_2}{1 - R_s} \quad .$$

a quantity indicative of how rapidly the frequencies are varying in space (ε_2 is an input parameter).

In a similar fashion, at each test point, n, (WPT on input card #6), the ratio $R_{nj} = \omega_{nj}/\omega_{nj-1}$ for $|\omega_{nj}| \leq |\omega_{nj-1}|$, or $R_{nj} = \omega_{nj-1}/\omega_n$ for $|\omega_{nj}| > |\omega_{nj-1}|$, where subscript j refers to the time step, is used to define

$$\varepsilon_{Tn} = \frac{\varepsilon_1}{1 - R_{nj}}$$

(ε_1 is an input parameter). The quantity ε_T, the maximum over all h of ε_{Tn} is then used as an indication of how rapidly the frequencies are changing in time. E_x' the maximum of ε_S and ε_T (but not less than ε_1) and T_6, the largest $|\omega_p \cdot h|$ are compared to determine if time step adjustment is necessary. If $E_x \geq 2T_6$ the time step size, h, is increased according to the input parameter TSTINC. If $T_6 > E_x$ and $T_6 > \varepsilon_3$ (ε_3 is another input parameter) the time step size, h, is decreased.

Recommended values for input constants (card 12) are:

$$\varepsilon_1 = 2 \times 10^{-4} \qquad \text{(EP1)},$$

$$\varepsilon_2 = 1.6 \times 10^{-2} \qquad \text{(EP2)},$$

$$\varepsilon_3 = 5 \times 10^{-3} \qquad \text{(EP3)},$$

$$\text{TSTINC} = 1.05.$$

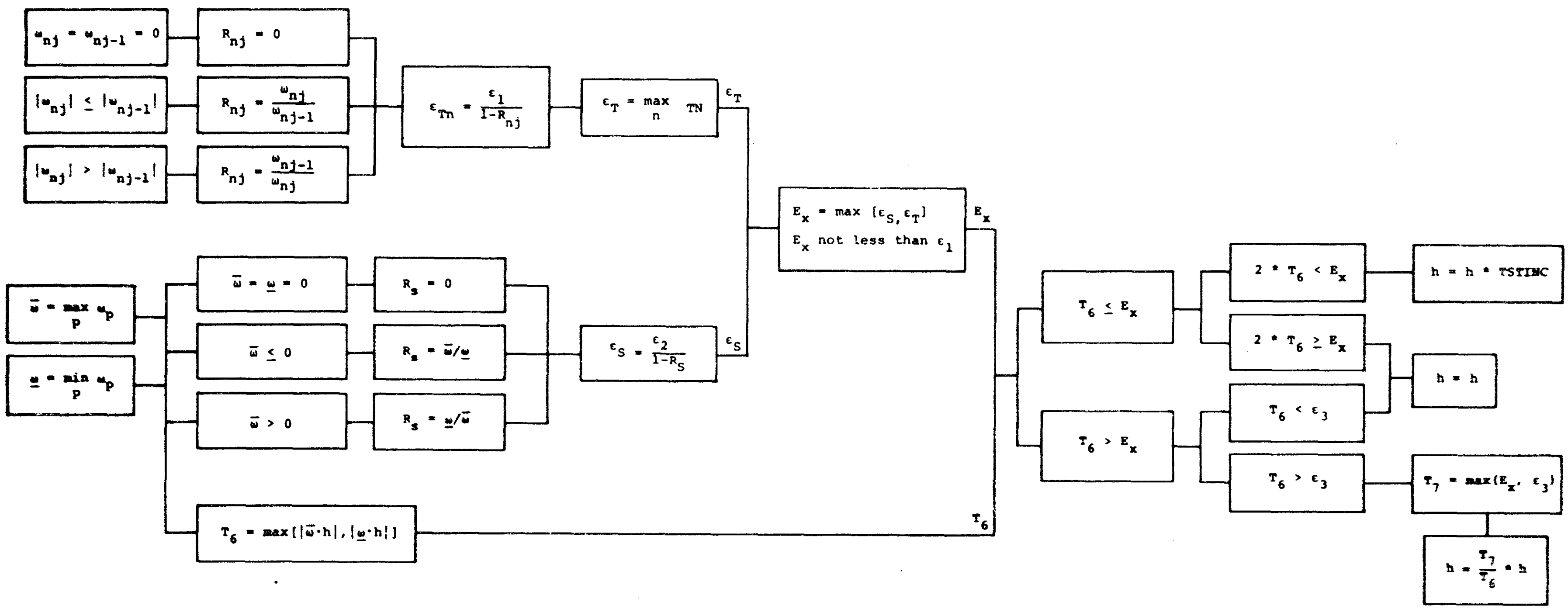

Figure 1 Automatic Time Step Adjustment Logic

5. Steady State Calculation

The initial flux-precursor vector used in GAKIN II must be the converged solution to a steady state calculation for the initial cross sections. These values may be input by the user (STEADY = 0 on Card 3) or they may be determined by the code (STEADY = 1,2). The method used to search for the steady state $\underline{\psi}$ is a simple power iteration and is discussed in this section.

Neglecting the derivative and source terms in equation (1) and using the associated precursor concentration equations (2) to define,

$$\bar{\underline{\chi}} = (1-\beta)\, \underline{\chi}_p + \sum_{i=1}^{I} \beta_i\, \underline{\chi}_i, \tag{22}$$

the group diffusion equations become

$$- \nabla \cdot [D(r)]\, \nabla\, \underline{\phi}(r) + [A(r)]\, \underline{\phi}(r) = \frac{1}{K_{eff}}\, \bar{\underline{\chi}}\, \underline{\nu\Sigma_f(r)}^{T} \cdot \underline{\phi}(r). \tag{23}$$

Discretizing the spatial variable as in section 2.2.1 and splitting [A] such that

$$[A] = [R] - [T],$$

where [R] contains all of the diagonal elements of [A], (23) becomes

$$\{[R] - [v]^{-1}[H]\} \ \underline{\phi} = [T] \ \underline{\phi} + \frac{1}{K_{eff}} \ \overline{\chi} \ \underline{\nu\Sigma_f}^T \cdot \underline{\phi}. \quad (24)$$

The terms involving the precursors are not considered since they have been accounted for implicity in $\overline{\chi}$. Also the division by K_{eff} is actually performed and ν is replaced by a new "equilibrium" value. Therefore, K_{eff} is unity after the steady state solution of equation (24) is completed.

$\{[R]-[v]^{-1}[H]\}$ is a nonsingular matrix with positive diagonal elements and nonpositive off diagonal elements. $[T] + \frac{1}{K_{eff}} \ \overline{\chi} \ \underline{\nu\Sigma_f}^T$ is nonnegative. Consequently, the Perron-Frobenius theorem applies and the solution, $\underline{\phi}$, corresponding to the largest eigenvalue K_{eff} has positive components.

6. Cross Sections and Input Parameters

6.1 Definitions

In terms of input parameters the variables used in Section 2 are defined in each region, R, as follows.

Σ_{trg} = SIGT(R,G) = Transport cross section.

D_G = $1/3\ \Sigma_{trG}$ = Diffusion coefficient.

Σ_{fG} = SIGF(R,G) = Fission cross section.

Σ_{cG} = SIGC(R,G) = Capture cross section.

$\Sigma_{sGG'}$ = SIGX(R,G,G') = Transfer cross section from group G' to G.

$$\Sigma_{tG'} = \Sigma_{fG'} + \Sigma_{cG'} + \sum_{G=1}^{GRP} \Sigma_{sGG'} = \text{SIGX}(R,G',G')$$

= Total interaction cross section in group G' (GRP is the number of neutron groups).

ν_G = NU(G) = Neutrons per fission.

v_G = V(G) = Group speed.

χ^p_G = CHI(G) = Prompt neutron yeild into group G.

χ^d_{IG} = SDIN(G,I) = Delayed neutron yield from delayed group I into neutron group G.

β_I = BETA(I) = Delay neutron fraction for delayed group I.

λ_I = DECAY(I) = Decay constant for delayed group I.

For each space point P = 1, ..., PT

ϕ_{PG} = PSI (P,G); G=1, ..., GRP

c_{PI} = PSI (P,G'); G'=GRP+I; I=1, ..., DEL

(DEL is the number of delayed neutron groups).

6.2 Xenon Feedback

The time rate of change of xenon can be expressed in the following form

$$\frac{d\underline{\chi}}{dt} = \gamma_x \sum_{g=1}^{G} \Sigma_{fg}\, \underline{\phi}_g + \lambda_I\, \underline{I} - \sum_{g=1}^{G} \sigma_{xg} \underline{\phi}_g \underline{\chi} \qquad (25)$$

where

$\underline{\chi}$: space point vector of xenon concentrations

$\underline{\phi}_g$: the vector of pointwise fluxes for group g

σ_{xg}: capture cross section for Xe-135 in group g

Σ_{fg}: macroscopic fission gross section

λ_x: xenon decay constant = $2.874 \times 10^{-5}\ \text{sec}^{-1}$

λ_I: iodine decay constant = 2.093×10^{-5} sec^{-1}

γ_x: cumulative yield for Xe-135

γ_I: cummulative yield for I-135

$\underline{I}$: space point vector of iodine concentration whose rate of change is of the form

$$\frac{d\underline{I}}{dt} = \lambda_I \sum_{g=1}^{G} \Sigma_{fg} \, \underline{\phi}_g \, \lambda_I \, \underline{I} \tag{26}$$

For each region, r, the vectors $\underline{X}_{j+1}$ and $\underline{I}_{j+1}$ can be computed for space points in r using the results of the previous step.

$$\underline{X}_{j+1} = e^{\alpha_x h} \underline{X}_j + \frac{\lambda_I}{\alpha_x - \lambda_I} \left(e^{-\lambda_I h} - e^{-\alpha_x h}\right) \underline{I}_j \tag{27}$$

$$+ \left(\frac{\gamma_x + \gamma_I}{\alpha_x}\right) \left(1 - e^{-\alpha_x h}\right) - \left(\frac{\gamma_I}{\alpha_x - \lambda_I}\right) \left(e^{-\lambda_I h} - e^{-\alpha_x h}\right) \bar{S}_f$$

$$\underline{I}_{j+1} = e^{-\lambda_I h} \underline{I}_j + \left(\frac{1 - e^{-\lambda_I h}}{\lambda_I}\right) \gamma_I \bar{S}_f \tag{28}$$

where

$$\alpha_x = \sum_{g=1}^{G} \sigma_{xg}\overline{\phi}_{gj+1} + \lambda_x$$

$\overline{\phi}_{g,j}$ is the volume averaged flux over region r for group g and step j.

$$\overline{S}_f = \sum_{g=1}^{G} [\Sigma_{fg}(\frac{\overline{\phi}_{g,j} - \overline{\phi}_{g,j+1}}{2})]$$

In GAKIN II the xenon concentration, XENON(R) is calculated for each region, R, and the iodine concentration, IODINE(R), is calculated for each region, R.

6.3 Time Dependent Cross Section Variation

The time variation in the cross sections may be either linear or quadratic at the users choice. As assumed in equation (9), the cross sections are constant over the interval of integration. Thus, the cross sections are time dependent step functions calculated in the following manner for each region R:

$$SIGX(R,G,G')_{j+1} = SIGX(R,G,G')_0 + CXL(R)\ \tau + CXQ(R)\ \tau^2$$

$$SIGT(R,G)_{j+1} = SIGT(R,G)_0 + CTL(R,G)\ \tau + CTQ(R,G)\ \tau^2$$

$$SIGC(R,G)_{j+1} = SIGC(R,G)_0 + CCL(R,G)\ \tau + CCQ(R,G)\ \tau^2 +$$

$$XABS(R,G) \cdot XENON(R)$$

$$SIGF(R,G)_{j+1} = SIGF(R,G)_0 + CFL(R,G)\ \tau + CFQ(R,G)\ \tau^2$$

where:

$$\tau = \frac{t-t_z}{\Delta TZ}$$

t_z: time at the beginning of the time zone.

t: time at step j.

ΔTZ: length of the time zone.

CXL(R), CXQ(R), {CTL(R,G), CTQ(R,G), CCL(R,G), CCQ(R,G), CFL(R,G), CFQ(R,G) |G=1,...,GRP}, are constants specified for each time zone.

XENON(R) is the xenon build-up in region R as calculated in equation (27).

SIGX(R,G,G'), SIGT(R,G), SIGC(R,G), SIGF(R,G) are defined as in Section 6.1.

XABS(R,G) is σ_{xg} in Section 6.2, the xenon capture cross section in group G and region R.

7. Summary of Changes to GAKIN

The most significant change in the original code, GAKIN, as described in Reference 1 is the replacement of the iterative scheme for frequency prediction by an explicit, order h^2 method. The algorithm itself has been altered to account for the slowing down source implicitly. The steady state calculation has been changed to account for the precursor concentrations implicitly and to eliminate calculation of them during flux iteration. A minor alteration has been made to more formally account for the effect of xenon buildup on cross-sections in that the xenon capture cross section has been made group dependent.

A number of programming changes have been made. The present version of GAKIN II has been programmed for use on the IBM-370 model 165 computer with Fortran G or H compiler. Several subroutines have been unified or eliminated in addition to those eliminated pursuant to the changes discussed above. The code has been restructured and object time dimensioning has been incorporated. Consequently, recompilation of only a short MAIN sub-program results in minimal storage costs for a class of problems to be solved. Changes in input format are detailed in Section 8.4.

8. User Information

8.1 General

GAKIN II is presently in load module form compiled in FORTRAN H(opt=2). The current dimensions can accomodate problems with 10 regions (M1), 10 neutron energy groups (M2), 6 delayed neutron groups (M4), 50 test points (M7), and 100 space points (M5). The number of edits for each time zone is limited to fifty. To increase or decrease the dimensions, the user need only recompile the short MAIN program with appropriate dimensions. The number of bytes of core storage necessary for use of the code can be approximated by

$$100{,}000 + 8[P(G+D) + 2GD + 9G + G(G+1) + 26R + 19RG + RG^2 + 11P + 4PG + 2N + 50]$$

where,

R is the number of regions,

G is the number of neutron energy groups,

D is the number of delayed groups,

P is the number of space points, and

N is the number of test points.

Computation time per step is roughly approximated by 2×10^{-4} [P(G + .3D)] seconds.

Input data is checked extensively for errors and execution is prevented if any are found. Problems may be stacked, i.e., the code automatically seeks new input data after completion of a problem. Sections 8.2 and 8.3 describe the input format in detail.

8.2 Detailed Input Specifications

CARD #1 - Problem Title. Printed at the head of each output sequence. (12A6)

CARD #2 - Problem Dimensions and Internal Controls. {GRP, THG, GF, DEL, REG, NUM, NCOMP, GEOM, BCL, BCR, MTZ, XEN}, (12I6)

GRP: Total number of neutron groups. ($0 < \text{GRP} \leq \text{M2}^*$)

THG: Number of the group for which the frequencies are to be calculated and tested. ($0 < \text{THG} \leq \text{GRP}$). For two group problems the last group is taken to be the thermal group and it is recommended that THG=GRP=2. In systems with more than one thermal group some experimentation may be required in the selection of THG.

GF: Number of fast groups. GF is used in the standard cross section input card #16. If the fast transfer matrix option, card #16, is not desired enter a zero or blank for GF. ($0 \leq \text{GF} \leq \text{GRP}$).

---

*See Section 8.1 for dimension limits

DEL: Total number of delayed neutron groups. ($0 \leq DEL \leq M4$*)

REG: Total number of homogeneous regions. ($0 < REG \leq M1$*)

NUM: Total number of space points at which the frequencies are to be computed and tested. These points are referred to as "test points". ($0 < NUM \leq M7$*, $NUM \geq REG$).

NCOMP: Total number of compositions. ($0 < NCOMP$).

GEOM: Geometry control

0 - Slab; 1 - Cylinder; 2 - Sphere

BCL: Left (or bottom) boundary condition = 0 -zero flux

BCR: Right (or top) boundary condition = 1 - zero gradient

MTZ: (a) If $MTZ > 0$ punch restart information

(b) $|MTZ| = NTZ$ = total number of time zones. Each time zone can have unique properties of time dependent cross sections, external sources, time steps and print-out control.

XEN: Is feedback from the buildup in xenon to be computed?

0 - No, 1 - Yes.

CARD #3 - Steady State Calculation and number of space points {STEADY, PUNBAL, TIGHT1,

TIGHT2, TIGHT3, PT}, (2I6,3E12.6, I6)

STEADY: Is there is to be a search for the flux distribution and ν which match the initial cross sections?

---

*See Section 8.1 for dimension limits.

0 - No,

1 - Yes, initial estimate entered on card #20,

2 - Yes, flat flux initial estimate,

3 - No, but initial precursor concentrations are to be calculated from the fluxes entered on card #20.

PUNBAL: If an initializing calculation is to be done (STEADY $\geq$ 1) should the resulting flux and precursor distribution (steady state distribution) be punched?

0 - No, 1 - Yes,

TIGHT1

TIGHT2 Convergence criterion for the steady state solution.

TIGHT3

In order for the j+1 steady state iteration to be acceptable it is necessary that the following be satisfied.

$$0 < \left| K_{eff}^{j+1}/K_{eff}^{j} - 1.0 \right| < \text{TIGHT1}$$

$$0 < \left| K_{eff}^{j+1} - 1.0 \right| < \text{TIGHT2}$$

$$0 < \left| \psi_q^{j+1}/\psi_q^{j} - 1.0 \right| < \text{TIGHT3} \quad \text{for all test points } q.$$

where K_{eff}^{j} is the K-effective at iteration j and ψ_q^{j} is the THG group flux at point q and iteration j.

PT: Number of space points (The left hand boundary of the problem is mesh point number one).

CARD #4 - Region boundaries. {PB(R) | R = 1,..., REG}, (12I6).

PB(R): Number of the mesh point at the right hand boundary of region R. The left hand boundary of region one is assumed to be mesh point number one. (Note that PB(REG) = PT)

CARD #5 - Region Lengths. {LR(R) | R = 1,...,REG}, (6E12.5).

LR(R): The length of region R (cm).

CARD #6 - Test Points. {WPT(N) | N = 1, NUM}, (12I6)

WPT(N): Space point to be used as test points in the calculation and checking of the frequencies and in testing convergence of the steady state solution.

If DEL = 0 then cards #7, #8, and #9 are <u>not</u> to be included.

CARD #7 - Delay Fraction, {BETA(G') | G' = 1,..., DEL}, (6E12.5).

BETA(G'): Delay fraction from fission into delay group G'.

CARD #8 - Yield Fraction. {SDIN(G,G') | G' = 1,..., DEL, G=1,..., GRP}, (6E12.5) (Start a new card for each neutron group G).

SDIN(G,G'): Fractional yield in group G from delayed group G'.

CARD #9 - Decay Constant. {DECAY(G') | G' = 1,..., DEL}, (6E12.5).

DECAY(G'): Decay constant for delayed group G'.

CARD #10 - Fission Yield. {CHI(G) | G = 1,...,GRP}

CHI(G): Yield from fission in group G.

CARD #11 - Neutron Speed. {V(G) | G = 1,...,GRP)}.

V(G): Average neutron speed for group G (cm/sec). This array should be in descending order with largest value first. All subsequent reference to group indexes assume the same ordering.

CARD #12 - Frequency Predition and Time Step Adjustment Controls {EP1, EP2, EP3, IEP4, IEP6, TSTINC}, (3E12.5, 2I12, E12.5)

EP1, EP2, EP3: These parameters are explained in Section 4 and are used for testing related to time step adjustment. Recommended values:

$EP1 = .2 \times 10^{-3}$

$EP2 = .16 \times 10^{-1}$

$EP3 = .5 \times 10^{-2}$

IEP4: Set IEP4 = 0 unless the frequencies are to be set to zero and the frequency prediction is to be bypassed (IEP4 = 1).

IEP6: = 0 auto. time step adjustment to be used.

= 1 no time step adjustment

TSTINC: Increase in time step size per time step (Recommended value 1.05).

CARD #13 - Composition Assignments. {NCMP(R) | R = 1, ..., REG}, (12I6).

NCMP(R): Number of the composition assigned to region R. One value for each region. NCMP(R) $\leq$ NCOMP for all R.

The sequence of cards #14 thru #18 is repeated for each composition. The ordering of compositions in this set of cards must be consistent with the numbers used to identify the compositions on card #13.

GAKIN makes no use of the (n,2n), (n,α), or (n,p) reaction rates or self-shielding factors, hence these terms are not included in the input.

CARD #14 - Composition I.D. and Transfer Matrix Control. {NUCNAM, I1, I2, I3}, (15A4, 3I4).

NUCNAM: Composition name used as identification during edit.

I1: Not used.

I2: = 0 - No fast and no full transfer matrix available. Do not include cards #16 and #17.

= 1 - Only fast transfer matrix available (i.e., only transfer from G into G' where G=1,...,GRP and G'=G+1,...,GF+1).

= 2 - Full transfer matrix is to be read.

I3: Not used.

Repeat card #15 for each neutron group G=1,...,GRP.

CARD #15 - Composition Macroscopic Cross Sections. {$\nu(G), \Sigma^{f}(G), \Sigma^{c}(G), \Sigma^{tr}(G), \Sigma^{(n,2n)}(G), \Sigma(G \rightarrow G+1)$}, (5E12.5).

$\nu(G)$: Neutrons per fission.

$\Sigma^{f}(G)$: Macroscopic fission cross section.

$\Sigma^{c}(G)$: Macroscopic capture cross section.

$\Sigma^{tr}(G)$: Macroscopic transport cross section.

$\Sigma^{(n,2n)}(G)$: Not used in GAKIN.

$\Sigma(G \to G+1)$: Sum of elastic and inelastic macroscopic scattering cross sections for energy transfer from group G to G+1.

After the data for composition M has been read, then all regions specified, on card #13, to contain composition M(i.e., all R such that M = NCMP(R)) receive the following storage instruction:

$$\nu(G) \to NU(R,G)$$
$$\Sigma^{f}(G) \to SIGF(R,G)$$
$$\Sigma^{tr}(G) \to SIGT(R,G)$$
$$\Sigma^{c}(G) \to SIGC(R,G)$$
$$\Sigma(G \to G') \to SIGX(R,G',G)$$

CARD #16 - Fast Transfer Matrix (supply this card only if I2=1 and GF$\neq$0). $\{\Sigma(G \to G') \mid G'=G+1,\ldots,GF+1;\ G=1,\ldots,GF\}$, (6E12.5) (Start a new card for each G).

$\Sigma(G \to G')$: Sum of elastic and inelastic macroscopic scattering cross sections for energy transfer from G to G'.

If GF=GRP then enter a zero for $\Sigma(GF \to GF+1)$.

CARD #17 - Full Transfer Matrix (supply this card only if I2=2).
$\{\Sigma(G\rightarrow G') \mid G'=1,\ldots,GRP;\ G=1,\ldots,GRP\}$, (6E12.5)
(Start a new card for each group G).
$\Sigma\ (G\rightarrow G')$: Same definition as for card #16.

Supply cards #18 and #19 only if XEN≠O.

CARD #18 - Fission Yields. {GAMAX, GAMAI}, (2E12.5)

GAMAX: Fission Yield for Xe-135

GAMAI: Fission Yield for I-135.

CARD #19 - Xenon and Iodine Parameters
{XENON(R), IODINE(R), XABS(R,G), G=1,...,GRP}.

XENON(R): Initial Xenon concentration in region R, atoms/cm^3. The initial cross sections must reflect the effect of this concentration.

IODINE(R): Initial Iodine concentration in region R atoms/cm^3.

XABS(R,G): Xenon capture cross section in region R in group G, barns.

(Start a new card for each region).

CARD #20 - Initial Flux Distribution. {PSI(PG) | P=1,..., PT; G=1,GRP}, (6E12.5).

The initial flux distribution is read in pointwise for each group (start a new card for each group).

If a steady state calculation is not performed (i.e., STEADY=0) then the initial precursor concentrations are read in immediately following the fluxes.
{PSI(P,G) | P=1,...,PT; G=GRP+1,...,GRP+DEL},
(6E12.5).
Omit Card #20 if STEADY=2.

The sequence of cards #21 thru #33 must be repeated for each time zone. Start with the first zone and arrange in increasing order. The problem will terminate at the end of time zone NTZ.

CARD #21 - Time Zone Control Card {HBEGIN, IH, TZ, IPRN, NUM2, NTAG, SORCE, IEP4, IEP6} (E12.5, I12, E12.5 6I6)
IEP4 & IEP6 are repeated here for possible alteration in each time zone (see Card #12).

HBEGIN: Initial time step size (Sec.).

IH: = 0 Time step is kept the same as at the end of the preceding time zone.

= 1 Step size set equal to HBEGIN.

TZ: $|TZ|$ = Time at the end of this zone.
TZ > 0 precursor concentrations printed at each edit time.
TZ < 0 precursor concentrations printed at end of time zone only.

IPRN: In this time zone every IPRN$^{\underline{th}}$ step will be edited. If IPRN=0 this edit criterion is ignored.

NUM2: (a) If NUM2 < 0 then NUM2 is the number of print times to be read in on card #22.

(b) If NUM2 > 0 then print-outs will occur at NUM2 evenly spaced intervals throughout the time zone. Do not supply card #22.

(c) If NUM2=0 this output option is ignored. Do not supply card #22.

$(|NUM2| \leq 50)$

NTAG: Time dependent cross section control index.

(a) If NTAG=0 then there are no time dependent cross sections in this time zone. Do not supply cards #23 thru #30.

(b) If NTAG=-1 then the same time dependent cross section parameters are used for this time zone as in the previous zone. Do not supply cards #23 thru #30.

(c) If NTAG > 0 then the time dependent cross section parameters are to be read in for NTAG regions. Only regions with changing cross sections need be considered. The omitted regions will be assumed to have zero change in their cross section.

SORCE: External source control index.

(a) If SORCE=0 then there are no external sources in this time zone. Do not supply cards #31, #32 or #33.

(b) If SORCE=-1 then the external source parameters are the same for this time zone as for the previous zone. Do not supply cards #31, #32 or #33.

(c) If SORCE > 0 then the external source parameters are to be read in for SORCE regions. Only regions with nonzero sources need be considered. The omitted regions will be assumed to have zero external sources.

CARD #22 - Print Timing (Do not use this card if NUM2 $\geq$ 0). {STPRN(N) |N=1,-NUM2}.

STPRN(N): The program will automatically adjust the time step so that a solution is calculated and printed at the time STPRN(N).

$TZ_o < STPRN(N) < STPRN(N+1) < TZ_1$, N=1,..,-NUM2
where TZ_o is the time at the beginning of the time zone and TZ_1=TZ is the time at the end of the zone.

The sequence of cards #23 thru #30 should be repeated NTAG times. Supply this sequence of cards only if NTAG > 0.

CARD #23 - Time Dependent Cross Section Control Card.
{R,TAGX(R), TAGT(R),TAGC(R),TAGF(R)},
(5I6).

R: Region number for which the following data applies.

TAGX(R): Is the transfer cross section changing with time.

TAGT(R): Is the transport cross section changing with time.

TAGC(R): Is the capture cross section changing with time.

TAGF(R): Is the fission cross section changing with time.

= 0 No.

= 1 Yes - linear change only.

= 2 Yes - linear and quadratic variation with time.

If t_j is the time at step j, TZ_o and TZ_1 are respectively the time at the beginning and end of the time zone, then the time dependent changes in the cross sections can be expressed as follows:

$$\Delta TZ = TZ_1 - TZ_o \qquad \tau = (t_j - TZ_o)/\Delta TZ$$

$$SIGX(R,G,G')_{j+1} = SIGX(R,G,G')_0 + CXL(R)\ \tau + CXQ(R)\ \tau^2$$

$$SIGT(R,G)_{j+1} = SIGT(R,G)_0 + CTRL(R,G)\ \tau + CTRQ(R,G)\ \tau^2$$

$$SIGC(R,G)_{j+1} = SIGC(R,G)_0 + CCL(R,G)\ \tau + CCQ(R,G)\ \tau^2$$

$$SIGF(R,G)_{j+1} = SIGF(R,G)_0 + CFL(R,G)\ \tau + CFQ(R,G)\ \tau^2$$

CARD #24 - Time Variations in the Transfer Cross Section. Supply this card if TAGX(R) = 1 or 2. CXL(R), CXQ(R), (2E12.5).

CXL(R): Total linear change in SIGX(R,G,G') over the time interval ΔTZ.

CXQ(R): Total quadratic change in SIGX(R,G,G') over the time interval ΔTZ.

CARD #25 - Linear Variations in the Transport Cross Section. Supply this card if TAGT(R) = 1 or 2. CTRL(R,G)/G=1,...,GRP , (6E12.5).

CTRL(R,G): Total linear change in SIGT(R,G) within the time interval ΔTZ.

CARD #26 - Quadratic Variations in the Transport Cross Section. Supply this card only if TAGT(R)= 2. CTRQ(R,G)/G=1,...,GRP , (6E12.5).

CTRQ(R,G): Total quadratic change in SIGT(R,G) in the time interval ΔTZ.

CARD #27 - Linear Variations in the Capture Cross Section. Supply this card if TAGC(R) = 1 or 2. CCL(R,G)/G=1,...,GRP , (6E12.5).

CCL(R,G): Total linear change in SIGC(R,G) in the time interval ΔTZ.

CARD #28 - Quadratic Variations in the Capture Cross Section. Supply this card only if TAGC(R)= 2. CCQ(R,G)/G=1,...,GRP , (6E12.5).

CCQ(R,G): Total quadratic change in SIGC(R,C) in the time interval ΔTZ.

CARD #29 - Linear Variation in the Fission Cross Section. Supply this card if TAGF(R)= 1 or 2. CFL(R,G)/G=1,...,GRP , (6E12.5).

CCQ(R,G): Total linear change in SIGF(R,G) in the time interval ΔTZ.

CARD #30 - Quadratic Variation in the Fission Cross Section. Supply this card only if TAGF(R) = 2. {CFQ(R,G)/G=1,GRP}, (6E12.5).

CFQ(R,G): Total quadratic change in SIGF(R,G) in the time interval ΔTZ.

The sequence of cards #31 thru #33 is repeated SORCE times. Supply this sequence of cards only if SORCE > 0. The sequence need not be repeated for any region with a zero external source. All omitted regions are assumed to have zero source.

CARD #31 - External Source Input Control Card. {R, SOR(R)}, (2I6).

R: Region for which the following data applies.

SOR(R): = 0 No external source for this region (equivalent to the omission of the sequence for this region).

= 1 Source input for each group and each interior point of the region.

= 2 Source input for each group. The one value is taken to be constant over the interior of the region.

CARD #32 - Pointwise External Source Input. Supply this card only if SOR(R) = 1. {SRCEO(P,G), SRCE1(P,G)/P interior to R in increasing order, G=1,...,GRP}, (6E12.5). (Start a new card for each group).

SRCEO(P,G): Initial external source space point P, group G.

SRCE1(P,G): Total linear change in SRCEO(P,G) in the time interval ΔTZ.

CARD #33 - Region Constant External Source. Supply this card only if SOR(R) = 2. {SRCEO(R,G), SRCE1(R,G)/G=1,...,GRP}, (6E12.5). (Three sets of two numbers per card, i.e., three groups per card).

SRCE0(P,G) = SRCEO(R,G), and SRCE1(P,G) = SRCE1(R,G) for all P interior to R.

SRCEO(P,G) = and SRCE1(P,G) are the same as defined on card #32.

8.3 Short Input Description

Card 1

Word	1
Column	2-72
Format	Alpha-Numeric
	Title Card
Symbol	

Card 2

Word	1	2	3	4	5	6
Column	1-6	7-12	13-18	19-24	25-30	31-36
Format	Integer	Integer	Integer	Integer	Integer	Integer
	Number of neutron groups	Test group	Total number of fast groups	Number of delayed groups	Number of regions	Number of test points
Symbol	GRP	THG	GF	DEL	REG	NUM

Card 2 (cont.)

Word	7	8	9	10	11	12
Column	37-42	43-48	49-54	55-60	61-66	67-72
Format	Integer	Integer	Integer	Integer	Integer	Integer
	Number of compositions	Geometry 0 - Slab 1 - Cylinder 2 - Sphere	Left (or bottom) boundary	Right (or top) boundary	Number of time zones <0 no punch >0 punched output	Xenon feedback 0 - no 1 - yes
			0 - Zero flux 1 - Zero gradient			
Symbol	NCOMP	GEOM	BCL	BCR	MTZ	XEN

Card 3

Word	1	2	3	4	5	6
Column	1-6	7-12	13-24	25-36	37-48	49-54
Format	Integer	Integer	Decimal	Decimal	Decimal	Integer
	Steady state calculation 0 - no 1 - yes 2 - yes 3 - no	Punch steady state fluxes 0 - no 1 - yes	Convergence criterion for steady state calculation			Number of space mesh points
Symbol	STEADY	PUNBAL	TIGHT1	TIGHT2	TIGHT3	PT

Card 4 Twelve words per card.

Word	1	2				REG
Column	1-6	7-12				
Format	Integer	Integer				Integer
	Right hand boundary, first region	Right hand boundary, second region		. . .		Right hand boundary, last region PB(REG)=PT
Symbol	PB(1)	PB(2)				PB(REG)

Card 5 Six words per card.

Word	1	2				REG
Column	1-12	13-24				
Format	Decimal	Decimal				Decimal
	Length of first region (cm)	Length of second region, (cm)		. . .		Length of last region, (cm)
Symbol	LR(1)	LR(2)				LR(REG)

Card 6 Twelve words per card.

Word	1	2		NUM
Column	1-6	7-12		
Format	Integer	Integer		Integer
	First test point	Second test point	. . .	Last test point **WPT(NUM)** $\leq$ PT
Symbol	WPT(1)	WPT(2)		WPT(NUM)

Card 7 Supply this card only if DEL>0, six words per card.

Word	1	2		DEL
Column	1-12	13-24		
Format	Decimal	Decimal		Decimal
	Delay fraction first delay group	Delay fraction second delay group	. . .	Delay fraction last group
Symbol	BETA(1)	BETA(2)		BETA(DEL)

Card 8 Supply this card only if DEL > 0, six words per card. Start a new card for each neutron group G. (G = 1,2,...,GRP)

Word	1	2		DEL
Column	1-12	13-24		
Format	Decimal	Decimal		Decimal
	Yield fraction in group G from delayed group 1.	Yield fraction in group G from delayed group 2.	. . .	Yield fraction in group G from delayed group DEL.
Symbol	SDIN(G,1)	SDIN(G,2)		SDIN(G,DEL)

Card 9 Supply this card only if DEL>0, six words per card.

Word	1	2		DEL
Column	1-12	13-24		
Format	Decimal	Decimal		Decimal
	Decay const. for first delayed group	Decay const. for second delayed group	. . .	Decay const. for last delayed group
Symbol	DECAY(1)	DECAY(2)		DECAY(DEL)

Card 10   Six words per card.

Word	1	2		GRP
Column	1-12	13-24		
Format				Decimal
	Fission yield first group	Fission yield second group	. . .	Fission yield last group
Symbol	CHI(1)	CHI(2)		CHI(GRP)

Card 11   Six words per card.

Word	1	2		GRP
Column	1-12	13-24		
Format	Decimal	Decimal		Decimal
	Neutron speed first group (cm/sec)	Neutron speed second group (cm/sec)	. . .	Neutron speed last group (cm/sec)
Symbol	V(1)	V(2)		V(GRP)

Card 12

Word	1	2	3	4	5	6
Column	1-12	13-24	25-36	37-48	149-60	61-72
Format	Decimal	Decimal	Decimal	Integer	Integer	Decimal
	Adjustable time step parameters.			Frequency Prediction: 0 - used 1 - by-passed	Time step: 0 - Adjusted 1 - Constant	Rate of time step increase
Symbol	EP1	EP2	EP3	IEP4	IEP6	TSTINC

Card 13 Twelve words per card.

Word	1	2		REG
Column	1-6	7-12		
Format	Integer	Integer		Integer
	Number of the com-position assigned to first region	Number of the con-position assigned to second region		Number of the com-position assigned to the last region
Symbol	NCMP(1)	NCMP(2)		NCMP(REG)

Card 14   Repeat the sequence #14 thru #18 for each composition.

Word	1		2	3	4
Column	1-6	7-60	61-64	65-68	69-72
Format	A6	Alpha-Numeric	Integer	Integer	Integer
	Composition I.D.	Additional I.D.	Not used	0 - No tran. matrix 1 - Only fast tran. matrix 2 - Full tran. matrix	
Symbol	NUCNAM		I1	I2	I3

Card 15   Supply this card for each group G,   (G = 1,2,...,GRP)

Word	1	2	3	4	5	6
Column	1-12	13-24	25-36	37-48	49-60	61-72
Format	Decimal	Decimal	Decimal	Decimal	Decimal	Decimal
	Neutrons per fission	Macroscopic fission	Macroscopic capture	Macroscopic transport	Not used	Macroscopic transfer from G to G+1
Symbol	$\nu(G)$	$\Sigma^{f}(G)$	$\Sigma^{c}(G)$	$\Sigma^{tr}(G)$	$\Sigma^{(n,2n)}(G)$	$\Sigma(G \rightarrow G+1)$

Card 16 Supply this card only if I2 = 1. Six words per card. Start a new card for each group G. (G = 1,2,...,GRP).

Word	1	2		
Column	1-12	13-24		
Format	Decimal	Decimal		Decimal
	Macroscopic transfer	Macroscopic transfer	. . .	Macroscopic transfer
Symbol	Σ(G→G+1)	Σ(G→G+2)		Σ(G→GF+1)

Card 17 Full Transfer Matrix. Supply this card only if I2 = 2. Six words per card. Start a new card for each group G. (G = 1,2,...,GRP).

Work	1	2		GRP
Column	1-12	13-24		
Format	Decimal	Decimal		Decimal
			. . .	
Symbol	Σ(G→1)	Σ(G→2)		Σ(G→GRP)

Card 18 Supply this card only if XEN = 1.

Word	1	2	
Column	1-12	13-24	
Format	Decimal	Decimal	
	Fission yield for Xe^{135}	Fission yield for I^{135}	
Symbol	GAMAX	GAMAI	

Card 19 Supply this card only if XEN = 1. Six words per card. Start a new card for each region R. (R = 1,2,...,REG).

Word	1	2	3	4		GRP
Column	1-12	13-24	25-36	37-48		
Format	Decimal	Decimal	Decimal	Decimal		Decimal
	Initial Xe^{135} concentration	Initial I^{135} concentration	Xenon capture cross section		. . .	
Symbol	XENON(R)	IODINE(R)	XABS(R,1)			XABS(R,GRP)

Card 20 Six words per card. Start a new card for each group G. (G = 1,2,..,K). K = GRP if STEADY=1,3; K = GRP+DEL if STEADY = 0; Omit card 20 if STEADY=2.

Word	1	2		PT
Column	1-12	13-24		
Format	Decimal	Decimal		Decimal
	Initial flux group G, point 1	Initial flux group G, point 2	. . .	Initial flux group G point PT
Symbol	PSI(1,G)	PSI(2,G)		PSI(PT,G)

Card 21 Repeat the sequence of cards #21 thru #33 once for each time zone.

Word	1	2	3	4	5	6
Column	1-12	13-24	25-36	37-42	43-48	49-54
Format	Decimal	Integer	Decimal	Integer	Integer	Integer
	Initial time step	Initial time step control 0 - H = HP 1-H=HBEGIN	Time at the end of the time zone. Precursor conc. printed: >0,each edit <0,at TZ only	Print every IPRN$\underline{th}$ step	Number of pring times > 0 Calculate < 0 Read card #22	# of regions with changing cross sections (-1 if same as last time zone.)
Symbol	HBEGIN	IH	TZ	IPRN	NUM2	NTAG

Card 21 (cont.)

Word	7	8	9	
Column	55-60	61-66	67-72	
Format	Integer	Integer	Integer	
	External source control index 0 - No 1 - Yes	See Card #12	See Card #12	
Symbol	SORCE	IEP4	IEP6	

Card 22 Supply this card only if NUM2 < 0. Six words per card.

Word	1	2		NUM2
Column	1-12	13-24		
Format	Decimal	Decimal		
	Print time number one	Print time number two	. . .	Last print time for this time zone
Symbol	STPRN(1)	STPRN(2)		STPRN(NUM2)

Card 23 Repeat the card sequence #23 through #30 NTAG times. If NTAG ≤ 0 omit the entire sequence.

Word	1	2	3	4	5	
Column	1-6	1-12	13-18	19-24	25-30	
Format	Integer	Integer	Integer	Integer	Integer	
	Region for which the following data applies	Time variation in SIGX(R)?	Time variation in SIGT(R)?	Time variation in SIGC(R)?	Time variation in SIGF(R)?	
		0 - no time dependent change; 1 - linear change with time; 2 - quadratic change with time.				
Symbol	R	TAGX(R)	TAGT(R)	TAGC(R)	TAGF(R)	

Card 24 Supply this card only if TAGX(R) = 1 or 2

Word	1	2	
Column	1-12	13-24	
Format	Decimal	Decimal	
	Total linear change in the transfer cross section	Total quadratic change in the transfer cross section	
Symbol	CXL(R)	CXQ(R)	

Card 25 Supply this card only if TAGT(R) = 1 or 2. Six words per card.

Word	1	2		GRP
Column	1-12	13-24		
Format	Decimal	Decimal		Decimal
	Total linear change in the transport cross section.			
	Group #1	Group #2		Last Group, GRP
Symbol	CTRL(R,1)	CTRL(R,2)	. . .	CTRL(R,GRP)

Card 26 Supply this card only if TAGT(R) = 2. Six words per card.

Word	1	2		GRP
Column	1-12	13-24		
Format	Decimal	Decimal		Decimal
	Total quadratic change in the transport cross section.			
	Group #1	Group #2		Last Group, GRP
Symbol	CTRQ(R,1)	CTRQ(R,2)	. . .	CTRQ(R,GRP)

Card 27 Supply this card <u>only</u> if TAGC(R) = 1 or 2. Six words per card.

Word	1	2		GRP
Column	1-12	13-24		
Format	Decimal	Decimal		Decimal
	Total linear change in the capture cross section.			
	Group #1	Group #2		Last Group, #GRP
Symbol	CCL(R,1)	CCL(R,2)	. . .	CCL(R,GRP)

Card 28 Supply this card <u>only</u> if TAGC(R) = 2. Six words per card.

Word	1	2		GRP
Column	1-12	13-24		
Format	Decimal	Decimal		Decimal
	Total quadratic change in the capture cross section.			
	Group #1	Group #2		Last Group, #GRP
Symbol	CCQ(R,1)	CCQ(R,2)	. . .	CCQ(R,GRP)

Card 29 Supply this card <u>only</u> if TAGF(R) = 1 or 2. Six words per card.

Word	1	2		GRP
Column	1-12	13-24		
Format	Decimal	Decimal		Decimal
	Total linear change in the fission cross section.			
	Group #1	Group #2		Last Group, #GRP
Symbol	CFL(R,1)	CFL(R,2)	. . .	CFL(R,GRP)

Card 30 Supply this card <u>only</u> if TAGF(R) = 2. Six words per card.

Word	1	2		GRP
Column	1-12	13-24		
Format	Decimal	Decimal		Decimal
	Total quadratic change in the fission cross section.			
	Group #1	Group #2		Last Group, #GRP
Symbol	CFQ(R,1)	CFQ(R,2)	. . .	CFQ(R,GRP)

Card 31 — Repeat the card sequence #31 thru #33 SORCE times. If SORCE = 0 omit the entire sequence.

Word	1	2
Column	1-6	7-12
Format	Integer	Integer
	Region for which the following data applies	= 0: no source for region R = 1: pointwise source read in (Card #32) = 2: constant source for region R (Card #33)
Symbol	R	SOR(R)

Card 32 — Supply this card <u>only</u> if SOR(R) = 1. Six words per card. K = PB(R-1)+ 1.

Word	1	2	3	4	
Column	1-12	13-24	25-36	37-48	
Format	Decimal	Decimal	Decimal	Decimal	
	Initial external source point K group G	Total linear change in source point K group G	Initial external source point K+1 group G	Total linear change in the source point K+1 group G	
Symbol	SRCEO(K,G)	SRCE1(K,G)	SRCEO(K+1,G)	SRCEL(K+1,G)	

Card 32 (cont.) Repeat card #32 once for each group G. (G = 1,2,...,GRP)

Word				
Column				
Format		Decimal	Decimal	
	. . .	Initial external source point PB(R)-1, group G	Total linear change in the source point PB(R)-1, group G	
Symbol		SRCEO(PB(R)-1,G)	SRCE1(PB(R)-1,G)	

Card 33 Supply this card only if SOR(R) = 2. Two words per card. Repeat the card once for each group G. (G = 1,2,...,GRP)

Word	1	2	
Column	1-12	13-24	
Format	Decimal	Decimal	
	Initial external source for region R, group G	Total linear change in source region R, group G	
Symbol	SRCEO(R,G)	SRCE1(R,G)	

8.4 Edit Description

At the intervals specified on Card 21 or 22 the following information will be printed.

1) Problem Title.
2) Step Number and Time Zone Number.
3) Time.
4) Time step size (this number will not reflect adjustments made in the time step size necessary to accomodate edit times or time zone endings).
5) Frequencies, ω, and $e^{\omega \cdot h}$ at each test point.
6) Neutron fluxes at each point in each energy group.
7) Precursor concentrations at each point in each group (this output may be suppressed except at the end of time zones by specifying a negative TZ on card 21).
8) Region averaged fluxes for each group.
9) Region averaged power normalized to initial power in each region.
10) Total core averaged power normalized to initial power.

8.5 How to Alter Previous GAKIN Input Decks

Input decks from the original GAKIN (Reference 1) must be altered as follows before use in GAKIN II.

Card 3; Word 6; Columns 49-54; should be PT, an integer, the total number of mesh points.

Card 12; Words 1, 2, and 3; Columns 1-12, 13-24, and 25-36; EP1, EP2, and EP3 are now decimal numbers chosen in accordance with Section 4 for time step adjustment criteria.

Word 4; Columns 37-48; IEP4 should be a 0 or 1 in column 48:

0 - Frequency prediction used

1 - Frequency prediction bypassed (all frequencies set equal to zero).

Word 5; Columns 49-60; IEP6 should be a 0 or 1 in column 60:

0 - Time step adjusted automatically

1 - Time step kept constant.

Card 19; Word 1; Columns 1-12; is now XENON(R) a decimal number equal to the initial Xe^{135} concentration (atoms/cm^3) in region R.

Word 2; Columns 13-24; is now IODINE(R) the initial I^{135} concentration (atoms/cm^3) in region R.

Word 3; 4,...,GRP+2; Columns 25-36, 37-48,...; are now the Xenon capture cross sections in region R for each group, XABS(1), XABS(2),..., XABS(GRP).

Card 21; Word 1; Columns 1-12; is now HBEGIN (decimal), the initial time step size in seconds.

Word 2; Columns 13-24; IH should be a 0 or 1 in column 24:

0 - Time step size (H) at the start of this time zone is equal to the time step size at the end of the previous time zone

1 - Time step size, H = HBEGIN.

Word 3; Columns 25-36; TZ may be specified with a minus sign in order to suppress printing of precursor concentrations except at the end of each time zone.

8.6 List of Subprograms

MAIN: Provides absolute dimensions for all arrays and calls three subroutines.

DIRECT: Called by MAIN and with the subroutines called by it comprises the code. Directs code execution.

CALC: Performs one time step calculation.

AVRAGE: Computes core and region averaged flux and power values.

COEF1: Calculates invariant matrix coefficients.

COEF2: Calculates those matrix elements which may vary from step to step.

DEN: Calculates the precursor concentrations from flux values at a point.

EQPREC:	Calculates the steady state precursor concentrations.
ERR:	Prints error messages.
FEDBKX:	Calculates the xenon concentrations.
FREQ:	Predicts the frequencies at each time step and adjusts the time step size.
INEDA:	Edits initial input data.
INEDB:	Edits input data initially and at each time zone.
INPTA1:	Reads cards 1-3. Called by MAIN to provide dimension variables.
INPTA2:	Reads cards 4-20. Called only once for each problem.
INPUTB:	Reads cards 21-33 (each time zone).
ITER:	Performs one steady state iteration.
LHS:	Calculates the left hand size (Equation 13) of the GAKIN algonithm.
MATINV:	Inverts the left hand side of the steady state and time dependent equations and solves for [ψ].
PREC:	Calculates the precursor concentrations at each step.
PRINTA:	Prints output edit information.
PROD:	Calculates the source (right hand side of equation (24)) for the steady state calculation.
PUN:	Punches restart input cards.
RHS:	Computes the right hand side of the GAKIN algorithm (Equation 13).
RESCAL:	Rescales flux values to keep flux norm constant.

SCALE: Computes flux norm.

SETUP: Directs steady state calculation.

SOURCE: Computes the external source term at each time step.

TEST: Tests for time zone ending, edit times and problem end.

TITLE: Prints problem title and end of problem note.

UPDATE: Recalculates time dependent cross sections before each time step.

9. Sample Problems

9.1 Prompt Supercritical Transient

This is problem X-A3 of the ANS Benchmark Series (Reference 7). The core analyzed consists of one central and two outer regions. The transient is initiated by decreasing the absorption cross section in region 1 (an outer region) by 5% in .01 seconds. Analysis is done with two energy groups and six delayed groups.

```
CARD  01
 BENCHMARK PRCBLEM  PROMPT SUPERCRITICAL TRANSIENT

CARC  02         2       2       1       6       3       5       2       C       C       C     -1       C

CARD  03         1      00.10CC000-06C.1CCC00C-060.1C0000C-06     97

CARC  04,       17      81      97

CARC  05    0.40CC000D 020.1600000 03C.4CCCCCC C2

CARD  06         9      33      49      65      89

CARC  07    0.25CCCCD-030.164COCD-02C.147COOD-02C.296000C-02C.86CCCCC-030.32CCCCC-C3

CARC  C8    0.1CCCCCD 010.10C0000 010.1COCOOC 01C.1CCCCCD 01C.1CCCCCC C1C.1CCCCCD C1

CARC  08    0.0           0.0           C.C           C.C           0.C           C.C

CARD  C9    0.124CCCD-010.305C000-010.111COOC 00C.301CCCC CCC.114CCCC C1C.3C1CCCC C1

CARC  10    0.1CCCCOD 010.0

CARC  11    0.10CC00D 080.300000D 06

CARC  12    C.2CCCCCD-030.16CC00D-01C.5C0C00C 05              0             CC.1C5CCCC C1

CARC  13         1       2       1

CARC  14     CUTER CORE                                                          C    1    C

CARD  15    C.25CCCCD 010.400C00D-02C.7C0C00C-02C.222222C CCC.C          C.C

CARD  15    C.25CCCCD C10.80CCCCD-01C.1CCC00C CCC.666667C CC0.C          C.C

CARC  16    0.15CCCCD-01

CARC  14     INNER CORE                                                          C    1    C

CARD  15    C.25CCCCD 010.20CCC0D-02C.8CCC00C-02C.333333C CC0.C          C.C

CARC  15    0.25CC000 010.396CCOD-01C.4C4CCCD-C1C.666667D CCC.C          C.C
```

```
CARD  16    0.100000D-01

CARD  2C    0.0          0.296339D 000.588292D 000.871539D 000.114189D 010.139534D 01
            0.162813D 010.183684D 010.201835D 010.217000D 010.228953D 010.237517D 01
            0.242561D 010.244001D 010.241765D 010.235688D 010.225038D 010.207080D 01
            0.192509D 010.179716D 010.168085D 010.157359D 010.147417D 010.138184D 01
            0.129608D 010.121645D 010.114256D 010.107406D 010.101062D 010.951949D 00
            0.897765D 000.847813D 000.801858D 000.759683D 000.721089D 000.685895D 00
            0.653934D 000.625056D 000.599124D 000.576017D 000.555625D 000.537853D 00
            0.522616D 000.509843D 000.499474D 000.491459D 000.485761D 000.482352D 00
            0.481218D 000.482352D 000.485761D 000.491459D 000.499474D 000.509843D 00
            0.522616D 000.537853D 000.555625D 000.576017D 000.599124D 000.625056D 00
            0.653934D 000.685895D 000.721089D 000.759683D 000.801858D 000.847813D 00
            0.897765D 000.951949D 000.101062D 010.107406D 010.114256D 010.121645D 01
            0.129608D 010.138184D 010.147417D 010.157359D 010.168085D 010.179716D 01
            0.192509D 010.207080D 010.225038D 010.235688D 010.241765D 010.244001D 01
            0.242561D 010.237517D 010.228953D 010.217000D 010.201835D 010.183684D 01
            0.162813D 010.139534D 010.114189D 010.871539D 000.588292D 000.296339D 00
            0.0

CARD  20    0.0          0.245335D-010.487040D-010.721536D-010.945354D-010.115518D 00
            0.134791D 000.152070D 000.167098D 000.179653D 000.189554D 000.196664D 00
            0.200924D 000.202462D 000.202036D 000.202884D 000.218305D 000.236848D 00
            0.233388D 000.222680D 000.210007D 000.197236D 000.185001D 000.173497D 00
            0.162759D 000.152770D 000.143494D 000.134892D 000.126926D 000.119557D 00
            0.112752D 000.106479D 000.100707D 000.954101D-010.905631D-010.861429D-01
            0.821289D-010.785020D-010.752452D-010.723432D-010.697821D-010.675501D-01
            0.656365D-010.640323D-010.627299D-010.617233D-010.610077D-010.605796D-01
            0.604372D-010.605796D-010.610077D-010.617233D-010.627299D-010.640323D-01
            0.656365D-010.675501D-010.697821D-010.723432D-010.752452D-010.785020D-01
            0.821289D-010.861429D-010.905631D-010.954101D-010.100707D 000.106479D 00
            0.112752D 000.119557D 000.126926D 000.134892D 000.143494D 000.152770D 00
            0.162759D 000.173497D 000.185001D 000.197236D 000.210007D 000.222680D 00
            0.233388D 000.236848D 000.218305D 000.202884D 000.202036D 000.202462D 00
            0.200924D 000.196664D 000.189554D 000.179653D 000.167098D 000.152070D 00
            0.134791D 000.115518D 000.945354D-010.721536D-010.487040D-010.245335D-01
            0.0

                        *** INPUT EDIT FOR TIME ZONE 1 ***

CARD  21    0.100000D-04            1-.100000D-01      0    -2      1      0      0      0

CARD  22    0.100000D-020.500000D-02

CARD  23          1      0      0      1      0

CARD  27    0.0          -.900000D-02
```

BENCHMARK PRCBLEM PRCMPT SUPERCRITICAL TRANSIENT

*** INPUT ECIT ***

2 NEUTRON GRCUP(S) ,   6 CELAYEC GROUP(S) ,   3 REGION(S) ,   2 CCMPCSITICN(S)

SLAB GEOMETRY ,   LEFT BOUNDARY ZERC   RIGHT BCUNCARY ZERO

IS THERE TC BE ENC CF PROBLEM PUNCHEC CUTPUT NC   ,

ARE THE STEADY STATE FLUXES TC BE PUNCHEC NC

TEST POINTS FOR FREQUENCY CALCULATICN   9   33   49   65   89

GRCUP   2 IS SPECIFIEC AS THE TEST GRCUP FOR THE FREQUENCY CALCULATICN

REGION NUMBER	MESH POINT BOUNDARIES LEFT	RIGHT
1	1	17
2	17	81
3	81	97

REGICN NUMBER	LENGTH (CM)	MESH SPACING (CM)
1	4C.CC00	2.5C0C
2	160.C000	2.5C00
3	4C.CC00	2.5C00

FRACTIONAL YIELC FROM DELAYED GRCUP I INTO NEUTRCN GRCUP G

GRCUP	I= 1	I= 2	I= 3	I= 4	I= 5	I= 6
1	C.C124C	0.03050	0.11100	0.301CC	1.14CCC	3.C1CCC
2	C.C	0.0	C.C	0.0	C.C	C.C

GRCUP NUMBER	AVERAGE NEUTRON SPEEC (CM/SEC)	NEUTRONS PER FISSICN	FISSICN YIELD
1	0.1CCC0CD C8	C.25CCC0C 01	0.1CCCCCC 01
2	0.3CCC0CD C6	C.25CCCCD 01	C.C

```
CCMPCSITICN    1
     GRCUP     DIFFUSION       GRCUP CEPENCENT CRCSS SECTICNS
     NUMBER   COEFFICIENT       (CAPTURE)      (FISSION)
        1     0.150000D 01  0.700000C-02  0.4CCCCCD-C2
        2     0.5CCCCCD C0  0.1CCCOOC C0  0.8C0000C-01


      SCATTERING MATRIX  GP INTO G  (THE TOTAL REMOVAL IS CCMPUTEC ANC STCREC AS THE CIAGCNAL ELEMENTS)
(G)        GP= 1        GP= 2
  1   0.26CCCCD-C10.0
  2   0.150000D-C10.18CCCOD C0

CCMPCSITICN    2
     GRCUP     DIFFUSION       GRCUP CEPENCENT CRCSS SECTICNS
     NUMBER   COEFFICIENT       (CAPTURE)      (FISSION)
        1     0.1CCCOCD 01  C.8C0000C-C2  0.2CCCCCD-C2
        2     C.5CCC00D 00  C.404000C-01  0.396CCCD-C1


      SCATTERING MATRIX  GP INTO G  (THE TOTAL REMOVAL IS CCMPUTEC ANC STOREC AS THE CIAGCNAL ELEMENTS)
(G)        GP= 1        GP= 2
  1   0.200000D-C1C.C
  2   0.1CCCCOD-C1C.8CCCOCD-01


CCMPCSITICN ASSIGNMENT TO REGICNS
  REGICN  CCMPCSITICN
     1          1
     2          2
     3          1


NO XENON BUILDUP CCNSICERC IN THIS FRCBLEM


ARE STEACY STATE CCNDITIONS TC BE CALCULATEC ?  YES
```

```
INPUT FLUX DISTRIBUTION
(  1) 0.0           (  2) 2.963389D-01(  3) 5.882921D-01(  4) 8.715388D-01(  5) 1.141887D 00(  6) 1.395336D 00
(  7) 1.628134D 00(  8) 1.836836D 00(  9) 2.018354D 00( 10) 2.170000D 00( 11) 2.289529D 00( 12) 2.375165D 00
( 13) 2.425611D 00( 14) 2.440005D 00( 15) 2.417649D 00( 16) 2.356881D 00( 17) 2.250384D 00( 18) 2.070800D 00
( 19) 1.925089D 00( 20) 1.797160D 00( 21) 1.680847D 00( 22) 1.573593D 00( 23) 1.474167D 00( 24) 1.381839D 00
( 25) 1.296079D 00( 26) 1.216448D 00( 27) 1.142558D 00( 28) 1.074057D 00( 29) 1.010621D 00( 30) 9.519489D-01
( 31) 8.977647D-01( 32) 8.478128D-01( 33) 8.018577D-01( 34) 7.596828D-01( 35) 7.210891D-01( 36) 6.858947D-01
( 37) 6.539338D-01( 38) 6.250557D-01( 39) 5.991242D-01( 40) 5.760171D-01( 41) 5.556254D-01( 42) 5.378531D-01
( 43) 5.226163D-01( 44) 5.098432D-01( 45) 4.994736D-01( 46) 4.914587D-01( 47) 4.857605D-01( 48) 4.823524D-01
( 49) 4.812181D-01( 50) 4.823524D-01( 51) 4.857605D-01( 52) 4.914587D-01( 53) 4.994736D-01( 54) 5.098432D-01
( 55) 5.226163D-01( 56) 5.378531D-01( 57) 5.556254D-01( 58) 5.760171D-01( 59) 5.991242D-01( 60) 6.250557D-01
( 61) 6.539338D-01( 62) 6.858947D-01( 63) 7.210891D-01( 64) 7.596828D-01( 65) 8.018577D-01( 66) 8.478128D-01
( 67) 8.977647D-01( 68) 9.519489D-01( 69) 1.010621D 00( 70) 1.074057D 00( 71) 1.142558D 00( 72) 1.216448D 00
( 73) 1.296079D 00( 74) 1.381839D 00( 75) 1.474167D 00( 76) 1.573593D 00( 77) 1.680847D 00( 78) 1.797160D 00
( 79) 1.925089D 00( 80) 2.070800D 00( 81) 2.250384D 00( 82) 2.356881D 00( 83) 2.417649D 00( 84) 2.440005D 00
( 85) 2.425611D 00( 86) 2.375165D 00( 87) 2.289529D 00( 88) 2.170000D 00( 89) 2.018354D 00( 90) 1.836836D 00
( 91) 1.628134D 00( 92) 1.395336D 00( 93) 1.141887D 00( 94) 8.715388D-01( 95) 5.882921D-01( 96) 2.963389D-01
( 97) 0.0           (
(  1) 0.0           (  2) 2.453354D-02(  3) 4.870399D-02(  4) 7.215364D-02(  5) 9.453544D-02(  6) 1.155182D-01
(  7) 1.347913D-01(  8) 1.520695D-01(  9) 1.670975D-01( 10) 1.796533D-01( 11) 1.895539D-01( 12) 1.966639D-01
( 13) 2.009241D-01( 14) 2.024615D-01( 15) 2.020363D-01( 16) 2.028838D-01( 17) 2.183045D-01( 18) 2.368475D-01
( 19) 2.333879D-01( 20) 2.226800D-01( 21) 2.100072D-01( 22) 1.972358D-01( 23) 1.850011D-01( 24) 1.734965D-01
( 25) 1.627586D-01( 26) 1.527695D-01( 27) 1.434938D-01( 28) 1.348922D-01( 29) 1.269256D-01( 30) 1.195571D-01
( 31) 1.127521D-01( 32) 1.064786D-01( 33) 1.007070D-01( 34) 9.541012D-02( 35) 9.056306D-02( 36) 8.614293D-02
( 37) 8.212890D-02( 38) 7.850204D-02( 39) 7.524524D-02( 40) 7.234317D-02( 41) 6.978214D-02( 42) 6.755008D-02
( 43) 6.563646D-02( 44) 6.403226D-02( 45) 6.272993D-02( 46) 6.172331D-02( 47) 6.100767D-02( 48) 6.057963D-02
( 49) 6.043717D-02( 50) 6.057963D-02( 51) 6.100767D-02( 52) 6.172331D-02( 53) 6.272993D-02( 54) 6.403226D-02
( 55) 6.563646D-02( 56) 6.755008D-02( 57) 6.978214D-02( 58) 7.234317D-02( 59) 7.524524D-02( 60) 7.850204D-02
( 61) 8.212890D-02( 62) 8.614293D-02( 63) 9.056306D-02( 64) 9.541012D-02( 65) 1.007070D-01( 66) 1.064786D-01
( 67) 1.127521D-01( 68) 1.195571D-01( 69) 1.269256D-01( 70) 1.348922D-01( 71) 1.434938D-01( 72) 1.527695D-01
( 73) 1.627586D-01( 74) 1.734965D-01( 75) 1.850011D-01( 76) 1.972358D-01( 77) 2.100072D-01( 78) 2.226800D-01
( 79) 2.333879D-01( 80) 2.368475D-01( 81) 2.183045D-01( 82) 2.028838D-01( 83) 2.020363D-01( 84) 2.024615D-01
( 85) 2.009241D-01( 86) 1.966639D-01( 87) 1.895539D-01( 88) 1.796533D-01( 89) 1.670975D-01( 90) 1.520695D-01
( 91) 1.347913D-01( 92) 1.155182D-01( 93) 9.453544D-02( 94) 7.215364D-02( 95) 4.870399D-02( 96) 2.453354D-02
( 97) 0.0           (

THE INITIAL PRECURSOR CONCENTRATIONS ARE CALCULATED FROM THE STEADY STATE FLUX DISTRIBUTION

ARE THERE ANY TIME DEPENDENT CHANGES IN THE
CROSS SECTION DATA   YES

TIME    CROSS SECTION    GROUP    REGION    TOTAL LINEAR    TOTAL QUADRATIC
ZONE                                          CHANGE          CHANGE
 1        CAPTURE          2         1       -.900000D-02     0.0

ARE THERE ANY TIME DEPENDENT SOURCES ?   NO
```

```
EQUILIBRIUM NU(G)    (   1) 0.277307CD C1(   2) C.277307CD 01(

EQUILIBRIUM FLUXES
 1)C.0            (   2)0.2862154D 00(   3)0.5683025D 00(   4)0.8421926C CC(   5)C.11C3935C C1(   6)C.1349755D C1
 7)C.1576107D 01(   8)0.1779726D 01(   9)C.1957674D C1(  1C)C.21C7386C C1(  11)C.2226699C C1(  12)C.2313890C 01
13)C.2367680D 01(  14)0.2387212D 01(  15)C.2371878D C1(  16)C.232C559D C1(  17)C.2228526C C1(  18)C.2C7C561C C1
19)C.1937223D C1(  20)0.1817865D 01(  21)0.1708274D C1(  22)0.1606625D C1(  23)C.1511992D C1(  24)C.1423793C C1
25)C.1341590D C1(  26)0.1265016D 01(  27)C.1193741C 01(  28)C.1127462C C1(  29)C.1C659C2C 01(  3C)C.1CC88C2C C1
31)C.9559232D 00(  32)0.9070443D 00(  33)C.8619608D CC(  34)C.82C4839C CC(  35)C.7824402C CC(  36)C.7476705C CC
37)C.7160292D CC(  38)0.6873840D 00(  39)0.6616150C CC(  4C)C.6386144C CC(  41)C.6182860D CC(  42)C.6CC5446C CC
43)C.5853161D CC(  44)0.5725367D 0C(  45)0.5621530D 00(  46)0.5541215C C0(  47)C.5484085C CC(  48)C.5449903C CC
49)0.5438525D CC(  5C)0.5449903D 0C(  51)C.5484085D CC(  52)C.5541215C C0(  53)C.562153CC 0C(  54)0.5725367C CC
55)0.5853161D 00(  56)0.6005446D 00(  57)0.6182860D 0C(  58)C.6386144C CC(  59)C.6616150C CC(  6C)C.687384CC CC
61)C.7160292D CC(  62)0.7476705D 0C(  63)0.7824402C 00(  64)0.8204839C CC(  65)C.8619608D 0C(  66)C.907C443D CC
67)0.9559232D 00(  68)C.1008802D 01(  69)C.10659C2D C1(  70)0.1127462C C1(  71)C.1193741C 01(  72)C.1265C16C 01
73)C.1341590D 01(  74)0.1423793D 01(  75)C.1511992D 01(  76)C.16C6625D C1(  77)C.17C8274C C1(  78)C.1817865C 01
79)C.1937223D C1(  80)0.207C561D 01(  81)0.2228526C 01(  82)0.232C559C C1(  83)C.2371878C C1(  84)C.2387212D C1
85)0.2367680D 01(  86)0.2313890D 01(  87)C.2226699D C1(  88)0.21C7386C C1(  89)C.1957674C 01(  9C)0.1779726C 01
91)C.1576107D 01(  92)0.1349755D 01(  93)C.1103935D C1(  94)C.8421926C CC(  95)C.5683C25C CC(  96)C.2862154C CC
97)C.C            (
 1)C.0            (   2)0.2369936D-01(   3)C.4705688D-C1(   4)0.6973568C-C1(   5)C.9140864C-01(   6)C.1117632C CC
 7)0.1305057D C0(   8)0.1473659D 0C(   9)C.1621008D CC(  1C)C.1744985C CC(  11)C.1843833C 0C(  12)C.1916242C CC
13)C.1961651D CC(  14)0.1981376D 00(  15)C.1983172C 0C(  16)C.1999832C CC(  17)C.2165C68C CC(  18)C.2366467C CC
19)C.2346132D CC(  2C)C.225C399D 00(  21)C.2132734C 00(  22)C.201246CC CC(  23)C.1896364C CC(  24)C.1786642C CC
25)0.1683822D C0(  26)0.1587837D 0C(  27)C.1498417D CC(  28)C.1415239C CC(  29)C.1337972C C0(  3C)0.12663CCC CC
31)C.1199924D 00(  32)0.1138569D 00(  33)C.1081978C CC(  34)C.1C29914C CC(  35)C.9821599D-C1(  36)C.9385151C-01
37)C.8987974D-C1(  38)0.8628404D-01(  39)0.8304938C-01(  40)C.8C16223C-C1(  41)C.7761049C-C1(  42)C.7538350D-C1
43)0.7347194D-01(  44)0.7186780D-01(  45)C.7C56438D-C1(  46)C.6955623C-C1(  47)C.6883911C-01(  48)C.6841C04C-C1
49)0.6826721D-01(  50)0.6841004D-01(  51)C.6883911D-C1(  52)C.6955623D-C1(  53)C.7C56438C-C1(  54)C.7186780C-C1
55)C.7347194D-C1(  56)0.7538350D-01(  57)C.7761049C-01(  58)0.8016223C-C1(  59)C.8304938C-C1(  6C)C.8628404D-C1
61)C.8987974D-C1(  62)0.9385151D-01(  63)C.9821599C-C1(  64)C.1C29914C C0(  65)C.1081978C CC(  66)C.1138569D CC
67)0.1199924D 00(  68)0.1266300D 00(  69)C.1337972D CC(  7C)C.1415239C CC(  71)C.1498417C CC(  72)C.1587837C CC
73)C.1683822D CC(  74)0.1786642D 00(  75)0.1896364C CC(  76)C.2012460C CC(  77)C.2132734C CC(  78)C.225C399C CC
79)C.2346132D CC(  8C)0.2366467D 0C(  81)C.2165068D CC(  82)0.1999832C C0(  83)C.1983172C CC(  84)C.1981376C CC
85)C.1961651D 00(  86)0.1916242D 00(  87)C.1843833D CC(  88)C.1744985C CC(  89)C.1621C08C CC(  9C)C.1473659C CC
91)C.13C5057D CC(  92)0.1117632D 00(  93)0.9140864C-C1(  94)C.6973568C-C1(  95)C.47C5688C-C1(  96)C.2369936C-C1
97)C.0            (
```

1)0.0 (	2)0.1700076D-03(	3)0.3375631D-03(	4)0.5002498D-03(	5)0.6557210D-03(	6)0.8017345D-03
7)0.9361841D-03(	8)0.1057131D-02(	9)0.1162831D-02(	10)0.1251763D-02(	11)0.1322657D-02(	12)0.1374542D-02
13)0.1406882D-02(	14)0.1420072D-02(	15)0.1417446D-02(	16)0.1413421D-02(	17)0.1097637D-02(	18)0.7554563D-03
19)0.7360447D-03(	20)0.7015033D-03(	21)0.6631983D-03(	22)0.6252038D-03(	23)0.5889187D-03(	24)0.5547643D-03
25)0.5228085D-03(	26)0.4929951D-03(	27)0.4652280D-03(	28)0.4394013D-03(	29)0.4154111D-03(	30)0.3931581D-03
31)0.3725500D-03(	32)0.3535006D-03(	33)0.3359303D-03(	34)0.3197656D-03(	35)0.3049390D-03(	36)0.2913882D-03
37)0.2790567D-03(	38)0.2678929D-03(	39)0.2578500D-03(	40)0.2488860D-03(	41)0.2409634D-03(	42)0.2340491D-03
43)0.2281141D-03(	44)0.2231336D-03(	45)0.2190868D-03(	46)0.2159567D-03(	47)0.2137302D-03(	48)0.2123980D-03
49)0.2119546D-03(	50)0.2123980D-03(	51)0.2137302D-03(	52)0.2159567D-03(	53)0.2190868D-03(	54)0.2231336D-03
55)0.2281141D-03(	56)0.2340491D-03(	57)0.2409634D-03(	58)0.2488860D-03(	59)0.2578500D-03(	60)0.2678929D-03
61)0.2790567D-03(	62)0.2913882D-03(	63)0.3049390D-03(	64)0.3197656D-03(	65)0.3359303D-03(	66)0.3535006D-03
67)0.3725500D-03(	68)0.3931581D-03(	69)0.4154111D-03(	70)0.4394013D-03(	71)0.4652280D-03(	72)0.4929951D-03
73)0.5228085D-03(	74)0.5547643D-03(	75)0.5889187D-03(	76)0.6252038D-03(	77)0.6631983D-03(	78)0.7015033D-03
79)0.7360447D-03(	80)0.7554563D-03(	81)0.1097637D-02(	82)0.1413421D-02(	83)0.1417446D-02(	84)0.1420072D-02
85)0.1406882D-02(	86)0.1374542D-02(	87)0.1322657D-02(	88)0.1251763D-02(	89)0.1162831D-02(	90)0.1057131D-02
91)0.9361841D-03(	92)0.8017345D-03(	93)0.6557210D-03(	94)0.5002498D-03(	95)0.3375631D-03(	96)0.1700076D-03
97)0.0 (					
1)0.0 (	2)0.4534131D-03(	3)0.9002864D-03(	4)0.1334174D-02(	5)0.1748819D-02(	6)0.2138239D-02
7)0.2496818D-02(	8)0.2819385D-02(	9)0.3101289D-02(	10)0.3338472D-02(	11)0.3527548D-02(	12)0.3665926D-02
13)0.3752176D-02(	14)0.3787355D-02(	15)0.3780352D-02(	16)0.3769618D-02(	17)0.2927417D-02(	18)0.2014814D-02
19)0.1963043D-02(	20)0.1870921D-02(	21)0.1768761D-02(	22)0.1667429D-02(	23)0.1570656D-02(	24)0.1479565D-02
25)0.1394339D-02(	26)0.1314826D-02(	27)0.1240771D-02(	28)0.1171891D-02(	29)0.1107908D-02(	30)0.1048559D-02
31)0.9935970D-03(	32)0.9427919D-03(	33)0.8959317D-03(	34)0.8528202D-03(	35)0.8132772D-03(	36)0.7771371D-03
37)0.7442488D-03(	38)0.7144747D-03(	39)0.6876901D-03(	40)0.6637830D-03(	41)0.6426534D-03(	42)0.6242128D-03
43)0.6083841D-03(	44)0.5951011D-03(	45)0.5843081D-03(	46)0.5759601D-03(	47)0.5700220D-03(	48)0.5664691D-03
49)0.5652864D-03(	50)0.5664691D-03(	51)0.5700220D-03(	52)0.5759601D-03(	53)0.5843081D-03(	54)0.5951011D-03
55)0.6083841D-03(	56)0.6242128D-03(	57)0.6426534D-03(	58)0.6637830D-03(	59)0.6876901D-03(	60)0.7144747D-03
61)0.7442488D-03(	62)0.7771371D-03(	63)0.8132772D-03(	64)0.8528202D-03(	65)0.8959317D-03(	66)0.9427919D-03
67)0.9935970D-03(	68)0.1048559D-02(	69)0.1107908D-02(	70)0.1171891D-02(	71)0.1240771D-02(	72)0.1314826D-02
73)0.1394339D-02(	74)0.1479565D-02(	75)0.1570656D-02(	76)0.1667429D-02(	77)0.1768761D-02(	78)0.1870921D-02
79)0.1963043D-02(	80)0.2014814D-02(	81)0.2927417D-02(	82)0.3769618D-02(	83)0.3780352D-02(	84)0.3787355D-02
85)0.3752176D-02(	86)0.3665926D-02(	87)0.3527548D-02(	88)0.3338472D-02(	89)0.3101289D-02(	90)0.2819385D-02
91)0.2496818D-02(	92)0.2138239D-02(	93)0.1748819D-02(	94)0.1334174D-02(	95)0.9002864D-03(	96)0.4534131D-03
97)0.0 (					

```
 1)0.0          (  2)0.1116720D-03(  3)0.2217334D-03(  4)0.3285965D-03(  5)0.4307201D-03(  6)0.5266312D-03
 7)0.6149464D-03(  8)0.6943921D-03(  9)0.7638228D-03( 10)0.8222391D-03( 11)0.8688069D-03( 12)0.9028884D-03
13)0.9241311D-03( 14)0.9327954D-03( 15)0.9310706D-03( 16)0.9284267D-03( 17)0.7209994D-03( 18)0.4962327D-03
19)0.4834819D-03( 20)0.4607929D-03( 21)0.4356316D-03( 22)0.4106744D-03( 23)0.3868400D-03( 24)0.3644052D-03
25)0.3434145D-03( 26)0.3238312D-03( 27)0.3055919D-03( 28)0.2886273D-03( 29)0.2728689D-03( 30)0.2582518D-03
31)0.2447150D-03( 32)0.2322021D-03( 33)0.2206608D-03( 34)0.2100428D-03( 35)0.2003037D-03( 36)0.1914027D-03
37)0.1833026D-03( 38)0.1759694D-03( 39)0.1693726D-03( 40)0.1634845D-03( 41)0.1582804D-03( 42)0.1537386D-03
43)0.1498402D-03( 44)0.1465687D-03( 45)0.1439104D-03( 46)0.1418544D-03( 47)0.1403919D-03( 48)0.1395168D-03
49)0.1392255D-03( 50)0.1395168D-03( 51)0.1403919D-03( 52)0.1418544D-03( 53)0.1439104D-03( 54)0.1465687D-03
55)0.1498402D-03( 56)0.1537386D-03( 57)0.1582804D-03( 58)0.1634845D-03( 59)0.1693726D-03( 60)0.1759694D-03
61)0.1833026D-03( 62)0.1914027D-03( 63)0.2003037D-03( 64)0.2100428D-03( 65)0.2206608D-03( 66)0.2322021D-03
67)0.2447150D-03( 68)0.2582518D-03( 69)0.2728689D-03( 70)0.2886273D-03( 71)0.3055919D-03( 72)0.3238312D-03
73)0.3434145D-03( 74)0.3644052D-03( 75)0.3868400D-03( 76)0.4106744D-03( 77)0.4356316D-03( 78)0.4607929D-03
79)0.4834819D-03( 80)0.4962327D-03( 81)0.7209994D-03( 82)0.9284267D-03( 83)0.9310706D-03( 84)0.9327954D-03
85)0.9241311D-03( 86)0.9028884D-03( 87)0.8688069D-03( 88)0.8222391D-03( 89)0.7638228D-03( 90)0.6943921D-03
91)0.6149464D-03( 92)0.5266312D-03( 93)0.4307201D-03( 94)0.3285965D-03( 95)0.2217334D-03( 96)0.1116720D-03
97)0.0          (
 1)0.0          (  2)0.8292306D-04(  3)0.1646501D-03(  4)0.2440022D-03(  5)0.3198350D-03(  6)0.3910546D-03
 7)0.4566339D-03(  8)0.5156270D-03(  9)0.5671833D-03( 10)0.6105609D-03( 11)0.6451402D-03( 12)0.6704478D-03
13)0.6862217D-03( 14)0.6926555D-03( 15)0.6913747D-03( 16)0.6894115D-03( 17)0.5353845D-03( 18)0.3684820D-03
19)0.3590138D-03( 20)0.3421658D-03( 21)0.3234821D-03( 22)0.3049499D-03( 23)0.2872515D-03( 24)0.2705923D-03
25)0.2550055D-03( 26)0.2404637D-03( 27)0.2269200D-03( 28)0.2143227D-03( 29)0.2026212D-03( 30)0.1917671D-03
31)0.1817153D-03( 32)0.1724237D-03( 33)0.1638536D-03( 34)0.1559691D-03( 35)0.1487373D-03( 36)0.1421277D-03
37)0.1361129D-03( 38)0.1306676D-03( 39)0.1257691D-03( 40)0.1213968D-03( 41)0.1175325D-03( 42)0.1141600D-03
43)0.1112651D-03( 44)0.1088358D-03( 45)0.1068620D-03( 46)0.1053352D-03( 47)0.1042492D-03( 48)0.1035994D-03
49)0.1033831D-03( 50)0.1035994D-03( 51)0.1042492D-03( 52)0.1053352D-03( 53)0.1068620D-03( 54)0.1088358D-03
55)0.1112651D-03( 56)0.1141600D-03( 57)0.1175325D-03( 58)0.1213968D-03( 59)0.1257691D-03( 60)0.1306676D-03
61)0.1361129D-03( 62)0.1421277D-03( 63)0.1487373D-03( 64)0.1559691D-03( 65)0.1638536D-03( 66)0.1724237D-03
67)0.1817153D-03( 68)0.1917671D-03( 69)0.2026212D-03( 70)0.2143227D-03( 71)0.2269200D-03( 72)0.2404637D-03
73)0.2550055D-03( 74)0.2705923D-03( 75)0.2872515D-03( 76)0.3049499D-03( 77)0.3234821D-03( 78)0.3421658D-03
79)0.3590138D-03( 80)0.3684820D-03( 81)0.5353845D-03( 82)0.6894115D-03( 83)0.6913747D-03( 84)0.6926555D-03
85)0.6862217D-03( 86)0.6704478D-03( 87)0.6451402D-03( 88)0.6105609D-03( 89)0.5671833D-03( 90)0.5156270D-03
91)0.4566339D-03( 92)0.3910546D-03( 93)0.3198350D-03( 94)0.2440022D-03( 95)0.1646501D-03( 96)0.8292306D-04
97)0.0          (
```

```
 1)0.0          (  2)0.6361268D-05(  3)0.1263078D-04(  4)0.1871812D-04(  5)0.2453547D-04(  6)0.2999893D-04
 7)0.3502971D-04(  8)0.3955524D-04(  9)0.4351028D-04( 10)0.4683790D-04( 11)0.4949058D-04( 12)0.5143199D-04
13)0.5264205D-04( 14)0.5313561D-04( 15)0.5303736D-04( 16)0.5288675D-04( 17)0.4107089D-04( 18)0.2826732D-04
19)0.2754099D-04( 20)0.2624853D-04( 21)0.2481525D-04( 22)0.2339359D-04( 23)0.2203589D-04( 24)0.2075792D-04
25)0.1956221D-04( 26)0.1844667D-04( 27)0.1740769D-04( 28)0.1644132D-04( 29)0.1554366D-04( 30)0.1471101D-04
31)0.1393991D-04( 32)0.1322712D-04( 33)0.1256969D-04( 34)0.1196485D-04( 35)0.1141007D-04( 36)0.1090303D-04
37)0.1044162D-04( 38)0.1002389D-04( 39)0.9648113D-05( 40)0.9312703D-05( 41)0.9016260D-05( 42)0.8757543D-05
43)0.8535471D-05( 44)0.8349113D-05( 45)0.8197690D-05( 46)0.8080570D-05( 47)0.7997260D-05( 48)0.7947413D-05
49)0.7930821D-05( 50)0.7947413D-05( 51)0.7997260D-05( 52)0.8080570D-05( 53)0.8197690D-05( 54)0.8349113D-05
55)0.8535471D-05( 56)0.8757543D-05( 57)0.9016260D-05( 58)0.9312703D-05( 59)0.9648113D-05( 60)0.1002389D-04
61)0.1044162D-04( 62)0.1090303D-04( 63)0.1141007D-04( 64)0.1196485D-04( 65)0.1256969D-04( 66)0.1322712D-04
67)0.1393991D-04( 68)0.1471101D-04( 69)0.1554366D-04( 70)0.1644132D-04( 71)0.1740769D-04( 72)0.1844667D-04
73)0.1956221D-04( 74)0.2075792D-04( 75)0.2203589D-04( 76)0.2339359D-04( 77)0.2481525D-04( 78)0.2624853D-04
79)0.2754099D-04( 80)0.2826732D-04( 81)0.4107089D-04( 82)0.5288675D-04( 83)0.5303736D-04( 84)0.5313561D-04
85)0.5264205D-04( 86)0.5143199D-04( 87)0.4949058D-04( 88)0.4683790D-04( 89)0.4351028D-04( 90)0.3955524D-04
91)0.3502971D-04( 92)0.2999893D-04( 93)0.2453547D-04( 94)0.1871812D-04( 95)0.1263078D-04( 96)0.6361268D-05
97)0.0          (
 1)0.0          (  2)0.8964655D-06(  3)0.1780001D-05(  4)0.2637862D-05(  5)0.3457676D-05(  6)0.4227618D-05
 7)0.4936583D-05(  8)0.5574346D-05(  9)0.6131712D-05( 10)0.6600659D-05( 11)0.6974489D-05( 12)0.7248084D-05
13)0.7418613D-05( 14)0.7488167D-05( 15)0.7474321D-05( 16)0.7453097D-05( 17)0.5787940D-05( 18)0.3983589D-05
19)0.3881230D-05( 20)0.3699090D-05( 21)0.3497104D-05( 22)0.3296756D-05( 23)0.3105421D-05( 24)0.2925322D-05
25)0.2756816D-05( 26)0.2599607D-05( 27)0.2453189D-05( 28)0.2317003D-05( 29)0.2190500D-05( 30)0.2073158D-05
31)0.1964490D-05( 32)0.1864040D-05( 33)0.1771391D-05( 34)0.1686153D-05( 35)0.1607970D-05( 36)0.1536516D-05
37)0.1471491D-05( 38)0.1412623D-05( 39)0.1359666D-05( 40)0.1312398D-05( 41)0.1270622D-05( 42)0.1234162D-05
43)0.1202866D-05( 44)0.1176604D-05( 45)0.1155264D-05( 46)0.1138759D-05( 47)0.1127019D-05( 48)0.1119994D-05
49)0.1117656D-05( 50)0.1119994D-05( 51)0.1127019D-05( 52)0.1138759D-05( 53)0.1155264D-05( 54)0.1176604D-05
55)0.1202866D-05( 56)0.1234162D-05( 57)0.1270622D-05( 58)0.1312398D-05( 59)0.1359666D-05( 60)0.1412623D-05
61)0.1471491D-05( 62)0.1536516D-05( 63)0.1607970D-05( 64)0.1686153D-05( 65)0.1771391D-05( 66)0.1864040D-05
67)0.1964490D-05( 68)0.2073158D-05( 69)0.2190500D-05( 70)0.2317003D-05( 71)0.2453189D-05( 72)0.2599607D-05
73)0.2756816D-05( 74)0.2925322D-05( 75)0.3105421D-05( 76)0.3296756D-05( 77)0.3497104D-05( 78)0.3699090D-05
79)0.3881230D-05( 80)0.3983589D-05( 81)0.5787940D-05( 82)0.7453097D-05( 83)0.7474321D-05( 84)0.7488167D-05
85)0.7418613D-05( 86)0.7248084D-05( 87)0.6974489D-05( 88)0.6600659D-05( 89)0.6131712D-05( 90)0.5574346D-05
91)0.4936583D-05( 92)0.4227618D-05( 93)0.3457676D-05( 94)0.2637862D-05( 95)0.1780001D-05( 96)0.8964655D-06
97)0.0          (
```

REGION	FRACTIONAL POWER
1	0.2789988D 00
2	0.4420024D 00
3	0.2789988D 00

TOTAL NORMALIZED POWER = 0.1000000D 01

```
BENCHMARK PROBLEM  PROMPT SUPERCRITICAL TRANSIENT

TIME ZONE= 1  STEP NUMBER=  80  TIME=0.100000D-02  TIME STEP=0.127628D-04


TEST POINT       MESH POINT       FREQUENCY         EXP(W*H)
     1                9           1.0086D 02        1.000030D 00
     2               33           4.5460D 01        1.000013D 00
     3               49           0.0               1.000000D 00
     4               65           0.0               1.000000D 00
     5               89           0.0               1.000000D 00

POINT-WISE FLUXES FOR GROUP    1
 (  1) 0.0           (  2) 3.029636D-01(  3) 6.015166D-01(  4) 8.913127D-01(  5) 1.168133D 00(  6) 1.427946D 00
 (  7) 1.666968D 00(  8) 1.881719D 00(  9) 2.069070D 00( 10) 2.226289D 00( 11) 2.351084D 00( 12) 2.441628D 00
 ( 13) 2.496576D 00( 14) 2.515040D 00( 15) 2.496402D 00( 16) 2.439536D 00( 17) 2.339610D 00( 18) 2.169044D 00
 ( 19) 2.024854D 00( 20) 1.895926D 00( 21) 1.777814D 00( 22) 1.668553D 00( 23) 1.567111D 00( 24) 1.472822D 00
 ( 25) 1.385176D 00( 26) 1.303737D 00( 27) 1.228116D 00( 28) 1.157960D 00( 29) 1.092942D 00( 30) 1.032759D 00
 ( 31) 9.771345D-01( 32) 9.258115D-01( 33) 8.785540D-01( 34) 8.351446D-01( 35) 7.953843D-01( 36) 7.590909D-01
 ( 37) 7.260984D-01( 38) 6.962535D-01( 39) 6.694238D-01( 40) 6.454840D-01( 41) 6.243248D-01( 42) 6.058492D-01
 ( 43) 5.899721D-01( 44) 5.766204D-01( 45) 5.657319D-01( 46) 5.572556D-01( 47) 5.511510D-01( 48) 5.473881D-01
 ( 49) 5.459473D-01( 50) 5.468188D-01( 51) 5.500032D-01( 52) 5.555110D-01( 53) 5.633626D-01( 54) 5.735887D-01
 ( 55) 5.862301D-01( 56) 6.013379D-01( 57) 6.189736D-01( 58) 6.392098D-01( 59) 6.621297D-01( 60) 6.878283D-01
 ( 61) 7.164120D-01( 62) 7.479996D-01( 63) 7.827225D-01( 64) 8.207252D-01( 65) 8.621659D-01( 66) 9.072157D-01
 ( 67) 9.560676D-01( 68) 1.008924D 00( 69) 1.066005D 00( 70) 1.127549D 00( 71) 1.193814D 00( 72) 1.265077D 00
 ( 73) 1.341642D 00( 74) 1.423835D 00( 75) 1.512027D 00( 76) 1.606655D 00( 77) 1.708298D 00( 78) 1.817885D 00
 ( 79) 1.937240D 00( 80) 2.070574D 00( 81) 2.228537D 00( 82) 2.320568D 00( 83) 2.371886D 00( 84) 2.387219D 00
 ( 85) 2.367685D 00( 86) 2.313894D 00( 87) 2.226703D 00( 88) 2.107389D 00( 89) 1.957676D 00( 90) 1.779727D 00
 ( 91) 1.576108D 00( 92) 1.349756D 00( 93) 1.103936D 00( 94) 8.421931D-01( 95) 5.683028D-01( 96) 2.862155D-01
 ( 97) 0.0           (

TOTAL INTEGRATED FLUX FOR REGION  1 GROUP  1 = 0.703650D 02

TOTAL INTEGRATED FLUX FOR REGION  2 GROUP  1 = 0.166478D 03

TOTAL INTEGRATED FLUX FOR REGION  3 GROUP  1 = 0.666838D 02
```

```
POINT-WISE FLUXES FOR GROUP    2
(  1) 0.0          (  2) 2.516062D-02(  3) 4.995501D-02(  4) 7.402229D-02(  5) 9.701212D-02(  6) 1.185898D-01
(  7) 1.384412D-01(  8) 1.562773D-01(  9) 1.718385D-01( 10) 1.848988D-01( 11) 1.952707D-01( 12) 2.028153D-01
( 13) 2.074725D-01( 14) 2.093781D-01( 15) 2.093351D-01( 16) 2.107297D-01( 17) 2.273334D-01( 18) 2.473800D-01
( 19) 2.445604D-01( 20) 2.340340D-01( 21) 2.213260D-01( 22) 2.084251D-01( 23) 1.960233D-01( 24) 1.843394D-01
( 25) 1.734205D-01( 26) 1.632530D-01( 27) 1.538035D-01( 28) 1.450332D-01( 29) 1.369036D-01( 30) 1.293777D-01
( 31) 1.224212D-01( 32) 1.160022D-01( 33) 1.100914D-01( 34) 1.046616D-01( 35) 9.968796D-02( 36) 9.514789D-02
( 37) 9.102061D-02( 38) 8.728731D-02( 39) 8.393099D-02( 40) 8.093633D-02( 41) 7.828968D-02( 42) 7.597896D-02
( 43) 7.399358D-02( 44) 7.232442D-02( 45) 7.096377D-02( 46) 6.990527D-02( 47) 6.914391D-02( 48) 6.867598D-02
( 49) 6.849905D-02( 50) 6.861197D-02( 51) 6.901484D-02( 52) 6.970901D-02( 53) 7.069709D-02( 54) 7.198296D-02
( 55) 7.357175D-02( 56) 7.546992D-02( 57) 7.768522D-02( 58) 8.022675D-02( 59) 8.310501D-02( 60) 8.633192D-02
( 61) 8.992086D-02( 62) 9.388675D-02( 63) 9.824610D-02( 64) 1.030171D-01( 65) 1.082196D-01( 66) 1.138748D-01
( 67) 1.200076D-01( 68) 1.266427D-01( 69) 1.338080D-01( 70) 1.415329D-01( 71) 1.498493D-01( 72) 1.587900D-01
( 73) 1.683875D-01( 74) 1.786686D-01( 75) 1.896400D-01( 76) 2.012489D-01( 77) 2.132758D-01( 78) 2.250418D-01
( 79) 2.346147D-01( 80) 2.366479D-01( 81) 2.165077D-01( 82) 1.999839D-01( 83) 1.983177D-01( 84) 1.981380D-01
( 85) 1.961655D-01( 86) 1.916245D-01( 87) 1.843835D-01( 88) 1.744987D-01( 89) 1.621009D-01( 90) 1.473660D-01
( 91) 1.305057D-01( 92) 1.117632D-01( 93) 9.140867D-02( 94) 6.973570D-02( 95) 4.705689D-02( 96) 2.369936D-02
( 97) 0.0          (

TOTAL INTEGRATED FLUX FOR REGION  1 GROUP  2 = 0.591216D 01

TOTAL INTEGRATED FLUX FOR REGION  2 GROUP  2 = 0.205262D 02

TOTAL INTEGRATED FLUX FOR REGION  3 GROUP  2 = 0.558751D 01

          REGION          NORMALIZED POWER

             1              0.1057022D 01
             2              0.1013323D 01
             3              0.1000002D 01

          TOTAL NORMALIZED POWER =  0.1021798D 01
```

BENCHMARK PROBLEM PROMPT SUPERCRITICAL TRANSIENT

TIME ZONE= 1 STEP NUMBER= 288 TIME=0.500000D-02 TIME STEP=0.252695D-04

TEST POINT	MESH POINT	FREQUENCY	EXP(W*H)
1	9	3.2554D 02	1.005006D 00
2	33	2.6144D 02	1.004018D 00
3	49	1.5368D 02	1.002360D 00
4	65	3.8046D 01	1.000584D 00
5	89	1.1413D 01	1.000175D 00

POINT-WISE FLUXES FOR GROUP 1

```
(  1) 0.0          (  2) 7.125541D-01(  3) 1.414306D 00(  4) 2.094616D 00(  5) 2.743170D 00(  6) 3.350134D 00
(  7) 3.906302D 00(  8) 4.403237D 00(  9) 4.833399D 00( 10) 5.190255D 00( 11) 5.468382D 00( 12) 5.663539D 00
( 13) 5.772705D 00( 14) 5.794024D 00( 15) 5.726411D 00( 16) 5.567876D 00( 17) 5.308726D 00( 18) 4.874881D 00
( 19) 4.504931D 00( 20) 4.174256D 00( 21) 3.872669D 00( 22) 3.595352D 00( 23) 3.339540D 00( 24) 3.103291D 00
( 25) 2.885041D 00( 26) 2.683428D 00( 27) 2.497226D 00( 28) 2.325313D 00( 29) 2.166662D 00( 30) 2.020324D 00
( 31) 1.885427D 00( 32) 1.761168D 00( 33) 1.646806D 00( 34) 1.541661D 00( 35) 1.445107D 00( 36) 1.356570D 00
( 37) 1.275520D 00( 38) 1.201475D 00( 39) 1.133991D 00( 40) 1.072665D 00( 41) 1.017126D 00( 42) 9.670382D-01
( 43) 9.220980D-01( 44) 8.820293D-01( 45) 8.465840D-01( 46) 8.155400D-01( 47) 7.886993D-01( 48) 7.658873D-01
( 49) 7.469510D-01( 50) 7.317585D-01( 51) 7.201979D-01( 52) 7.121764D-01( 53) 7.076195D-01( 54) 7.064709D-01
( 55) 7.086914D-01( 56) 7.142589D-01( 57) 7.231680D-01( 58) 7.354296D-01( 59) 7.510710D-01( 60) 7.701358D-01
( 61) 7.926838D-01( 62) 8.187912D-01( 63) 8.485508D-01( 64) 8.820723D-01( 65) 9.194827D-01( 66) 9.609264D-01
( 67) 1.006566D 00( 68) 1.056584D 00( 69) 1.111180D 00( 70) 1.170577D 00( 71) 1.235017D 00( 72) 1.304766D 00
( 73) 1.380115D 00( 74) 1.461386D 00( 75) 1.548942D 00( 76) 1.643217D 00( 77) 1.744794D 00( 78) 1.854608D 00
( 79) 1.974507D 00( 80) 2.108769D 00( 81) 2.268213D 00( 82) 2.361064D 00( 83) 2.412578D 00( 84) 2.427578D 00
( 85) 2.407209D 00( 86) 2.352097D 00( 87) 2.263117D 00( 88) 2.141567D 00( 89) 1.989201D 00( 90) 1.808213D 00
( 91) 1.601205D 00( 92) 1.371158D 00( 93) 1.121380D 00( 94) 8.554664D-01( 95) 5.772429D-01( 96) 2.907131D-01
( 97) 0.0          (
```

TOTAL INTEGRATED FLUX FOR REGION 1 GROUP 1 = 0.163238D 03

TOTAL INTEGRATED FLUX FOR REGION 2 GROUP 1 = 0.254271D 03

TOTAL INTEGRATED FLUX FOR REGION 3 GROUP 1 = 0.677847D 02

```
POINT-WISE FLUXES FOR GROUP    2
 (  1) 0.0          (  2) 6.010576D-02(  3) 1.193005D-01(  4) 1.766868D-01(  5) 2.313949D-01(  6) 2.825954D-01
 (  7) 3.295118D-01(  8) 3.714326D-01(  9) 4.077224D-01( 10) 4.378318D-01( 11) 4.613130D-01( 12) 4.778278D-01
 ( 13) 4.872422D-01( 14) 4.898506D-01( 15) 4.873938D-01( 16) 4.871000D-01( 17) 5.180021D-01( 18) 5.534876D-01
 ( 19) 5.403078D-01( 20) 5.112783D-01( 21) 4.782678D-01( 22) 4.454875D-01( 23) 4.143547D-01( 24) 3.852738D-01
 ( 25) 3.582870D-01( 26) 3.333122D-01( 27) 3.102293D-01( 28) 2.889110D-01( 29) 2.692342D-01( 30) 2.510834D-01
 ( 31) 2.343509D-01( 32) 2.189376D-01( 33) 2.047519D-01( 34) 1.917096D-01( 35) 1.797332D-01( 36) 1.687516D-01
 ( 37) 1.586993D-01( 38) 1.495166D-01( 39) 1.411486D-01( 40) 1.335452D-01( 41) 1.266607D-01( 42) 1.204535D-01
 ( 43) 1.148861D-01( 44) 1.099242D-01( 45) 1.055372D-01( 46) 1.016977D-01( 47) 9.838123D-02( 48) 9.556616D-02
 ( 49) 9.323368D-02( 50) 9.136751D-02( 51) 8.995390D-02( 52) 8.898145D-02( 53) 8.844105D-02( 54) 8.832585D-02
 ( 55) 8.863114D-02( 56) 8.935430D-02( 57) 9.049484D-02( 58) 9.205428D-02( 59) 9.403618D-02( 60) 9.644614D-02
 ( 61) 9.929177D-02( 62) 1.025828D-01( 63) 1.063309D-01( 64) 1.105499D-01( 65) 1.152559D-01( 66) 1.204670D-01
 ( 67) 1.262038D-01( 68) 1.324891D-01( 69) 1.393480D-01( 70) 1.468081D-01( 71) 1.548992D-01( 72) 1.636527D-01
 ( 73) 1.730997D-01( 74) 1.832659D-01( 75) 1.941566D-01( 76) 2.057170D-01( 77) 2.177229D-01( 78) 2.294840D-01
 ( 79) 2.390354D-01( 80) 2.409414D-01( 81) 2.203223D-01( 82) 2.034344D-01( 83) 2.016793D-01( 84) 2.014468D-01
 ( 85) 1.993997D-01( 86) 1.947491D-01( 87) 1.873613D-01( 88) 1.772936D-01( 89) 1.646788D-01( 90) 1.496952D-01
 ( 91) 1.325579D-01( 92) 1.135132D-01( 93) 9.283505D-02( 94) 7.082103D-02( 95) 4.778791D-02( 96) 2.406712D-02
 ( 97) 0.0          (

TOTAL INTEGRATED FLUX FOR REGION  1 GROUP  2 = 0.139158D 02

TOTAL INTEGRATED FLUX FOR REGION  2 GROUP  2 = 0.311389D 02

TOTAL INTEGRATED FLUX FOR REGION  3 GROUP  2 = 0.567870D 01

          REGION          NORMALIZED POWER

             1             0.2474610D 01
             2             0.1540279D 01
             3             0.1016394D 01

          TOTAL NORMALIZED POWER =   0.1654793D 01
```

```
BENCHMARK PROBLEM  PROMPT SUPERCRITICAL TRANSIENT

TIME ZONE= 1  STEP NUMBER= 486  TIME=0.1000000D-01  TIME STEP=0.252695D-04


TEST POINT       MESH POINT        FREQUENCY          EXP(W*H)
     1                9            7.7692D 02        1.017167D 00
     2               33            7.1604D 02        1.015811D 00
     3               49            6.3323D 02        1.013970D 00
     4               65            3.7774D 02        1.008310D 00
     5               89            1.5345D 02        1.003367D 00

POINT-WISE FLUXES FOR GROUP    1
 (  1) 0.0           (  2) 9.960839D 00(  3) 1.976312D 01(  4) 2.925080D 01(  5) 3.827284D 01(  6) 4.668561D 01
 (  7) 5.435517D 01(  8) 6.115937D 01(  9) 6.698986D 01( 10) 7.175372D 01( 11) 7.537501D 01( 12) 7.779581D 01
 ( 13) 7.897690D 01( 14) 7.889704D 01( 15) 7.754818D 01( 16) 7.491500D 01( 17) 7.089311D 01( 18) 6.430270D 01
 ( 19) 5.864968D 01( 20) 5.361523D 01( 21) 4.905974D 01( 22) 4.491068D 01( 23) 4.112181D 01( 24) 3.765815D 01
 ( 25) 3.449037D 01( 26) 3.159264D 01( 27) 2.894170D 01( 28) 2.651644D 01( 29) 2.429759D 01( 30) 2.226757D 01
 ( 31) 2.041033D 01( 32) 1.871118D 01( 33) 1.715672D 01( 34) 1.573469D 01( 35) 1.443390D 01( 36) 1.324410D 01
 ( 37) 1.215595D 01( 38) 1.116089D 01( 39) 1.025113D 01( 40) 9.419516D 00( 41) 8.659541D 00( 42) 7.965249D 00
 ( 43) 7.331201D 00( 44) 6.752434D 00( 45) 6.224416D 00( 46) 5.743011D 00( 47) 5.304446D 00( 48) 4.905283D 00
 ( 49) 4.542385D 00( 50) 4.212899D 00( 51) 3.914227D 00( 52) 3.644007D 00( 53) 3.400094D 00( 54) 3.180545D 00
 ( 55) 2.983599D 00( 56) 2.807663D 00( 57) 2.651305D 00( 58) 2.513235D 00( 59) 2.392298D 00( 60) 2.287465D 00
 ( 61) 2.197822D 00( 62) 2.122565D 00( 63) 2.060991D 00( 64) 2.012491D 00( 65) 1.976550D 00( 66) 1.952734D 00
 ( 67) 1.940694D 00( 68) 1.940157D 00( 69) 1.950926D 00( 70) 1.972876D 00( 71) 2.005952D 00( 72) 2.050171D 00
 ( 73) 2.105621D 00( 74) 2.172464D 00( 75) 2.250951D 00( 76) 2.341460D 00( 77) 2.444590D 00( 78) 2.561438D 00
 ( 79) 2.694323D 00( 80) 2.848781D 00( 81) 3.038985D 00( 82) 3.148976D 00( 83) 3.205370D 00( 84) 3.214800D 00
 ( 85) 3.178938D 00( 86) 3.098710D 00( 87) 2.975328D 00( 88) 2.810526D 00( 89) 2.606596D 00( 90) 2.366370D 00
 ( 91) 2.093190D 00( 92) 1.790855D 00( 93) 1.463574D 00( 94) 1.115904D 00( 95) 7.526873D-01( 96) 3.789838D-01
 ( 97) 0.0           (

TOTAL INTEGRATED FLUX FOR REGION  1 GROUP  1 = 0.224286D 04

TOTAL INTEGRATED FLUX FOR REGION  2 GROUP  1 = 0.208022D 04

TOTAL INTEGRATED FLUX FOR REGION  3 GROUP  1 = 0.893007D 02
```

```
POINT-WISE FLUXES FOR GROUP    2
 (  1) 0.0            (  2) 8.542783D-01(  3) 1.694960D 00(  4) 2.508666D 00(  5) 3.282443D 00(  6) 4.003976D 00
 (  7) 4.661778D 00(  8) 5.245378D 00(  9) 5.745487D 00( 10) 6.154161D 00( 11) 6.464972D 00( 12) 6.673303D 00
 ( 13) 6.777180D 00( 14) 6.780350D 00( 15) 6.704384D 00( 16) 6.636956D 00( 17) 6.924807D 00( 18) 7.221613D 00
 ( 19) 6.932234D 00( 20) 6.463639D 00( 21) 5.960859D 00( 22) 5.473963D 00( 23) 5.018731D 00( 24) 4.598687D 00
 ( 25) 4.213091D 00( 26) 3.859825D 00( 27) 3.536433D 00( 28) 3.240477D 00( 29) 2.969662D 00( 30) 2.721864D 00
 ( 31) 2.495134D 00( 32) 2.287685D 00( 33) 2.097886D 00( 34) 1.924243D 00( 35) 1.765392D 00( 36) 1.620084D 00
 ( 37) 1.487182D 00( 38) 1.365642D 00( 39) 1.254513D 00( 40) 1.152926D 00( 41) 1.060085D 00( 42) 9.752651D-01
 ( 43) 8.978031D-01( 44) 8.270937D-01( 45) 7.625843D-01( 46) 7.037707D-01( 47) 6.501928D-01( 48) 6.014311D-01
 ( 49) 5.571035D-01( 50) 5.168618D-01( 51) 4.803893D-01( 52) 4.473980D-01( 53) 4.176265D-01( 54) 3.908377D-01
 ( 55) 3.668170D-01( 56) 3.453704D-01( 57) 3.263234D-01( 58) 3.095188D-01( 59) 2.948161D-01( 60) 2.820901D-01
 ( 61) 2.712295D-01( 62) 2.621368D-01( 63) 2.547265D-01( 64) 2.489250D-01( 65) 2.446698D-01( 66) 2.419089D-01
 ( 67) 2.406000D-01( 68) 2.407107D-01( 69) 2.422175D-01( 70) 2.451058D-01( 71) 2.493688D-01( 72) 2.550070D-01
 ( 73) 2.620251D-01( 74) 2.704249D-01( 75) 2.801861D-01( 76) 2.912133D-01( 77) 3.031929D-01( 78) 3.152015D-01
 ( 79) 3.246392D-01( 80) 3.243222D-01( 81) 2.945593D-01( 82) 2.706846D-01( 83) 2.672876D-01( 84) 2.661025D-01
 ( 85) 2.626657D-01( 86) 2.559286D-01( 87) 2.457158D-01( 88) 2.321031D-01( 89) 2.152634D-01( 90) 1.954266D-01
 ( 91) 1.728677D-01( 92) 1.479004D-01( 93) 1.208722D-01( 94) 9.215970D-02( 95) 6.216278D-02( 96) 3.129951D-02
 ( 97) 0.0            (

TOTAL INTEGRATED FLUX FOR REGION  1 GROUP  2 = 0.194127D 03

TOTAL INTEGRATED FLUX FOR REGION  2 GROUP  2 = 0.249632D 03

TOTAL INTEGRATED FLUX FOR REGION  3 GROUP  2 = 0.746430D 01

PRECURSOR CONCENTRATION FOR DELAYED GROUP    1
 (  1) 0.0            (  2) 1.701128D-04(  3) 3.377719D-04(  4) 5.005587D-04(  5) 6.561253D-04(  6) 8.022277D-04
 (  7) 9.367584D-04(  8) 1.057777D-03(  9) 1.163539D-03( 10) 1.252522D-03( 11) 1.323454D-03( 12) 1.375366D-03
 ( 13) 1.407718D-03( 14) 1.420909D-03( 15) 1.418272D-03( 16) 1.414233D-03( 17) 1.098251D-03( 18) 7.558629D-04
 ( 19) 7.364296D-04( 20) 7.018606D-04( 21) 6.635274D-04( 22) 6.255061D-04( 23) 5.891960D-04( 24) 5.550186D-04
 ( 25) 5.230417D-04( 26) 4.932090D-04( 27) 4.654240D-04( 28) 4.395811D-04( 29) 4.155759D-04( 30) 3.933093D-04
 ( 31) 3.726886D-04( 32) 3.536277D-04( 33) 3.360469D-04( 34) 3.198726D-04( 35) 3.050370D-04( 36) 2.914782D-04
 ( 37) 2.791392D-04( 38) 2.679686D-04( 39) 2.579194D-04( 40) 2.489497D-04( 41) 2.410219D-04( 42) 2.341028D-04
 ( 43) 2.281634D-04( 44) 2.231788D-04( 45) 2.191283D-04( 46) 2.159948D-04( 47) 2.137652D-04( 48) 2.124302D-04
 ( 49) 2.119841D-04( 50) 2.124252D-04( 51) 2.137552D-04( 52) 2.159796D-04( 53) 2.191079D-04( 54) 2.231531D-04
 ( 55) 2.281320D-04( 56) 2.340656D-04( 57) 2.409787D-04( 58) 2.489001D-04( 59) 2.578630D-04( 60) 2.679049D-04
 ( 61) 2.790679D-04( 62) 2.913986D-04( 63) 3.049486D-04( 64) 3.197747D-04( 65) 3.359388D-04( 66) 3.535086D-04
 ( 67) 3.725575D-04( 68) 3.931653D-04( 69) 4.154178D-04( 70) 4.394078D-04( 71) 4.652342D-04( 72) 4.930012D-04
 ( 73) 5.228144D-04( 74) 5.547701D-04( 75) 5.889244D-04( 76) 6.252095D-04( 77) 6.632040D-04( 78) 7.015091D-04
 ( 79) 7.360505D-04( 80) 7.554621D-04( 81) 1.097645D-03( 82) 1.413431D-03( 83) 1.417456D-03( 84) 1.420082D-03
 ( 85) 1.406891D-03( 86) 1.374552D-03( 87) 1.322666D-03( 88) 1.251771D-03( 89) 1.162839D-03( 90) 1.057138D-03
 ( 91) 9.361903D-04( 92) 8.017398D-04( 93) 6.557254D-04( 94) 5.002531D-04( 95) 3.375654D-04( 96) 1.700087D-04
 ( 97) 0.0            (
```

```
PRECURSOR CONCENTRATION FOR DELAYED GROUP    2
(  1) 0.0          (  2) 4.541032D-04(  3) 9.016557D-04(  4) 1.336201D-03(  5) 1.751471D-03(  6) 2.141475D-03
(  7) 2.500586D-03(  8) 2.823625D-03(  9) 3.105935D-03( 10) 3.343450D-03( 11) 3.532779D-03( 12) 3.671328D-03
( 13) 3.757663D-03( 14) 3.792845D-03( 15) 3.785772D-03( 16) 3.774941D-03( 17) 2.931440D-03( 18) 2.017482D-03
( 19) 1.965568D-03( 20) 1.873264D-03( 21) 1.770920D-03( 22) 1.669412D-03( 23) 1.572475D-03( 24) 1.481234D-03
( 25) 1.395869D-03( 26) 1.316229D-03( 27) 1.242057D-03( 28) 1.173070D-03( 29) 1.108990D-03( 30) 1.049551D-03
( 31) 9.945064D-04( 32) 9.436259D-04( 33) 8.966965D-04( 34) 8.535217D-04( 35) 8.139206D-04( 36) 7.777273D-04
( 37) 7.447902D-04( 38) 7.149713D-04( 39) 6.881457D-04( 40) 6.642010D-04( 41) 6.430369D-04( 42) 6.245647D-04
( 43) 6.087071D-04( 44) 5.953975D-04( 45) 5.845802D-04( 46) 5.762099D-04( 47) 5.702514D-04( 48) 5.666798D-04
( 49) 5.654800D-04( 50) 5.666470D-04( 51) 5.701856D-04( 52) 5.761105D-04( 53) 5.844466D-04( 54) 5.952285D-04
( 55) 6.085016D-04( 56) 6.243211D-04( 57) 6.427533D-04( 58) 6.638753D-04( 59) 6.877755D-04( 60) 7.145538D-04
( 61) 7.443222D-04( 62) 7.772054D-04( 63) 8.133408D-04( 64) 8.528796D-04( 65) 8.959873D-04( 66) 9.428442D-04
( 67) 9.936463D-04( 68) 1.048606D-03( 69) 1.107953D-03( 70) 1.171933D-03( 71) 1.240812D-03( 72) 1.314866D-03
( 73) 1.394378D-03( 74) 1.479604D-03( 75) 1.570693D-03( 76) 1.667466D-03( 77) 1.768798D-03( 78) 1.870959D-03
( 79) 1.963081D-03( 80) 2.014852D-03( 81) 2.927470D-03( 82) 3.769685D-03( 83) 3.780418D-03( 84) 3.787421D-03
( 85) 3.752240D-03( 86) 3.665988D-03( 87) 3.527607D-03( 88) 3.338528D-03( 89) 3.101340D-03( 90) 2.819432D-03
( 91) 2.496859D-03( 92) 2.138274D-03( 93) 1.748847D-03( 94) 1.334196D-03( 95) 9.003010D-04( 96) 4.534205D-04
( 97) 0.0          (
```

```
PRECURSOR CONCENTRATION FOR DELAYED GROUP    3
(  1) 0.0          (  2) 1.122905D-04(  3) 2.229605D-04(  4) 3.304129D-04(  5) 4.330970D-04(  6) 5.295310D-04
(  7) 6.183232D-04(  8) 6.981924D-04(  9) 7.679864D-04( 10) 8.267002D-04( 11) 8.734948D-04( 12) 9.077292D-04
( 13) 9.290487D-04( 14) 9.377154D-04( 15) 9.359280D-04( 16) 9.331973D-04( 17) 7.246054D-04( 18) 4.986232D-04
( 19) 4.857447D-04( 20) 4.628932D-04( 21) 4.375665D-04( 22) 4.124516D-04( 23) 3.884706D-04( 24) 3.659005D-04
( 25) 3.447857D-04( 26) 3.250884D-04( 27) 3.067447D-04( 28) 2.896843D-04( 29) 2.738382D-04( 30) 2.591406D-04
( 31) 2.455300D-04( 32) 2.329496D-04( 33) 2.213463D-04( 34) 2.106715D-04( 35) 2.008803D-04( 36) 1.919316D-04
( 37) 1.837877D-04( 38) 1.764145D-04( 39) 1.697809D-04( 40) 1.638591D-04( 41) 1.586241D-04( 42) 1.540540D-04
( 43) 1.501296D-04( 44) 1.468343D-04( 45) 1.441543D-04( 46) 1.420783D-04( 47) 1.405975D-04( 48) 1.397057D-04
( 49) 1.393990D-04( 50) 1.396763D-04( 51) 1.405385D-04( 52) 1.419892D-04( 53) 1.440345D-04( 54) 1.466829D-04
( 55) 1.499454D-04( 56) 1.538357D-04( 57) 1.583700D-04( 58) 1.635672D-04( 59) 1.694491D-04( 60) 1.760403D-04
( 61) 1.833683D-04( 62) 1.914638D-04( 63) 2.003607D-04( 64) 2.100960D-04( 65) 2.207107D-04( 66) 2.322490D-04
( 67) 2.447592D-04( 68) 2.582937D-04( 69) 2.729088D-04( 70) 2.886655D-04( 71) 3.056287D-04( 72) 3.238668D-04
( 73) 3.434493D-04( 74) 3.644393D-04( 75) 3.868737D-04( 76) 4.107079D-04( 77) 4.356652D-04( 78) 4.608267D-04
( 79) 4.835159D-04( 80) 4.962664D-04( 81) 7.210469D-04( 82) 9.284868D-04( 83) 9.311299D-04( 84) 9.328541D-04
( 85) 9.241885D-04( 86) 9.029440D-04( 87) 8.688599D-04( 88) 8.222889D-04( 89) 7.638687D-04( 90) 6.944336D-04
( 91) 6.149830D-04( 92) 5.266624D-04( 93) 4.307456D-04( 94) 3.286159D-04( 95) 2.217464D-04( 96) 1.116786D-04
( 97) 0.0          (
```

PRECURSOR CONCENTRATION FOR DELAYED GROUP 4

(1)	0.0	(2)	8.416804D-05	(3)	1.671203D-04	(4)	2.476587D-04	(5)	3.246198D-04	(6)	3.968920D-04
(7)	4.634314D-04	(8)	5.232770D-04	(9)	5.755648D-04	(10)	6.195411D-04	(11)	6.545771D-04	(12)	6.801922D-04
(13)	6.961210D-04	(14)	7.025594D-04	(15)	7.011527D-04	(16)	6.990147D-04	(17)	5.426433D-04	(18)	3.732939D-04
(19)	3.635687D-04	(20)	3.463937D-04	(21)	3.273770D-04	(22)	3.085274D-04	(23)	2.905338D-04	(24)	2.736024D-04
(25)	2.577656D-04	(26)	2.429945D-04	(27)	2.292405D-04	(28)	2.164505D-04	(29)	2.045723D-04	(30)	1.935563D-04
(31)	1.833560D-04	(32)	1.739283D-04	(33)	1.652335D-04	(34)	1.572347D-04	(35)	1.498980D-04	(36)	1.431924D-04
(37)	1.370895D-04	(38)	1.315635D-04	(39)	1.265910D-04	(40)	1.221509D-04	(41)	1.182244D-04	(42)	1.147949D-04
(43)	1.118478D-04	(44)	1.093706D-04	(45)	1.073529D-04	(46)	1.057859D-04	(47)	1.046631D-04	(48)	1.039796D-04
(49)	1.037324D-04	(50)	1.039204D-04	(51)	1.045443D-04	(52)	1.056066D-04	(53)	1.071117D-04	(54)	1.090658D-04
(55)	1.114770D-04	(56)	1.143553D-04	(57)	1.177128D-04	(58)	1.215634D-04	(59)	1.259231D-04	(60)	1.308103D-04
(61)	1.362453D-04	(62)	1.422508D-04	(63)	1.488519D-04	(64)	1.560763D-04	(65)	1.639540D-04	(66)	1.725181D-04
(67)	1.818043D-04	(68)	1.918515D-04	(69)	2.027016D-04	(70)	2.143997D-04	(71)	2.269940D-04	(72)	2.405354D-04
(73)	2.550754D-04	(74)	2.706609D-04	(75)	2.873193D-04	(76)	3.050174D-04	(77)	3.235497D-04	(78)	3.422338D-04
(79)	3.590821D-04	(80)	3.685497D-04	(81)	5.354802D-04	(82)	6.895324D-04	(83)	6.914941D-04	(84)	6.927735D-04
(85)	6.863373D-04	(86)	6.705596D-04	(87)	6.452469D-04	(88)	6.106611D-04	(89)	5.672758D-04	(90)	5.157106D-04
(91)	4.567076D-04	(92)	3.911175D-04	(93)	3.198863D-04	(94)	2.440413D-04	(95)	1.646764D-04	(96)	8.293629D-05
(97)	0.0	(									

PRECURSOR CONCENTRATION FOR DELAYED GROUP 5

(1)	0.0	(2)	6.722517D-06	(3)	1.334756D-05	(4)	1.977908D-05	(5)	2.592383D-05	(6)	3.169271D-05
(7)	3.700209D-05	(8)	4.177500D-05	(9)	4.594227D-05	(10)	4.944362D-05	(11)	5.222880D-05	(12)	5.425945D-05
(13)	5.551445D-05	(14)	5.600934D-05	(15)	5.587457D-05	(16)	5.567323D-05	(17)	4.317713D-05	(18)	2.966356D-05
(19)	2.886265D-05	(20)	2.747530D-05	(21)	2.594538D-05	(22)	2.443165D-05	(23)	2.298829D-05	(24)	2.163135D-05
(25)	2.036309D-05	(26)	1.918100D-05	(27)	1.808101D-05	(28)	1.705871D-05	(29)	1.610978D-05	(30)	1.523014D-05
(31)	1.441596D-05	(32)	1.366370D-05	(33)	1.297007D-05	(34)	1.233205D-05	(35)	1.174686D-05	(36)	1.121195D-05
(37)	1.072498D-05	(38)	1.028383D-05	(39)	9.886583D-06	(40)	9.531491D-06	(41)	9.217008D-06	(42)	8.941757D-06
(43)	8.704530D-06	(44)	8.504284D-06	(45)	8.340134D-06	(46)	8.211351D-06	(47)	8.117357D-06	(48)	8.057723D-06
(49)	8.032167D-06	(50)	8.040553D-06	(51)	8.082887D-06	(52)	8.159323D-06	(53)	8.270156D-06	(54)	8.415831D-06
(55)	8.596938D-06	(56)	8.814216D-06	(57)	9.068560D-06	(58)	9.361020D-06	(59)	9.692805D-06	(60)	1.006529D-05
(61)	1.048003D-05	(62)	1.093874D-05	(63)	1.144334D-05	(64)	1.199593D-05	(65)	1.259881D-05	(66)	1.325450D-05
(67)	1.396574D-05	(68)	1.473550D-05	(69)	1.556698D-05	(70)	1.646364D-05	(71)	1.742917D-05	(72)	1.846748D-05
(73)	1.958250D-05	(74)	2.077783D-05	(75)	2.205557D-05	(76)	2.341318D-05	(77)	2.483487D-05	(78)	2.626827D-05
(79)	2.756083D-05	(80)	2.828698D-05	(81)	4.109866D-05	(82)	5.292165D-05	(83)	5.307201D-05	(84)	5.316986D-05
(85)	5.267560D-05	(86)	5.146444D-05	(87)	4.952154D-05	(88)	4.686698D-05	(89)	4.353712D-05	(90)	3.957951D-05
(91)	3.505110D-05	(92)	3.001719D-05	(93)	2.455035D-05	(94)	1.872945D-05	(95)	1.263842D-05	(96)	6.365108D-06
(97)	0.0	(									

```
PRECURSOR CONCENTRATION FOR DELAYED GROUP    6
 (   1) 0.0           (   2) 1.030495D-06(   3) 2.045939D-06(   4) 3.031500D-06(   5) 3.972782D-06(   6) 4.856039D-06
 (   7) 5.668371D-06(   8) 6.397915D-06(   9) 7.034024D-06(  10) 7.567428D-06(  11) 7.990415D-06(  12) 8.297120D-06
 (  13) 8.484318D-06(  14) 8.554367D-06(  15) 8.526971D-06(  16) 8.486921D-06(  17) 6.569384D-06(  18) 4.501609D-06
 (  19) 4.371582D-06(  20) 4.154232D-06(  21) 3.916393D-06(  22) 3.681883D-06(  23) 3.458767D-06(  24) 3.249369D-06
 (  25) 3.053948D-06(  26) 2.872050D-06(  27) 2.702993D-06(  28) 2.546056D-06(  29) 2.400532D-06(  30) 2.265756D-06
 (  31) 2.141106D-06(  32) 2.026009D-06(  33) 1.919931D-06(  34) 1.822385D-06(  35) 1.732921D-06(  36) 1.651124D-06
 (  37) 1.576619D-06(  38) 1.509061D-06(  39) 1.448138D-06(  40) 1.393568D-06(  41) 1.345099D-06(  42) 1.302505D-06
 (  43) 1.265587D-06(  44) 1.234171D-06(  45) 1.208110D-06(  46) 1.187278D-06(  47) 1.171574D-06(  48) 1.160918D-06
 (  49) 1.155255D-06(  50) 1.154548D-06(  51) 1.158786D-06(  52) 1.167976D-06(  53) 1.182149D-06(  54) 1.201356D-06
 (  55) 1.225671D-06(  56) 1.255188D-06(  57) 1.290026D-06(  58) 1.330324D-06(  59) 1.376247D-06(  60) 1.427983D-06
 (  61) 1.485743D-06(  62) 1.549766D-06(  63) 1.620316D-06(  64) 1.697686D-06(  65) 1.782197D-06(  66) 1.874200D-06
 (  67) 1.974077D-06(  68) 2.082244D-06(  69) 2.199152D-06(  70) 2.325284D-06(  71) 2.461161D-06(  72) 2.607329D-06
 (  73) 2.764344D-06(  74) 2.932712D-06(  75) 3.112726D-06(  76) 3.304026D-06(  77) 3.504385D-06(  78) 3.706415D-06
 (  79) 3.888594D-06(  80) 3.990885D-06(  81) 5.798247D-06(  82) 7.466124D-06(  83) 7.487181D-06(  84) 7.500881D-06
 (  85) 7.431064D-06(  86) 7.260129D-06(  87) 6.985980D-06(  88) 6.611453D-06(  89) 6.141676D-06(  90) 5.583354D-06
 (  91) 4.944524D-06(  92) 4.234393D-06(  93) 3.463200D-06(  94) 2.642067D-06(  95) 1.782833D-06(  96) 8.978907D-07
 (  97) 0.0           (

          REGION          NORMALIZED POWER

             1              0.3432872D 02
             2              0.1242193D 02
             3              0.1337118D 01

          TOTAL NORMALIZED POWER =   0.1544125D 02
  BENCHMARK PROBLEM  PROMPT SUPERCRITICAL TRANSIENT
 END OF PROBLEM
```

9.2 Delayed Supercritical Transient

This problem (Problem X-Al of Reference 7) involves the same core as in Section 9.1, but with initiation from a 1% decrease in the absorption cross section in region 1 occurring in 1.0 seconds.

```
CARD  C1
 BENCHMARK PROBLEM DELAYEC SUPERCRITICAL TRANSIENT

CARC  02        2      2      1      6      3      5      2      C      C      C     -2      0

CARD  03        1      00.100C00D-06C.1C0C00C-060.1CCCCCD-C6     97

CARD  C4,      17     81     97

CARC  C5   0.4C0C000D 020.16CCCCD 03C.4CCCCCD 02

CARD  06        9     33     49     65     89

CARD  C7   C.25CCCCD-030.164C00D-02C.147C00C-02C.296000C-020.86CCCCC-C3C.32CCCCC-C3

CARC  08   0.100C00D 010.10C000D 01C.1CCC00D 01C.1CCCCCD C1C.1CCCCCC C1C.1CCCCCC C1

CARD  C8   C.0          0.C          C.C          C.0          0.C          C.C

CARC  09   0.124C00D-010.305C00D-01C.111CCCD CCC.3C1CCCC CCC.114CCCC C1C.3C1CCCC C1

CARD  1C   C.1CCCCCD C1C.C

CARC  11   0.1CCCC0D 08C.3CCCCCD 06

CARC  12   0.200C00D-030.160C0C-01C.5CCCCCC-02             C             CC.1C3CCCC C1

CARD  13        1      2      1

CARC  14    OUTER CORE                                                    C    1    C

CARC  15   0.25C000CD 010.400000C-02C.7CCCCCC-02C.222222D CCC.C          C.C

CARD  15   C.25CCCCD 010.8CCC000-01C.1CCC00C 00C.666667C 0C0.C          C.C

CARC  16   C.15CCCCD-01

CARC  14    INNER CORE                                                    C    1    0

CARD  15   C.25CCCCD 010.2CCC00D-02C.8CCC00C-02C.333333C CCC.C          C.C

CARC  15   0.25CCCCD C10.3960CCD-01C.4C4C00C-01C.666667C CCC.C          C.C
```

```
CARC  16   C.1CCCOCD-01

CARD  2C   C.0          0.296339D 00C.588292C 00C.871539C CCC.114189C C1C.139534C C1
           0.162813D 01C.183684D 01C.201835D 010.217000C 010.228953C C1C.237517C C1
           0.242561D 010.244001D 01C.241765D C1C.235688D C1C.225C38C C1C.2C7C8CC C1
           0.192509D 010.179716D 010.168085D 01C.157359D C1C.147417C C1C.138184C C1
           0.129608D 010.121645D 01C.114256D 010.107406C 010.1C1C62C C1C.951949C CC
           0.897765D 000.847813D CCC.8C1858D CCC.759683D CC0.721C89C CCC.685895C C0
           0.653934D 000.625056D 00C.599124C 00C.576C17D CCC.555625D CCC.537853C CC
           C.522616D 0C0.509843D 000.499474C 000.491459C 000.485761C CCC.482352C CC
           0.481218D 000.482352D 0CC.485761C CCC.491459D CC0.499474C CCC.509843C CC
           0.522616D 000.537853D 0CC.555625C CCC.576C17D CCC.599124D CCC.625C56C CC
           C.653934D 000.685895D 0CC.721089C C0C.759683C 000.8C1858C CCC.847813C CC
           0.897765D CC0.951949D CCC.1C1C62D 01C.1C7406C 010.114256C C1C.121645C C1
           0.129608D 010.138184D 01C.147417D 01C.157359D 01C.168C85D C1C.179716C C1
           0.192509D 010.207080D 010.225038C 01C.235688D 01C.241765C C1C.244CC1C C1
           C.242561D 010.237517D 01C.228953C 010.21700CC 010.2C1835C C1C.183684C C1
           0.162813D 010.139534D 01C.114189D 01C.871539D CCC.588292C CCC.296339C CC
           C.0

CARD  2C   C.0          0.245335D-01C.487C40C-01C.721536C-010.945354C-C1C.115518C CC
           0.134791D 000.152070D CCC.167C98C CCC.179653D CCC.189554C CCC.196664C CC
           0.200924D 000.202462D 0CC.202036C 0CC.2C2884D CCC.218305D CCC.236848C CC
           C.233388D C0C.222680D CCC.21CC07C 000.197236C 000.185CC1C CCC.173497C CC
           0.162759D C00.152770D 0CC.143494D CCC.134892D CC0.126926C CCC.119557C CC
           0.112752D 000.106479D 0CC.1CC7C7C CCC.9541C1D-01C.9C5631D-C1C.861429D-C1
           C.821289D-010.785020D-01C.752452C-010.723432C-010.697821D-C1C.6755C1D-C1
           0.656365D-010.64C323D-01C.627299D-01C.617233D-010.61CC77C-C10.6C5796D-C1
           0.604372D-010.605796D-01C.61CC77C-C1C.617233D-C1C.627299D-C1C.64C323D-C1
           C.656365D-010.675501D-01C.697821C-01C.723432C-010.752452C-C1C.785C2CC-C1
           0.821289D-010.861429D-01C.9C5631C-01C.9541C1C-01C.1CC7C7C CCC.1C6479C CC
           0.112752D 000.119557D 0CC.126926D CCC.134892D CCC.143494D CCC.15277CC CC
           C.162759D C00.173497D 0CC.185C01C C0C.197236C CCC.21CCC7C CCC.2226800 CC
           C.233388D CCC.236848D CCC.218305C C00.202884C 0C0.2C2C36C C0C.2C2462C CC
           0.2C0924D CCC.196664D 0CC.189554C CCC.179653D CCC.167C98C CCC.152C7CC CC
           0.134791D 000.115518D 00C.945354C-01C.721536D-C1C.487C4CC-C1C.245335C-C1
           C.0
                        *** INPUT EDIT FCR TIME ZONE 1 ***

CARC  21   C.1CCCCCD-02            1-.1CCCCOC 01      0    -2     1     C     C     C

CARC  22   0.1CCCCCD C00.5CCCCCD 0C

CARC  23         1      0      0      1      C

CARC  27   C.C         -.18CCCOC-02
```

BENCHMARK PROBLEM DELAYEC SUPERCRITICAL TRANSIENT

*** INPUT ECIT ***

2 NEUTRON GRCUP(S) , 6 DELAYEC GROUP(S) , 3 REGION(S) , 2 CCMPCSITICN(S)

SLAB GECMETRY , LEFT BCUNCARY ZERC RIGHT BCUNCARY ZERO

IS THERE TC BE END CF PROBLEM PUNCHEC OUTPUT NC ,

ARE THE STEADY STATE FLUXES TC BE PUNCHEC NO

TEST POINTS FOR FREQUENCY CALCULATICN 9 33 49 65 89

GRCUP 2 IS SPECIFIED AS THE TEST GROUP FOR THE FREQUENCY CALCULATICN

REGION NUMBER	MESH PCINT BCUNDARIES LEFT	RIGHT
1	1	17
2	17	81
3	81	97

REGICN NUMBER	LENGTH (CM)	MESH SPACING (CM)
1	4C.CCOC	2.5C00
2	160.CC00	2.5COC
3	40.0C00	2.5000

FRACTIONAL YIELD FROM DELAYEC GROUP I INTC NEUTRCN GROUP G

GRCUP	I= 1	I= 2	I= 3	I= 4	I= 5	I= 6
1	0.01240	0.03050	0.111CC	0.301CC	1.14CCC	3.C1CCC
2	C.C	0.0	0.0	0.0	C.C	C.C

GROUP NUMBER	AVERAGE NEUTRON SPEEC (CM/SEC)	NEUTRCNS PER FISSICN	FISSION YIELD
1	0.1CCCCCD 08	0.25CCCCC 01	0.1CCCCCC C1
2	0.3CCCCCD C6	C.25CCCCC 01	0.0

```
CCMPCSITICN    1
     GRCUP    DIFFUSION       GROUP CEPENCENT CRCSS SECTICNS
     NUMBER  CCEFFICIENT       (CAPTURE)     (FISSION)
        1     0.15C000D 01  0.7C0C0CC-C2  0.4C0CCCD-C2
        2     0.5C0000D C0  0.10000CC CC  0.8CCCCCD-C1


      SCATTERING MATRIX  GP INTO G  (THE TCTAL REMOVAL IS COMPUTEC ANC STOREC AS THE CIAGONAL ELEMENTS)
(G)         GP= 1        GP= 2
 1    0.260C000D-010.0
 2    C.15CC0CD-C10.180C000 00

CCMPCSITION   2
     GRCUP    CIFFUSION       GROUP CEPENCENT CRCSS SECTICNS
     NUMBER  CCEFFICIENT       (CAPTURE)     (FISSION)
        1     0.1CCC0CD 01  0.8C0C00C-02  0.2C00C0C-02
        2     0.5C0C0CD C0  C.404C0CC-C1  C.396CCCD-C1


      SCATTERING MATRIX  GP INTO G  (THE TOTAL REMCVAL IS COMPLTEC ANC STCREC AS THE CIAGCNAL ELEMENTS)
(G)         GP= 1        GP= 2
 1    0.200000D-010.C
 2    0.1C0000C-010.800C00D-01


CCMPCSITICN ASSIGNMENT TC REGICNS
  REGION  COMPOSITION
     1          1
     2          2
     3          1


NC XENCN BUILDUP CCNSICERC IN THIS PRCBLEM


ARE STEACY STATE CCNCITICNS TC BE CALCULATEC ?  YES
```

```
INPUT FLUX DISTRIBUTION
(  1) 0.0           (  2) 2.963389D-01(  3) 5.882921D-01(  4) 8.715388D-01(  5) 1.141887D 00(  6) 1.395336D 00
(  7) 1.628134D 00(  8) 1.836836D 00(  9) 2.018354D 00( 10) 2.170000D 00( 11) 2.289529D 00( 12) 2.375165D 00
( 13) 2.425611D 00( 14) 2.440005D 00( 15) 2.417649D 00( 16) 2.356881D 00( 17) 2.250384D 00( 18) 2.070800D 00
( 19) 1.925089D 00( 20) 1.797160D 00( 21) 1.680847D 00( 22) 1.573593D 00( 23) 1.474167D 00( 24) 1.381839D 00
( 25) 1.296079D 00( 26) 1.216448D 00( 27) 1.142558D 00( 28) 1.074057D 00( 29) 1.010621D 00( 30) 9.519489D-01
( 31) 8.977647D-01( 32) 8.478128D-01( 33) 8.018577D-01( 34) 7.596828D-01( 35) 7.210891D-01( 36) 6.858947D-01
( 37) 6.539338D-01( 38) 6.250557D-01( 39) 5.991242D-01( 40) 5.760171D-01( 41) 5.556254D-01( 42) 5.378531D-01
( 43) 5.226163D-01( 44) 5.098432D-01( 45) 4.994736D-01( 46) 4.914587D-01( 47) 4.857605D-01( 48) 4.823524D-01
( 49) 4.812181D-01( 50) 4.823524D-01( 51) 4.857605D-01( 52) 4.914587D-01( 53) 4.994736D-01( 54) 5.098432D-01
( 55) 5.226163D-01( 56) 5.378531D-01( 57) 5.556254D-01( 58) 5.760171D-01( 59) 5.991242D-01( 60) 6.250557D-01
( 61) 6.539338D-01( 62) 6.858947D-01( 63) 7.210891D-01( 64) 7.596828D-01( 65) 8.018577D-01( 66) 8.478128D-01
( 67) 8.977647D-01( 68) 9.519489D-01( 69) 1.010621D 00( 70) 1.074057D 00( 71) 1.142558D 00( 72) 1.216448D 00
( 73) 1.296079D 00( 74) 1.381839D 00( 75) 1.474167D 00( 76) 1.573593D 00( 77) 1.680847D 00( 78) 1.797160D 00
( 79) 1.925089D 00( 80) 2.070800D 00( 81) 2.250384D 00( 82) 2.356881D 00( 83) 2.417649D 00( 84) 2.440005D 00
( 85) 2.425611D 00( 86) 2.375165D 00( 87) 2.289529D 00( 88) 2.170000D 00( 89) 2.018354D 00( 90) 1.836836D 00
( 91) 1.628134D 00( 92) 1.395336D 00( 93) 1.141887D 00( 94) 8.715388D-01( 95) 5.882921D-01( 96) 2.963389D-01
( 97) 0.0           (
(  1) 0.0           (  2) 2.453354D-02(  3) 4.870399D-02(  4) 7.215364D-02(  5) 9.453544D-02(  6) 1.155182D-01
(  7) 1.347913D-01(  8) 1.520695D-01(  9) 1.670975D-01( 10) 1.796533D-01( 11) 1.895539D-01( 12) 1.966639D-01
( 13) 2.009241D-01( 14) 2.024615D-01( 15) 2.020363D-01( 16) 2.028838D-01( 17) 2.183045D-01( 18) 2.368475D-01
( 19) 2.333879D-01( 20) 2.226800D-01( 21) 2.100072D-01( 22) 1.972358D-01( 23) 1.850011D-01( 24) 1.734965D-01
( 25) 1.627586D-01( 26) 1.527695D-01( 27) 1.434938D-01( 28) 1.348922D-01( 29) 1.269256D-01( 30) 1.195571D-01
( 31) 1.127521D-01( 32) 1.064786D-01( 33) 1.007070D-01( 34) 9.541012D-02( 35) 9.056306D-02( 36) 8.614293D-02
( 37) 8.212890D-02( 38) 7.850204D-02( 39) 7.524524D-02( 40) 7.234317D-02( 41) 6.978214D-02( 42) 6.755008D-02
( 43) 6.563646D-02( 44) 6.403226D-02( 45) 6.272993D-02( 46) 6.172331D-02( 47) 6.100767D-02( 48) 6.057963D-02
( 49) 6.043717D-02( 50) 6.057963D-02( 51) 6.100767D-02( 52) 6.172331D-02( 53) 6.272993D-02( 54) 6.403226D-02
( 55) 6.563646D-02( 56) 6.755008D-02( 57) 6.978214D-02( 58) 7.234317D-02( 59) 7.524524D-02( 60) 7.850204D-02
( 61) 8.212890D-02( 62) 8.614293D-02( 63) 9.056306D-02( 64) 9.541012D-02( 65) 1.007070D-01( 66) 1.064786D-01
( 67) 1.127521D-01( 68) 1.195571D-01( 69) 1.269256D-01( 70) 1.348922D-01( 71) 1.434938D-01( 72) 1.527695D-01
( 73) 1.627586D-01( 74) 1.734965D-01( 75) 1.850011D-01( 76) 1.972358D-01( 77) 2.100072D-01( 78) 2.226800D-01
( 79) 2.333879D-01( 80) 2.368475D-01( 81) 2.183045D-01( 82) 2.028838D-01( 83) 2.020363D-01( 84) 2.024615D-01
( 85) 2.009241D-01( 86) 1.966639D-01( 87) 1.895539D-01( 88) 1.796533D-01( 89) 1.670975D-01( 90) 1.520695D-01
( 91) 1.347913D-01( 92) 1.155182D-01( 93) 9.453544D-02( 94) 7.215364D-02( 95) 4.870399D-02( 96) 2.453354D-02
( 97) 0.0           (

THE INITIAL PRECURSOR CONCENTRATIONS ARE CALCULATED FROM THE STEADY STATE FLUX DISTRIBUTION

ARE THERE ANY TIME DEPENDENT CHANGES IN THE
CROSS SECTION DATA   YES

TIME   CROSS SECTION   GROUP   REGION   TOTAL LINEAR   TOTAL QUADRATIC
ZONE                                       CHANGE          CHANGE
 1       CAPTURE         2        1      -.18000D-02      0.0

ARE THERE ANY TIME DEPENDENT SOURCES ?   NO
```

```
EQUILIBRIUM NU(G)    (   1) 0.2773070D 01(   2) 0.2773070D 01(

EQUILIBRIUM FLUXES
 1)0.0           (   2)0.2862154D 00(   3)0.5683025D 00(   4)0.8421926D 00(   5)0.1103935D 01(   6)0.1349755D 01
 7)0.1576107D 01(   8)0.1779726D 01(   9)0.1957674D 01(  10)0.2107386D 01(  11)0.2226699D 01(  12)0.2313890D 01
13)0.2367680D 01(  14)0.2387212D 01(  15)0.2371878D 01(  16)0.2320559D 01(  17)0.2228526D 01(  18)0.2070561D 01
19)0.1937223D 01(  20)0.1817865D 01(  21)0.1708274D 01(  22)0.1606625D 01(  23)0.1511992D 01(  24)0.1423793D 01
25)0.1341590D 01(  26)0.1265016D 01(  27)0.1193741D 01(  28)0.1127462D 01(  29)0.1065902D 01(  30)0.1008802D 01
31)0.9559232D 00(  32)0.9070443D 00(  33)0.8619608D 00(  34)0.8204839D 00(  35)0.7824402D 00(  36)0.7476705D 00
37)0.7160292D 00(  38)0.6873840D 00(  39)0.6616150D 00(  40)0.6386144D 00(  41)0.6182860D 00(  42)0.6005446D 00
43)0.5853161D 00(  44)0.5725367D 00(  45)0.5621530D 00(  46)0.5541215D 00(  47)0.5484085D 00(  48)0.5449903D 00
49)0.5438525D 00(  50)0.5449903D 00(  51)0.5484085D 00(  52)0.5541215D 00(  53)0.5621530D 00(  54)0.5725367D 00
55)0.5853161D 00(  56)0.6005446D 00(  57)0.6182860D 00(  58)0.6386144D 00(  59)0.6616150D 00(  60)0.6873840D 00
61)0.7160292D 00(  62)0.7476705D 00(  63)0.7824402D 00(  64)0.8204839D 00(  65)0.8619608D 00(  66)0.9070443D 00
67)0.9559232D 00(  68)0.1008802D 01(  69)0.1065902D 01(  70)0.1127462D 01(  71)0.1193741D 01(  72)0.1265016D 01
73)0.1341590D 01(  74)0.1423793D 01(  75)0.1511992D 01(  76)0.1606625D 01(  77)0.1708274D 01(  78)0.1817865D 01
79)0.1937223D 01(  80)0.2070561D 01(  81)0.2228526D 01(  82)0.2320559D 01(  83)0.2371878D 01(  84)0.2387212D 01
85)0.2367680D 01(  86)0.2313890D 01(  87)0.2226699D 01(  88)0.2107386D 01(  89)0.1957674D 01(  90)0.1779726D 01
91)0.1576107D 01(  92)0.1349755D 01(  93)0.1103935D 01(  94)0.8421926D 00(  95)0.5683025D 00(  96)0.2862154D 00
97)0.0           (
 1)0.0           (   2)0.2369936D-01(   3)0.4705688D-01(   4)0.6973568D-01(   5)0.9140864D-01(   6)0.1117632D 00
 7)0.1305057D 00(   8)0.1473659D 00(   9)0.1621008D 00(  10)0.1744985D 00(  11)0.1843833D 00(  12)0.1916242D 00
13)0.1961651D 00(  14)0.1981376D 00(  15)0.1983172D 00(  16)0.1999832D 00(  17)0.2165068D 00(  18)0.2366467D 00
19)0.2346132D 00(  20)0.2250399D 00(  21)0.2132734D 00(  22)0.2012460D 00(  23)0.1896364D 00(  24)0.1786642D 00
25)0.1683822D 00(  26)0.1587837D 00(  27)0.1498417D 00(  28)0.1415239D 00(  29)0.1337972D 00(  30)0.1266300D 00
31)0.1199924D 00(  32)0.1138569D 00(  33)0.1081978D 00(  34)0.1029914D 00(  35)0.9821599D-01(  36)0.9385151D-01
37)0.8987974D-01(  38)0.8628404D-01(  39)0.8304938D-01(  40)0.8016223D-01(  41)0.7761049D-01(  42)0.7538350D-01
43)0.7347194D-01(  44)0.7186780D-01(  45)0.7056438D-01(  46)0.6955623D-01(  47)0.6883911D-01(  48)0.6841004D-01
49)0.6826721D-01(  50)0.6841004D-01(  51)0.6883911D-01(  52)0.6955623D-01(  53)0.7056438D-01(  54)0.7186780D-01
55)0.7347194D-01(  56)0.7538350D-01(  57)0.7761049D-01(  58)0.8016223D-01(  59)0.8304938D-01(  60)0.8628404D-01
61)0.8987974D-01(  62)0.9385151D-01(  63)0.9821599D-01(  64)0.1029914D 00(  65)0.1081978D 00(  66)0.1138569D 00
67)0.1199924D 00(  68)0.1266300D 00(  69)0.1337972D 00(  70)0.1415239D 00(  71)0.1498417D 00(  72)0.1587837D 00
73)0.1683822D 00(  74)0.1786642D 00(  75)0.1896364D 00(  76)0.2012460D 00(  77)0.2132734D 00(  78)0.2250399D 00
79)0.2346132D 00(  80)0.2366467D 00(  81)0.2165068D 00(  82)0.1999832D 00(  83)0.1983172D 00(  84)0.1981376D 00
85)0.1961651D 00(  86)0.1916242D 00(  87)0.1843833D 00(  88)0.1744985D 00(  89)0.1621008D 00(  90)0.1473659D 00
91)0.1305057D 00(  92)0.1117632D 00(  93)0.9140864D-01(  94)0.6973568D-01(  95)0.4705688D-01(  96)0.2369936D-01
97)0.0           (
```

```
  1)0.0        (  2)0.1700076D-03(  3)0.3375631D-03(  4)0.5002498D-03(  5)0.6557210D-03(  6)0.8017345D-03
  7)0.9361841D-03(  8)0.1057131D-02(  9)0.1162831D-02( 10)0.1251763D-02( 11)0.1322657D-02( 12)0.1374542D-02
 13)0.1406882D-02( 14)0.1420072D-02( 15)0.1417446D-02( 16)0.1413421D-02( 17)0.1097637D-02( 18)0.7554563D-03
 19)0.7360447D-03( 20)0.7015033D-03( 21)0.6631983D-03( 22)0.6252038D-03( 23)0.5889187D-03( 24)0.5547643D-03
 25)0.5228085D-03( 26)0.4929951D-03( 27)0.4652280D-03( 28)0.4394013D-03( 29)0.4154111D-03( 30)0.3931581D-03
 31)0.3725500D-03( 32)0.3535006D-03( 33)0.3359303D-03( 34)0.3197656D-03( 35)0.3049390D-03( 36)0.2913882D-03
 37)0.2790567D-03( 38)0.2678929D-03( 39)0.2578500D-03( 40)0.2488860D-03( 41)0.2409634D-03( 42)0.2340491D-03
 43)0.2281141D-03( 44)0.2231336D-03( 45)0.2190868D-03( 46)0.2159567D-03( 47)0.2137302D-03( 48)0.2123980D-03
 49)0.2119546D-03( 50)0.2123980D-03( 51)0.2137302D-03( 52)0.2159567D-03( 53)0.2190868D-03( 54)0.2231336D-03
 55)0.2281141D-03( 56)0.2340491D-03( 57)0.2409634D-03( 58)0.2488860D-03( 59)0.2578500D-03( 60)0.2678929D-03
 61)0.2790567D-03( 62)0.2913882D-03( 63)0.3049390D-03( 64)0.3197656D-03( 65)0.3359303D-03( 66)0.3535006D-03
 67)0.3725500D-03( 68)0.3931581D-03( 69)0.4154111D-03( 70)0.4394013D-03( 71)0.4652280D-03( 72)0.4929951D-03
 73)0.5228085D-03( 74)0.5547643D-03( 75)0.5889187D-03( 76)0.6252038D-03( 77)0.6631983D-03( 78)0.7015033D-03
 79)0.7360447D-03( 80)0.7554563D-03( 81)0.1097637D-02( 82)0.1413421D-02( 83)0.1417446D-02( 84)0.1420072D-02
 85)0.1406882D-02( 86)0.1374542D-02( 87)0.1322657D-02( 88)0.1251763D-02( 89)0.1162831D-02( 90)0.1057131D-02
 91)0.9361841D-03( 92)0.8017345D-03( 93)0.6557210D-03( 94)0.5002498D-03( 95)0.3375631D-03( 96)0.1700076D-03
 97)0.0        (
  1)0.0        (  2)0.4534131D-03(  3)0.9002864D-03(  4)0.1334174D-02(  5)0.1748819D-02(  6)0.2138239D-02
  7)0.2496818D-02(  8)0.2819385D-02(  9)0.3101289D-02( 10)0.3338472D-02( 11)0.3527548D-02( 12)0.3665926D-02
 13)0.3752176D-02( 14)0.3787355D-02( 15)0.3780352D-02( 16)0.3769618D-02( 17)0.2927417D-02( 18)0.2014814D-02
 19)0.1963043D-02( 20)0.1870921D-02( 21)0.1768761D-02( 22)0.1667429D-02( 23)0.1570656D-02( 24)0.1479565D-02
 25)0.1394339D-02( 26)0.1314826D-02( 27)0.1240771D-02( 28)0.1171891D-02( 29)0.1107908D-02( 30)0.1048559D-02
 31)0.9935970D-03( 32)0.9427919D-03( 33)0.8959317D-03( 34)0.8528202D-03( 35)0.8132772D-03( 36)0.7771371D-03
 37)0.7442488D-03( 38)0.7144747D-03( 39)0.6876901D-03( 40)0.6637830D-03( 41)0.6426534D-03( 42)0.6242128D-03
 43)0.6083841D-03( 44)0.5951011D-03( 45)0.5843081D-03( 46)0.5759601D-03( 47)0.5700220D-03( 48)0.5664691D-03
 49)0.5652864D-03( 50)0.5664691D-03( 51)0.5700220D-03( 52)0.5759601D-03( 53)0.5843081D-03( 54)0.5951011D-03
 55)0.6083841D-03( 56)0.6242128D-03( 57)0.6426534D-03( 58)0.6637830D-03( 59)0.6876901D-03( 60)0.7144747D-03
 61)0.7442488D-03( 62)0.7771371D-03( 63)0.8132772D-03( 64)0.8528202D-03( 65)0.8959317D-03( 66)0.9427919D-03
 67)0.9935970D-03( 68)0.1048559D-02( 69)0.1107908D-02( 70)0.1171891D-02( 71)0.1240771D-02( 72)0.1314826D-02
 73)0.1394339D-02( 74)0.1479565D-02( 75)0.1570656D-02( 76)0.1667429D-02( 77)0.1768761D-02( 78)0.1870921D-02
 79)0.1963043D-02( 80)0.2014814D-02( 81)0.2927417D-02( 82)0.3769618D-02( 83)0.3780352D-02( 84)0.3787355D-02
 85)0.3752176D-02( 86)0.3665926D-02( 87)0.3527548D-02( 88)0.3338472D-02( 89)0.3101289D-02( 90)0.2819385D-02
 91)0.2496818D-02( 92)0.2138239D-02( 93)0.1748819D-02( 94)0.1334174D-02( 95)0.9002864D-03( 96)0.4534131D-03
 97)0.0        (
```

1)C.0 (	2)0.1116720D-03(	3)0.2217334D-03(	4)0.3285965C-C3(	5)C.43C72C1D-03(	6)C.5266312D-C3
7)0.6149464D-03(	8)0.6943921D-03(	S)C.7638228D-C3(	1C)C.8222391C-C3(	11)C.8688069C-03(	12)0.9C28884C-03
13)C.9241311D-03(	14)0.9327954D-03(	15)0.93107C6D-03(	16)C.S284267C-C3(	17)C.72CSS94D-03(	18)C.4S62327C-03
1S)C.4834819D-C3(	2C)C.4607929D-03(	21)C.4356316D-03(	22)0.4106744C-C3(	23)C.3868400D-C3(	24)C.3644C52D-C3
25)0.3434145D-C3(	26)0.3238312D-03(	27)C.3C55919D-C3(	28)C.2886273C-C3(	2S)C.2728689C-03(	3C)0.2582518D-03
31)C.2447150D-03(	32)0.2322021D-03(	33)C.22066C8D-C3(	34)C.21CC428C-C3(	35)C.2CC3C37C-03(	36)C.1S14C27D-03
37)C.1823026D-C3(	38)0.1759694D-03(	39)0.1693726D-03(	40)0.1634845C-C3(	41)C.1582C4D-C3(	42)C.1537386D-C3
43)0.1498402D-03(	44)0.1465687D-03(	45)C.14391C4D-03(	46)C.1418544C-C3(	47)C.14C3919C-03(	48)0.1395168D-03
49)C.1392255D-03(	50)0.1395168D-03(	51)C.1403919D-C3(	52)C.1418544C-C3(	53)C.14391C4C-03(	54)0.1465687C-03
55)C.14984C2D-C3(	56)0.1537386D-03(	57)0.15828C4D-03(	58)0.1634845C-C3(	5S)C.1693726D-C3(	6C)C.1759694D-C3
61)C.1823026D-C3(	62)0.1914027D-03(	63)C.2C03037D-03(	64)0.21CC428C-C3(	65)C.22C66C8C-03(	66)C.2322C21D-C3
67)C.2447150D-03(	68)0.2582518D-03(	69)C.2728689D-C3(	7C)C.2886273C-C3(	71)C.3C55919C-03(	72)C.3238312C-03
73)C.3434145D-C3(	74)0.3644052D-03(	75)0.38684CCC-03(	76)C.41C6744C-C3(	77)C.4356316D-C3(	78)C.46C7929C-C3
7S)C.4834819D-C3(	8C)0.4962327D-03(	81)C.7209994D-C3(	82)C.S284267C-C3(	83)0.S31C7C6D-03(	84)0.S327954C-C3
85)0.9241311C-03(	86)0.9028884D-03(	87)C.8688C69D-C3(	88)C.8222391C-C3(	8S)C.7638228C-03(	9C)0.6943921C-03
91)C.6149464D-03(	92)0.5266312D-03(	93)0.4307201C-C3(	94)C.3285965C-C3(	S5)C.2217334D-C3(	S6)C.111672CC-C3
97)C.0 (					
1)0.0 (	2)0.8292306D-04(	3)C.16465C1D-C3(	4)C.244CC22C-C3(	5)C.319835CC-03(	6)0.3910546D-03
7)0.4566339D-03(	8)0.5156270D-03(	S)C.5671833D-03(	1C)C.61C56C9D-C3(	11)C.64514C2C-C3(	12)0.67C4478C-03
13)C.6862217D-C3(	14)0.6926555D-03(	15)0.6913747D-03(	16)C.6894115C-C3(	17)C.5353845C-C3(	18)C.368482CD-C3
19)0.3590138D-03(	2C)0.3421658D-03(	21)C.3234821D-C3(	22)C.3C49499C-C3(	23)C.2872515C-03(	24)0.2705923D-03
25)0.2550055D-03(	26)0.2404637D-03(	27)C.22692CCD-C3(	28)C.2143227C-C3(	2S)C.2C26212C-03(	3C)0.1917671C-03
31)C.1817153D-C3(	32)0.1724237D-03(	33)C.1638536C-03(	34)0.1559691C-C3(	35)C.1487373D-C3(	36)C.1421277D-C3
37)C.1361129D-C3(	38)0.1306676D-03(	3S)C.1257691D-C3(	4C)C.1213968C-C3(	41)C.1175325C-03(	42)C.11416CCD-C3
43)C.1112651C-03(	44)0.1088358D-03(	45)C.106862CD-C3(	46)C.1C53352D-C3(	47)C.1C42492C-03(	48)C.1C35994C-03
4S)C.1C33831D-C3(	5C)0.1035994D-03(	51)C.1042492C-03(	52)C.1C53352C-C3(	53)C.1C6862CD-C3(	54)C.1C88358C-C3
55)C.1112651D-C3(	56)0.114160CD-03(	57)C.1175325D-C3(	58)C.1213968C-C3(	59)C.1257691C-03(	6C)C.13C6676D-C3
61)0.1361129D-03(	62)0.1421277D-03(	63)C.1487373D-C3(	64)C.1559691C-C3(	65)C.1638536C-03(	66)0.1724237C-03
67)C.1817153D-03(	68)0.1917671D-03(	69)0.2C26212C-03(	7C)C.2143227C-C3(	71)C.22692CCD-C3(	72)C.24C4637C-C3
73)C.255C055D-C3(	74)0.2705923D-03(	75)0.2872515D-03(	76)0.3C49499C-C3(	77)C.3234821C-03(	78)C.3421658D-C3
79)0.3590138D-03(	80)0.368482CD-03(	81)C.5353845D-C3(	82)C.6894115C-C3(	83)C.6913747C-03(	84)0.6926555C-03
85)0.6862217D-03(	86)C.6704478D-03(	87)C.64514C2D-03(	88)C.61C56C9C-C3(	8S)C.5671833D-C3(	9C)C.515627CC-C3
91)C.4566339D-03(	92)0.391C546D-03(	93)0.3198350D-03(	94)0.244CC22C-C3(	S5)C.16465C1D-C3(	S6)C.82923C6D-C4
97)0.0 (					

```
 1)0.0          (  2)0.6361268D-05(  3)0.1263078D-04(  4)0.1871812D-04(  5)0.2453547D-04(  6)0.2999893D-04
 7)0.3502971D-04(  8)0.3955524D-04(  9)0.4351028D-04( 10)0.4683790D-04( 11)0.4949058D-04( 12)0.5143199D-04
13)0.5264205D-04( 14)0.5313561D-04( 15)0.5303736D-04( 16)0.5288675D-04( 17)0.4107089D-04( 18)0.2826732D-04
19)0.2754099D-04( 20)0.2624853D-04( 21)0.2481525D-04( 22)0.2339359D-04( 23)0.2203589D-04( 24)0.2075792D-04
25)0.1956221D-04( 26)0.1844667D-04( 27)0.1740769D-04( 28)0.1644132D-04( 29)0.1554366D-04( 30)0.1471101D-04
31)0.1393991D-04( 32)0.1322712D-04( 33)0.1256969D-04( 34)0.1196485D-04( 35)0.1141007D-04( 36)0.1090303D-04
37)0.1044162D-04( 38)0.1002389D-04( 39)0.9648113D-05( 40)0.9312703D-05( 41)0.9016260D-05( 42)0.8757543D-05
43)0.8535471D-05( 44)0.8349113D-05( 45)0.8197690D-05( 46)0.8080570D-05( 47)0.7997260D-05( 48)0.7947413D-05
49)0.7930821D-05( 50)0.7947413D-05( 51)0.7997260D-05( 52)0.8080570D-05( 53)0.8197690D-05( 54)0.8349113D-05
55)0.8535471D-05( 56)0.8757543D-05( 57)0.9016260D-05( 58)0.9312703D-05( 59)0.9648113D-05( 60)0.1002389D-04
61)0.1044162D-04( 62)0.1090303D-04( 63)0.1141007D-04( 64)0.1196485D-04( 65)0.1256969D-04( 66)0.1322712D-04
67)0.1393991D-04( 68)0.1471101D-04( 69)0.1554366D-04( 70)0.1644132D-04( 71)0.1740769D-04( 72)0.1844667D-04
73)0.1956221D-04( 74)0.2075792D-04( 75)0.2203589D-04( 76)0.2339359D-04( 77)0.2481525D-04( 78)0.2624853D-04
79)0.2754099D-04( 80)0.2826732D-04( 81)0.4107089D-04( 82)0.5288675D-04( 83)0.5303736D-04( 84)0.5313561D-04
85)0.5264205D-04( 86)0.5143199D-04( 87)0.4949058D-04( 88)0.4683790D-04( 89)0.4351028D-04( 90)0.3955524D-04
91)0.3502971D-04( 92)0.2999893D-04( 93)0.2453547D-04( 94)0.1871812D-04( 95)0.1263078D-04( 96)0.6361268D-05
97)0.0          (
 1)0.0          (  2)0.8964655D-06(  3)0.1780001D-05(  4)0.2637862D-05(  5)0.3457676D-05(  6)0.4227618D-05
 7)0.4936583D-05(  8)0.5574346D-05(  9)0.6131712D-05( 10)0.6600659D-05( 11)0.6974489D-05( 12)0.7248084D-05
13)0.7418613D-05( 14)0.7488167D-05( 15)0.7474321D-05( 16)0.7453097D-05( 17)0.5787940D-05( 18)0.3983589D-05
19)0.3881230D-05( 20)0.3699090D-05( 21)0.3497104D-05( 22)0.3296756D-05( 23)0.3105421D-05( 24)0.2925322D-05
25)0.2756816D-05( 26)0.2599607D-05( 27)0.2453189D-05( 28)0.2317003D-05( 29)0.2190500D-05( 30)0.2073158D-05
31)0.1964490D-05( 32)0.1864040D-05( 33)0.1771391D-05( 34)0.1686153D-05( 35)0.1607970D-05( 36)0.1536516D-05
37)0.1471491D-05( 38)0.1412623D-05( 39)0.1359666D-05( 40)0.1312398D-05( 41)0.1270622D-05( 42)0.1234162D-05
43)0.1202866D-05( 44)0.1176604D-05( 45)0.1155264D-05( 46)0.1138759D-05( 47)0.1127019D-05( 48)0.1119994D-05
49)0.1117656D-05( 50)0.1119994D-05( 51)0.1127019D-05( 52)0.1138759D-05( 53)0.1155264D-05( 54)0.1176604D-05
55)0.1202866D-05( 56)0.1234162D-05( 57)0.1270622D-05( 58)0.1312398D-05( 59)0.1359666D-05( 60)0.1412623D-05
61)0.1471491D-05( 62)0.1536516D-05( 63)0.1607970D-05( 64)0.1686153D-05( 65)0.1771391D-05( 66)0.1864040D-05
67)0.1964490D-05( 68)0.2073158D-05( 69)0.2190500D-05( 70)0.2317003D-05( 71)0.2453189D-05( 72)0.2599607D-05
73)0.2756816D-05( 74)0.2925322D-05( 75)0.3105421D-05( 76)0.3296756D-05( 77)0.3497104D-05( 78)0.3699090D-05
79)0.3881230D-05( 80)0.3983589D-05( 81)0.5787940D-05( 82)0.7453097D-05( 83)0.7474321D-05( 84)0.7488167D-05
85)0.7418613D-05( 86)0.7248084D-05( 87)0.6974489D-05( 88)0.6600659D-05( 89)0.6131712D-05( 90)0.5574346D-05
91)0.4936583D-05( 92)0.4227618D-05( 93)0.3457676D-05( 94)0.2637862D-05( 95)0.1780001D-05( 96)0.8964655D-06
97)0.0          (
```

REGION	FRACTIONAL POWER
1	0.2789988D 00
2	0.4420024D 00
3	0.2789988D 00

TOTAL NORMALIZED POWER = 0.1000000D 01

BENCHMARK PROBLEM DELAYED SUPERCRITICAL TRANSIENT

TIME ZONE= 1 STEP NUMBER= 65 TIME=0.100000D 00 TIME STEP=0.242726D-02

TEST POINT	MESH POINT	FREQUENCY	EXP(W*H)
1	9	4.4589D-01	1.000875D 00
2	33	3.3967D-01	1.000666D 00
3	49	1.7308D-01	1.000339D 00
4	65	3.4460D-02	1.000068D 00
5	89	0.0	1.000000D 00

POINT-WISE FLUXES FOR GROUP 1

(1)	0.0	(2)	3.016838D-01	(3)	5.990086D-01	(4)	8.876786D-01	(5)	1.163523D 00	(6)	1.422556D 00
(7)	1.661034D 00	(8)	1.875513D 00	(9)	2.062892D 00	(10)	2.220465D 00	(11)	2.345953D 00	(12)	2.437536D 00
(13)	2.493873D 00	(14)	2.514062D 00	(15)	2.497467D 00	(16)	2.442918D 00	(17)	2.345456D 00	(18)	2.178325D 00
(19)	2.037179D 00	(20)	1.910817D 00	(21)	1.794802D 00	(22)	1.687209D 00	(23)	1.587054D 00	(24)	1.493719D 00
(25)	1.406738D 00	(26)	1.325716D 00	(27)	1.250301D 00	(28)	1.180169D 00	(29)	1.115023D 00	(30)	1.054586D 00
(31)	9.986026D-01	(32)	9.468352D-01	(33)	8.990647D-01	(34)	8.550888D-01	(35)	8.147213D-01	(36)	7.777913D-01
(37)	7.441422D-01	(38)	7.136314D-01	(39)	6.861297D-01	(40)	6.615204D-01	(41)	6.396991D-01	(42)	6.205730D-01
(43)	6.040611D-01	(44)	5.900929D-01	(45)	5.786090D-01	(46)	5.695604D-01	(47)	5.629082D-01	(48)	5.586238D-01
(49)	5.566885D-01	(50)	5.570933D-01	(51)	5.598395D-01	(52)	5.649377D-01	(53)	5.724088D-01	(54)	5.822835D-01
(55)	5.946027D-01	(56)	6.094174D-01	(57)	6.267892D-01	(58)	6.467905D-01	(59)	6.695045D-01	(60)	6.950262D-01
(61)	7.234618D-01	(62)	7.549303D-01	(63)	7.895631D-01	(64)	8.275048D-01	(65)	8.689141D-01	(66)	9.139642D-01
(67)	9.628433D-01	(68)	1.015756D 00	(69)	1.072924D 00	(70)	1.134586D 00	(71)	1.201001D 00	(72)	1.272447D 00
(73)	1.349229D 00	(74)	1.431674D 00	(75)	1.520155D 00	(76)	1.615110D 00	(77)	1.717122D 00	(78)	1.827122D 00
(79)	1.946943D 00	(80)	2.080819D 00	(81)	2.239437D 00	(82)	2.331851D 00	(83)	2.383361D 00	(84)	2.398719D 00
(85)	2.379049D 00	(86)	2.324965D 00	(87)	2.237327D 00	(88)	2.117420D 00	(89)	1.966976D 00	(90)	1.788167D 00
(91)	1.583572D 00	(92)	1.356140D 00	(93)	1.109152D 00	(94)	8.461696D-01	(95)	5.709846D-01	(96)	2.875658D-01
(97)	0.0	(									

TOTAL INTEGRATED FLUX FOR REGION 1 GROUP 1 = 0.702472D 02

TOTAL INTEGRATED FLUX FOR REGION 2 GROUP 1 = 0.168493D 03

TOTAL INTEGRATED FLUX FOR REGION 3 GROUP 1 = 0.670028D 02

POINT-WISE FLUXES FOR GROUP 2

(1)	0.0	(2)	2.500405D-02	(3)	4.964683D-02	(4)	7.357227D-02	(5)	9.643469D-02	(6)	1.179038D-01
(7)	1.376693D-01	(8)	1.554457D-01	(9)	1.709764D-01	(10)	1.840376D-01	(11)	1.944437D-01	(12)	2.020568D-01
(13)	2.068176D-01	(14)	2.088644D-01	(15)	2.090125D-01	(16)	2.107064D-01	(17)	2.279811D-01	(18)	2.489996D-01
(19)	2.467321D-01	(20)	2.365539D-01	(21)	2.240816D-01	(22)	2.113448D-01	(23)	1.990555D-01	(24)	1.874434D-01
(25)	1.765631D-01	(26)	1.664066D-01	(27)	1.569450D-01	(28)	1.481433D-01	(29)	1.399663D-01	(30)	1.323800D-01
(31)	1.253526D-01	(32)	1.188543D-01	(33)	1.128577D-01	(34)	1.073375D-01	(35)	1.022702D-01	(36)	9.763441D-02
(37)	9.341047D-02	(38)	8.958048D-02	(39)	8.612821D-02	(40)	8.303901D-02	(41)	8.029978D-02	(42)	7.789890D-02
(43)	7.582614D-02	(44)	7.407271D-02	(45)	7.263112D-02	(46)	7.149522D-02	(47)	7.066015D-02	(48)	7.012229D-02
(49)	6.987930D-02	(50)	6.993008D-02	(51)	7.027474D-02	(52)	7.091466D-02	(53)	7.185244D-02	(54)	7.309193D-02
(55)	7.463826D-02	(56)	7.649786D-02	(57)	7.867844D-02	(58)	8.118908D-02	(59)	8.404025D-02	(60)	8.724385D-02
(61)	9.081323D-02	(62)	9.476331D-02	(63)	9.911058D-02	(64)	1.038732D-01	(65)	1.090711D-01	(66)	1.147260D-01
(67)	1.208616D-01	(68)	1.275034D-01	(69)	1.346791D-01	(70)	1.424186D-01	(71)	1.507535D-01	(72)	1.597170D-01
(73)	1.693415D-01	(74)	1.796539D-01	(75)	1.906610D-01	(76)	2.023096D-01	(77)	2.143790D-01	(78)	2.261872D-01
(79)	2.357923D-01	(80)	2.378218D-01	(81)	2.175697D-01	(82)	2.009576D-01	(83)	1.992779D-01	(84)	1.990930D-01
(85)	1.971074D-01	(86)	1.925416D-01	(87)	1.852636D-01	(88)	1.753297D-01	(89)	1.628712D-01	(90)	1.480651D-01
(91)	1.311240D-01	(92)	1.122920D-01	(93)	9.184074D-02	(94)	7.006508D-02	(95)	4.727904D-02	(96)	2.381121D-02
(97)	0.0	(									

TOTAL INTEGRATED FLUX FOR REGION 1 GROUP 2 = 0.589146D 01

TOTAL INTEGRATED FLUX FOR REGION 2 GROUP 2 = 0.207988D 02

TOTAL INTEGRATED FLUX FOR REGION 3 GROUP 2 = 0.561426D 01

REGION	NORMALIZED POWER
1	0.1054041D 01
2	0.1026433D 01
3	0.1004788D 01

TOTAL NORMALIZED POWER = 0.1028097D 01

```
BENCHMARK PROBLEM DELAYED SUPERCRITICAL TRANSIENT

TIME ZCNE= 1  STEP NUMBER= 177  TIME=0.5COC00D CC  TIME STEP=C.523461D-C2


TEST PCINT       MESH PCINT        FRECUENCY          EXP(W*H)
    1                 9            8.0829D-01        1.CC32C1D CC
    2                33            6.8191D-C1        1.CC27CCD CC
    3                49            4.1C25D-01        1.0C1623D CC
    4                65            1.35C0D-01        1.000534D 00
    5                89            6.7972D-C2        1.CC0269D CC

PCINT-WISE FLUXES FOR GRCUP    1
 (  1) C.0            (  2) 4.001681D-C1(  3) 7.945125D-01(  4) 1.177294D CC(  5) 1.542943D CO(  6) 1.886137D CC
 (  7) 2.201882D 00(  8) 2.485581D CC(  9) 2.733107D CC( 1C) 2.940855D CC( 11) 3.105799D CO( 12) 3.225531D 00
 ( 13) 3.298281D 00( 14) 3.322875D CC( 15) 3.29B5C2D CC( 16) 3.223667D CC( 17) 3.C91939D CO( 18) 2.866845D 0C
 ( 19) 2.676319D CC( 20) 2.505642D C0( 21) 2.348957D 0C( 22) 2.2C3695D CC( 23) 2.C68522D CO( 24) 1.942588D CC
 ( 25) 1.825242D CC( 26) 1.715932D CC( 27) 1.614162D 0C( 28) 1.519477D 0C( 29) 1.431459D CO( 3C) 1.349716D CC
 ( 31) 1.273888D 00( 32) 1.203639D CC( 33) 1.138658D CC( 34) 1.C78658D CC( 35) 1.C23373D CO( 36) 9.725594D-01
 ( 37) 9.259907D-01( 38) 8.834608D-01( 39) 8.447808D-01( 4C) 8.C97787D-C1( 41) 7.782987D-C1( 42) 7.5C2CC3D-C1
 ( 43) 7.253577D-01( 44) 7.036595D-C1( 45) 6.85CC79D-01( 46) 6.693182D-C1( 47) 6.565189D-01( 48) 6.4655C7D-C1
 ( 49) 6.393667D-01( 50) 6.349322D-C1( 51) 6.332241D-01( 52) 6.342311D-C1( 53) 6.379539D-01( 54) 6.444045D-01
 ( 55) 6.536067D-C1( 56) 6.655961D-01( 57) 6.8042C4D-01( 58) 6.981391D-C1( 59) 7.188243D-C1( 6C) 7.425606D-C1
 ( 61) 7.694456D-01( 62) 7.995903D-01( 63) 8.331196D-01( 64) 8.7C1727D-C1( 65) 9.109C37D-01( 66) 9.554822D-C1
 ( 67) 1.004094D 00( 68) 1.056943D CC( 69) 1.11425CD CC( 7C) 1.176254D CC( 71) 1.243216D 00( 72) 1.315417D CC
 ( 73) 1.393164D 00( 74) 1.476792D C0( 75) 1.566678D 0C( 76) 1.663269D CC( 77) 1.767161D CO( 78) 1.879310D CC
 ( 79) 2.001594D 0C( 80) 2.138359D CC( 81) 2.300594D 00( 82) 2.395072D CC( 83) 2.447582D CO( 84) 2.463014D CC
 ( 85) 2.442527D 00( 86) 2.386757D CC( 87) 2.296588D CC( 88) 2.173341D CC( 89) 2.018793D 00( 90) 1.835173D 0C
 ( 91) 1.625124D 00( 92) 1.391672D CC( 93) 1.138178D CC( 94) 8.682929D-C1( 95) 5.859C35D-01( 96) 2.950765D-01
 ( 97) C.0            (

TOTAL INTEGRATED FLUX FOR REGION  1 GRCUP  1 = C.929578D C2

TCTAL INTEGRATED FLUX FCR REGICN  2 GRCUP  1 = C.196132D C3

TOTAL INTEGRATED FLUX FCR REGICN  3 GRCUP  1 = C.687835D C2
```

```
POINT-WISE FLUXES FOR GROUP    2
(  1) 0.0          (  2) 3.329665D-02(  3) 6.610873D-02(  4) 9.795874D-02(  5) 1.283831D-01(  6) 1.569392D-01
(  7) 1.832112D-01(  8) 2.068170D-01(  9) 2.274132D-01( 10) 2.447010D-01( 11) 2.584327D-01( 12) 2.684248D-01
( 13) 2.745987D-01( 14) 2.771362D-01( 15) 2.771069D-01( 16) 2.790150D-01( 17) 3.011626D-01( 18) 3.279117D-01
( 19) 3.242287D-01( 20) 3.102455D-01( 21) 2.933127D-01( 22) 2.760827D-01( 23) 2.594824D-01( 24) 2.438077D-01
( 25) 2.291251D-01( 26) 2.154196D-01( 27) 2.026492D-01( 28) 1.907640D-01( 29) 1.797142D-01( 30) 1.694517D-01
( 31) 1.599315D-01( 32) 1.511117D-01( 33) 1.429534D-01( 34) 1.354203D-01( 35) 1.284793D-01( 36) 1.220995D-01
( 37) 1.162527D-01( 38) 1.109130D-01( 39) 1.060566D-01( 40) 1.016619D-01( 41) 9.770947D-02( 42) 9.418154D-02
( 43) 9.106237D-02( 44) 8.833795D-02( 45) 8.599600D-02( 46) 8.402591D-02( 47) 8.241868D-02( 48) 8.116686D-02
( 49) 8.026459D-02( 50) 7.970747D-02( 51) 7.949262D-02( 52) 7.961864D-02( 53) 8.008558D-02( 54) 8.089495D-02
( 55) 8.204975D-02( 56) 8.355445D-02( 57) 8.541502D-02( 58) 8.763894D-02( 59) 9.023525D-02( 60) 9.321458D-02
( 61) 9.658917D-02( 62) 1.003730D-01( 63) 1.045816D-01( 64) 1.092326D-01( 65) 1.143453D-01( 66) 1.199410D-01
( 67) 1.260430D-01( 68) 1.326767D-01( 69) 1.398699D-01( 70) 1.476523D-01( 71) 1.560559D-01( 72) 1.651139D-01
( 73) 1.748594D-01( 74) 1.853193D-01( 75) 1.965001D-01( 76) 2.083469D-01( 77) 2.206326D-01( 78) 2.326564D-01
( 79) 2.424236D-01( 80) 2.444159D-01( 81) 2.235300D-01( 82) 2.064132D-01( 83) 2.046508D-01( 84) 2.044314D-01
( 85) 2.023683D-01( 86) 1.976604D-01( 87) 1.901722D-01( 88) 1.799614D-01( 89) 1.671631D-01( 90) 1.519584D-01
( 91) 1.345656D-01( 92) 1.152350D-01( 93) 9.424483D-02( 94) 7.189748D-02( 95) 4.851472D-02( 96) 2.443329D-02
( 97) 0.0          (

TOTAL INTEGRATED FLUX FOR REGION  1 GROUP  2 = 0.782531D 01

TOTAL INTEGRATED FLUX FOR REGION  2 GROUP  2 = 0.242103D 02

TOTAL INTEGRATED FLUX FOR REGION  3 GROUP  2 = 0.576359D 01

          REGION          NORMALIZED POWER

             1              0.1398077D 01
             2              0.1194797D 01
             3              0.1031505D 01

          TOTAL NORMALIZED POWER =  0.1205954D 01
```

```
BENCHMARK PROBLEM DELAYED SUPERCRITICAL TRANSIENT

TIME ZONE= 1  STEP NUMBER= 272  TIME=0.100000D 01  TIME STEP=0.355353D-02


TEST POINT      MESH POINT      FREQUENCY        EXP(W*H)
    1               9           1.6015D 00      1.001812D 00
    2              33           1.4628D 00      1.001655D 00
    3              49           1.0743D 00      1.001215D 00
    4              65           5.0491D-01      1.000571D 00
    5              89           3.1852D-01      1.000360D 00

POINT-WISE FLUXES FOR GROUP    1
 (  1) 0.0         (  2) 6.921405D-01(  3) 1.374115D 00(  4) 2.035906D 00(  5) 2.667793D 00(  6) 3.260495D 00
 (  7) 3.805305D 00(  8) 4.294220D 00(  9) 4.720058D 00( 10) 5.076561D 00( 11) 5.358489D 00( 12) 5.561687D 00
 ( 13) 5.683121D 00( 14) 5.720813D 00( 15) 5.673434D 00( 16) 5.538536D 00( 17) 5.305359D 00( 18) 4.908603D 00
 ( 19) 4.571807D 00( 20) 4.269854D 00( 21) 3.992677D 00( 22) 3.735799D 00( 23) 3.496856D 00( 24) 3.274306D 00
 ( 25) 3.066958D 00( 26) 2.873789D 00( 27) 2.693882D 00( 28) 2.526393D 00( 29) 2.370542D 00( 30) 2.225603D 00
 ( 31) 2.090904D 00( 32) 1.965817D 00( 33) 1.849762D 00( 34) 1.742198D 00( 35) 1.642626D 00( 36) 1.550583D 00
 ( 37) 1.465638D 00( 38) 1.387397D 00( 39) 1.315494D 00( 40) 1.249594D 00( 41) 1.189387D 00( 42) 1.134592D 00
 ( 43) 1.084951D 00( 44) 1.040230D 00( 45) 1.000218D 00( 46) 9.647246D-01( 47) 9.335806D-01( 48) 9.066362D-01
 ( 49) 8.837607D-01( 50) 8.648417D-01( 51) 8.497850D-01( 52) 8.385132D-01( 53) 8.309664D-01( 54) 8.271010D-01
 ( 55) 8.268899D-01( 56) 8.303224D-01( 57) 8.374038D-01( 58) 8.481555D-01( 59) 8.626153D-01( 60) 8.808372D-01
 ( 61) 9.028915D-01( 62) 9.288657D-01( 63) 9.588640D-01( 64) 9.930083D-01( 65) 1.031439D 00( 66) 1.074314D 00
 ( 67) 1.121811D 00( 68) 1.174128D 00( 69) 1.231483D 00( 70) 1.294118D 00( 71) 1.362295D 00( 72) 1.436303D 00
 ( 73) 1.516457D 00( 74) 1.603106D 00( 75) 1.696643D 00( 76) 1.797539D 00( 77) 1.906425D 00( 78) 2.024320D 00
 ( 79) 2.153234D 00( 80) 2.297821D 00( 81) 2.469865D 00( 82) 2.569957D 00( 83) 2.625144D 00( 84) 2.640702D 00
 ( 85) 2.617894D 00( 86) 2.557411D 00( 87) 2.460207D 00( 88) 2.327700D 00( 89) 2.161795D 00( 90) 1.964873D 00
 ( 91) 1.739760D 00( 92) 1.489685D 00( 93) 1.218236D 00( 94) 9.293088D-01( 95) 6.270475D-01( 96) 3.157892D-01
 ( 97) 0.0         (

TOTAL INTEGRATED FLUX FOR REGION  1 GROUP  1 = 0.160288D 03

TOTAL INTEGRATED FLUX FOR REGION  2 GROUP  1 = 0.277738D 03

TOTAL INTEGRATED FLUX FOR REGION  3 GROUP  1 = 0.737011D 02
```

```
POINT-WISE FLUXES FOR GROUP    2
 (  1) 0.0            (  2) 5.787691D-02(  3) 1.149037D-01(  4) 1.702428D-01(  5) 2.230813D-01(  6) 2.726431D-01
 (  7) 3.182003D-01(  8) 3.590836D-01(  9) 3.946929D-01( 10) 4.245068D-01( 11) 4.480942D-01( 12) 4.651365D-01
 ( 13) 4.754977D-01( 14) 4.794891D-01( 15) 4.789348D-01( 16) 4.814834D-01( 17) 5.181045D-01( 18) 5.618953D-01
 ( 19) 5.540441D-01( 20) 5.287981D-01( 21) 4.986538D-01( 22) 4.681118D-01( 23) 4.387378D-01( 24) 4.110234D-01
 ( 25) 3.850712D-01( 26) 3.608456D-01( 27) 3.382654D-01( 28) 3.172374D-01( 29) 2.976680D-01( 30) 2.794680D-01
 ( 31) 2.625533D-01( 32) 2.468457D-01( 33) 2.322720D-01( 34) 2.187648D-01( 35) 2.062610D-01( 36) 1.947025D-01
 ( 37) 1.840355D-01( 38) 1.742102D-01( 39) 1.651808D-01( 40) 1.569052D-01( 41) 1.493444D-01( 42) 1.424633D-01
 ( 43) 1.362293D-01( 44) 1.306131D-01( 45) 1.255881D-01( 46) 1.211306D-01( 47) 1.172191D-01( 48) 1.138350D-01
 ( 49) 1.109618D-01( 50) 1.085853D-01( 51) 1.066938D-01( 52) 1.052775D-01( 53) 1.043289D-01( 54) 1.038426D-01
 ( 55) 1.038150D-01( 56) 1.042449D-01( 57) 1.051329D-01( 58) 1.064817D-01( 59) 1.082961D-01( 60) 1.105828D-01
 ( 61) 1.133506D-01( 62) 1.166105D-01( 63) 1.203757D-01( 64) 1.246613D-01( 65) 1.294850D-01( 66) 1.348667D-01
 ( 67) 1.408286D-01( 68) 1.473955D-01( 69) 1.545949D-01( 70) 1.624564D-01( 71) 1.710125D-01( 72) 1.802971D-01
 ( 73) 1.903439D-01( 74) 2.011804D-01( 75) 2.128124D-01( 76) 2.251796D-01( 77) 2.380375D-01( 78) 2.506331D-01
 ( 79) 2.608257D-01( 80) 2.626935D-01( 81) 2.400311D-01( 82) 2.215062D-01( 83) 2.195066D-01( 84) 2.191853D-01
 ( 85) 2.169023D-01( 86) 2.117973D-01( 87) 2.037247D-01( 88) 1.927466D-01( 89) 1.790075D-01( 90) 1.627010D-01
 ( 91) 1.440605D-01( 92) 1.233531D-01( 93) 1.008758D-01( 94) 7.695122D-02( 95) 5.192253D-02( 96) 2.614886D-02
 ( 97) 0.0            (

TOTAL INTEGRATED FLUX FOR REGION  1 GROUP  2 = 0.135573D 02

TOTAL INTEGRATED FLUX FOR REGION  2 GROUP  2 = 0.342823D 02

TOTAL INTEGRATED FLUX FOR REGION  3 GROUP  2 = 0.617601D 01

PRECURSOR CONCENTRATION FOR DELAYED GROUP    1
 (  1) 0.0            (  2) 1.710523D-04(  3) 3.396370D-04(  4) 5.033220D-04(  5) 6.597458D-04(  6) 8.066520D-04
 (  7) 9.419212D-04(  8) 1.063602D-03(  9) 1.169940D-03( 10) 1.259405D-03( 11) 1.330717D-03( 12) 1.382901D-03
 ( 13) 1.415417D-03( 14) 1.428664D-03( 15) 1.425993D-03( 16) 1.421904D-03( 17) 1.104172D-03( 18) 7.599027D-04
 ( 19) 7.403379D-04( 20) 7.055599D-04( 21) 6.669998D-04( 22) 6.287549D-04( 23) 5.922319D-04( 24) 5.578540D-04
 ( 25) 5.256894D-04( 26) 4.956812D-04( 27) 4.677325D-04( 28) 4.417367D-04( 29) 4.175888D-04( 30) 3.951890D-04
 ( 31) 3.744441D-04( 32) 3.552674D-04( 33) 3.375785D-04( 34) 3.213034D-04( 35) 3.063739D-04( 36) 2.927274D-04
 ( 37) 2.803069D-04( 38) 2.690602D-04( 39) 2.589402D-04( 40) 2.499046D-04( 41) 2.419154D-04( 42) 2.349392D-04
 ( 43) 2.289468D-04( 44) 2.239129D-04( 45) 2.198166D-04( 46) 2.166407D-04( 47) 2.143717D-04( 48) 2.130003D-04
 ( 49) 2.125205D-04( 50) 2.129305D-04( 51) 2.142318D-04( 52) 2.164299D-04( 53) 2.195340D-04( 54) 2.235571D-04
 ( 55) 2.285159D-04( 56) 2.344311D-04( 57) 2.413276D-04( 58) 2.492342D-04( 59) 2.581839D-04( 60) 2.682142D-04
 ( 61) 2.793670D-04( 62) 2.916890D-04( 63) 3.052318D-04( 64) 3.200519D-04( 65) 3.362115D-04( 66) 3.537780D-04
 ( 67) 3.728251D-04( 68) 3.934322D-04( 69) 4.156855D-04( 70) 4.396775D-04( 71) 4.655072D-04( 72) 4.932788D-04
 ( 73) 5.230981D-04( 74) 5.550611D-04( 75) 5.892242D-04( 76) 6.255194D-04( 77) 6.635251D-04( 78) 7.018419D-04
 ( 79) 7.363936D-04( 80) 7.558089D-04( 81) 1.098143D-03( 82) 1.414066D-03( 83) 1.418089D-03( 84) 1.420712D-03
 ( 85) 1.407513D-03( 86) 1.375156D-03( 87) 1.323246D-03( 88) 1.252318D-03( 89) 1.163345D-03( 90) 1.057597D-03
 ( 91) 9.365966D-04( 92) 8.020872D-04( 93) 6.560091D-04( 94) 5.004694D-04( 95) 3.377112D-04( 96) 1.700822D-04
 ( 97) 0.0            (
```

```
PRECURSOR CONCENTRATION FOR DELAYED GROUP    2
(  1) 0.0          (  2) 4.602329D-04(  3) 9.138245D-04(  4) 1.354229D-03(  5) 1.775092D-03(  6) 2.170340D-03
(  7) 2.534270D-03(  8) 2.861630D-03(  9) 3.147698D-03( 10) 3.388356D-03( 11) 3.580164D-03( 12) 3.720495D-03
( 13) 3.807896D-03( 14) 3.843440D-03( 15) 3.836143D-03( 16) 3.824993D-03( 17) 2.970074D-03( 18) 2.043840D-03
( 19) 1.991069D-03( 20) 1.897402D-03( 21) 1.793577D-03( 22) 1.690611D-03( 23) 1.592284D-03( 24) 1.499735D-03
( 25) 1.413145D-03( 26) 1.332361D-03( 27) 1.257120D-03( 28) 1.187136D-03( 29) 1.122124D-03( 30) 1.061817D-03
( 31) 1.005962D-03( 32) 9.543255D-04( 33) 9.066910D-04( 34) 8.628586D-04( 35) 8.226444D-04( 36) 7.858797D-04
( 37) 7.524101D-04( 38) 7.220951D-04( 39) 6.948075D-04( 40) 6.704327D-04( 41) 6.488683D-04( 42) 6.300237D-04
( 43) 6.138199D-04( 44) 6.001887D-04( 45) 5.890727D-04( 46) 5.804254D-04( 47) 5.742101D-04( 48) 5.704008D-04
( 49) 5.689812D-04( 50) 5.699453D-04( 51) 5.732969D-04( 52) 5.790498D-04( 53) 5.872281D-04( 54) 5.978658D-04
( 55) 6.110072D-04( 56) 6.267073D-04( 57) 6.450317D-04( 58) 6.660569D-04( 59) 6.898708D-04( 60) 7.165731D-04
( 61) 7.462753D-04( 62) 7.791017D-04( 63) 8.151896D-04( 64) 8.546899D-04( 65) 8.977680D-04( 66) 9.446039D-04
( 67) 9.953936D-04( 68) 1.050349D-03( 69) 1.109701D-03( 70) 1.173695D-03( 71) 1.242595D-03( 72) 1.316680D-03
( 73) 1.396231D-03( 74) 1.481505D-03( 75) 1.572652D-03( 76) 1.669491D-03( 77) 1.770896D-03( 78) 1.873133D-03
( 79) 1.965323D-03( 80) 2.017119D-03( 81) 2.930720D-03( 82) 3.773834D-03( 83) 3.784551D-03( 84) 3.791538D-03
( 85) 3.756300D-03( 86) 3.669938D-03( 87) 3.531395D-03( 88) 3.342102D-03( 89) 3.104652D-03( 90) 2.822435D-03
( 91) 2.499514D-03( 92) 2.140544D-03( 93) 1.750702D-03( 94) 1.335609D-03( 95) 9.012541D-04( 96) 4.539003D-04
( 97) 0.0          (

PRECURSOR CONCENTRATION FOR DELAYED GROUP    3
(  1) 0.0          (  2) 1.176542D-04(  3) 2.336086D-04(  4) 3.461883D-04(  5) 4.537667D-04(  6) 5.547898D-04
(  7) 6.477982D-04(  8) 7.314482D-04(  9) 8.045321D-04( 10) 8.659960D-04( 11) 9.149609D-04( 12) 9.507551D-04
( 13) 9.730074D-04( 14) 9.819921D-04( 15) 9.800094D-04( 16) 9.770150D-04( 17) 7.584180D-04( 18) 5.216941D-04
( 19) 5.080661D-04( 20) 4.840223D-04( 21) 4.574008D-04( 22) 4.310100D-04( 23) 4.058131D-04( 24) 3.820988D-04
( 25) 3.599124D-04( 26) 3.392136D-04( 27) 3.199347D-04( 28) 3.020013D-04( 29) 2.853403D-04( 30) 2.698824D-04
( 31) 2.555625D-04( 32) 2.423203D-04( 33) 2.300999D-04( 34) 2.188495D-04( 35) 2.085217D-04( 36) 1.990728D-04
( 37) 1.904628D-04( 38) 1.826552D-04( 39) 1.756172D-04( 40) 1.693188D-04( 41) 1.637334D-04( 42) 1.588373D-04
( 43) 1.546098D-04( 44) 1.510329D-04( 45) 1.480914D-04( 46) 1.457728D-04( 47) 1.440673D-04( 48) 1.429673D-04
( 49) 1.424683D-04( 50) 1.425679D-04( 51) 1.432664D-04( 52) 1.445666D-04( 53) 1.464739D-04( 54) 1.489959D-04
( 55) 1.521433D-04( 56) 1.559291D-04( 57) 1.603691D-04( 58) 1.654817D-04( 59) 1.712882D-04( 60) 1.778130D-04
( 61) 1.850832D-04( 62) 1.931292D-04( 63) 2.019847D-04( 64) 2.116866D-04( 65) 2.222755D-04( 66) 2.337957D-04
( 67) 2.462954D-04( 68) 2.598268D-04( 69) 2.744464D-04( 70) 2.902150D-04( 71) 3.071977D-04( 72) 3.254630D-04
( 73) 3.450804D-04( 74) 3.661132D-04( 75) 3.885984D-04( 76) 4.124909D-04( 77) 4.375129D-04( 78) 4.627417D-04
( 79) 4.854904D-04( 80) 4.982630D-04( 81) 7.239107D-04( 82) 9.321423D-04( 83) 9.347709D-04( 84) 9.364815D-04
( 85) 9.277654D-04( 86) 9.064245D-04( 87) 8.721973D-04( 88) 8.254379D-04( 89) 7.667865D-04( 90) 6.970803D-04
( 91) 6.173226D-04( 92) 5.286629D-04( 93) 4.323797D-04( 94) 3.298614D-04( 95) 2.225863D-04( 96) 1.121014D-04
( 97) 0.0          (
```

PRECURSOR CONCENTRATION FOR DELAYED GROUP 4

(1)	0.0	(2)	9.438311D-05	(3)	1.873997D-04	(4)	2.777031D-04	(5)	3.639858D-04	(6)	4.449986D-04
(7)	5.195686D-04	(8)	5.866162D-04	(9)	6.451711D-04	(10)	6.943872D-04	(11)	7.335589D-04	(12)	7.621476D-04
(13)	7.798562D-04	(14)	7.869040D-04	(15)	7.851296D-04	(16)	7.824695D-04	(17)	6.070706D-04	(18)	4.172615D-04
(19)	4.061134D-04	(20)	3.866704D-04	(21)	3.651895D-04	(22)	3.439114D-04	(23)	3.236029D-04	(24)	3.044929D-04
(25)	2.866155D-04	(26)	2.699370D-04	(27)	2.544015D-04	(28)	2.399485D-04	(29)	2.265180D-04	(30)	2.140533D-04
(31)	2.025013D-04	(32)	1.918127D-04	(33)	1.819416D-04	(34)	1.728458D-04	(35)	1.644862D-04	(36)	1.568271D-04
(37)	1.498355D-04	(38)	1.434815D-04	(39)	1.377378D-04	(40)	1.325797D-04	(41)	1.279849D-04	(42)	1.239338D-04
(43)	1.204087D-04	(44)	1.173946D-04	(45)	1.148783D-04	(46)	1.128488D-04	(47)	1.112974D-04	(48)	1.102171D-04
(49)	1.096031D-04	(50)	1.094525D-04	(51)	1.097644D-04	(52)	1.105398D-04	(53)	1.117818D-04	(54)	1.134953D-04
(55)	1.156873D-04	(56)	1.183668D-04	(57)	1.215448D-04	(58)	1.252344D-04	(59)	1.294511D-04	(60)	1.342122D-04
(61)	1.395376D-04	(62)	1.454495D-04	(63)	1.519726D-04	(64)	1.591341D-04	(65)	1.669638D-04	(66)	1.754945D-04
(67)	1.847618D-04	(68)	1.948046D-04	(69)	2.056646D-04	(70)	2.173870D-04	(71)	2.300203D-04	(72)	2.436155D-04
(73)	2.582241D-04	(74)	2.738935D-04	(75)	2.906509D-04	(76)	3.084627D-04	(77)	3.271210D-04	(78)	3.459363D-04
(79)	3.629003D-04	(80)	3.724114D-04	(81)	5.410198D-04	(82)	6.966044D-04	(83)	6.985385D-04	(84)	6.997922D-04
(85)	6.932585D-04	(86)	6.772947D-04	(87)	6.517055D-04	(88)	6.167553D-04	(89)	5.729226D-04	(90)	5.208329D-04
(91)	4.612356D-04	(92)	3.949893D-04	(93)	3.230491D-04	(94)	2.464519D-04	(95)	1.663020D-04	(96)	8.375468D-05
(97)	0.0	(									

PRECURSOR CONCENTRATION FOR DELAYED GROUP 5

(1)	0.0	(2)	9.082536D-06	(3)	1.803285D-05	(4)	2.672064D-05	(5)	3.501943D-05	(6)	4.280840D-05
(7)	4.997417D-05	(8)	5.641241D-05	(9)	6.202943D-05	(10)	6.674361D-05	(11)	7.048698D-05	(12)	7.320777D-05
(13)	7.487749D-05	(14)	7.551717D-05	(15)	7.530206D-05	(16)	7.498648D-05	(17)	5.809593D-05	(18)	3.985292D-05
(19)	3.872816D-05	(20)	3.681981D-05	(21)	3.472258D-05	(22)	3.264908D-05	(23)	3.067179D-05	(24)	2.881199D-05
(25)	2.707249D-05	(26)	2.544968D-05	(27)	2.393785D-05	(28)	2.253088D-05	(29)	2.122274D-05	(30)	2.000772D-05
(31)	1.888046D-05	(32)	1.783599D-05	(33)	1.686969D-05	(34)	1.597727D-05	(35)	1.515478D-05	(36)	1.439858D-05
(37)	1.370531D-05	(38)	1.307188D-05	(39)	1.249549D-05	(40)	1.197357D-05	(41)	1.150379D-05	(42)	1.108406D-05
(43)	1.071248D-05	(44)	1.038740D-05	(45)	1.010734D-05	(46)	9.871037D-06	(47)	9.677407D-06	(48)	9.525556D-06
(49)	9.414769D-06	(50)	9.344511D-06	(51)	9.314420D-06	(52)	9.324309D-06	(53)	9.374161D-06	(54)	9.464135D-06
(55)	9.594558D-06	(56)	9.765932D-06	(57)	9.978935D-06	(58)	1.023442D-05	(59)	1.053343D-05	(60)	1.087719D-05
(61)	1.126710D-05	(62)	1.170477D-05	(63)	1.219203D-05	(64)	1.273088D-05	(65)	1.332358D-05	(66)	1.397259D-05
(67)	1.468062D-05	(68)	1.545062D-05	(69)	1.628580D-05	(70)	1.718965D-05	(71)	1.816588D-05	(72)	1.921845D-05
(73)	2.035136D-05	(74)	2.156826D-05	(75)	2.287125D-05	(76)	2.425765D-05	(77)	2.571111D-05	(78)	2.717751D-05
(79)	2.849924D-05	(80)	2.923671D-05	(81)	4.246185D-05	(82)	5.466280D-05	(83)	5.480673D-05	(84)	5.489869D-05
(85)	5.438079D-05	(86)	5.312410D-05	(87)	5.111330D-05	(88)	4.836916D-05	(89)	4.492919D-05	(90)	4.084241D-05
(91)	3.616757D-05	(92)	3.097193D-05	(93)	2.533032D-05	(94)	1.932395D-05	(95)	1.303933D-05	(96)	6.566946D-06
(97)	0.0	(									

PRECURSOR CONCENTRATION FOR DELAYED GROUP 6

(1) 0.0 (2) 1.601972D-06(3) 3.180524D-06(4) 4.712577D-06(5) 6.175733D-06(6) 7.548599D-06

(7) 8.811105D-06(8) 9.944792D-06(9) 1.093309D-05(10) 1.176158D-05(11) 1.241826D-05(12) 1.289400D-05

(13) 1.318381D-05(14) 1.329137D-05(15) 1.324738D-05(16) 1.318359D-05(17) 1.020286D-05(18) 6.988265D-06

(19) 6.782801D-06(20) 6.441118D-06(21) 6.067101D-06(22) 5.697845D-06(23) 5.345948D-06(24) 5.015067D-06

(25) 4.705633D-06(26) 4.416955D-06(27) 4.147988D-06(28) 3.897609D-06(29) 3.664718D-06(30) 3.448273D-06

(31) 3.247298D-06(32) 3.060884D-06(33) 2.888185D-06(34) 2.728419D-06(35) 2.580860D-06(36) 2.444838D-06

(37) 2.319736D-06(38) 2.204982D-06(39) 2.100056D-06(40) 2.004478D-06(41) 1.917812D-06(42) 1.839660D-06

(43) 1.769664D-06(44) 1.7C7502D-06(45) 1.652885D-06(46) 1.605561D-06(47) 1.565307D-06(48) 1.531933D-06

(49) 1.505280D-06(50) 1.485216D-06(51) 1.471642D-06(52) 1.464484D-06(53) 1.463698D-06(54) 1.469266D-06

(55) 1.481201D-06(56) 1.499541D-06(57) 1.524352D-06(58) 1.555730D-06(59) 1.593796D-06(60) 1.638704D-06

(61) 1.690634D-06(62) 1.749798D-06(63) 1.816439D-06(64) 1.890832D-06(65) 1.973283D-06(66) 2.064137D-06

(67) 2.163769D-06(68) 2.272597D-06(69) 2.391073D-06(70) 2.519691D-06(71) 2.658982D-06(72) 2.8095C8D-06

(73) 2.971842D-06(74) 3.146507D-06(75) 3.333801D-06(76) 3.533327D-06(77) 3.7427C6D-06(78) 3.954068D-06

(79) 4.144509D-06(80) 4.250162D-06(81) 6.170733D-06(82) 7.942123D-06(83) 7.961708D-06(84) 7.973983D-06

(85) 7.897861D-06(86) 7.714596D-06(87) 7.421968D-06(88) 7.022996D-06(89) 6.523123D-06(90) 5.929466D-06

(91) 5.250544D-06(92) 4.496116D-06(93) 3.677029D-06(94) 2.805064D-06(95) 1.892759D-06(96) 9.532337D-07

(97) 0.0 (

REGION	NORMALIZED POWER
1	0.2417898D 01
2	0.1691876D 01
3	0.1105293D 01

TOTAL NORMALIZED PCWER = 0.1730779D 01

*** INPUT EDIT FOR TIME ZONE 2 ***

CARD 21 0.2500COD-C2 1-.3000000D 01 0 -2 0 0 0 1

CARD 22 0.150000D C10.20CC00D 01

ARE THERE ANY TIME CEPENDENT CHANGES IN THE
CROSS SECTION DATA NO

ARE THERE ANY TIME CEPENDENT SOURCES ? NO

BENCHMARK PROBLEM DELAYED SUPERCRITICAL TRANSIENT

TIME ZONE= 2 STEP NUMBER= 200 TIME=0.150000D 01 TIME STEP=0.250000D-02

TEST POINT	MESH POINT	FREQUENCY	EXP(W*H)
1	9	2.3870D-01	1.000597D 00
2	33	2.3162D-01	1.000579D 00
3	49	1.8913D-01	1.000473D 00
4	65	1.1109D-01	1.000278D 00
5	89	8.2628D-02	1.000207D 00

POINT-WISE FLUXES FOR GROUP 1

```
(  1) 0.0          (  2) 8.150433D-01(  3) 1.618111D 00(  4) 2.397402D 00(  5) 3.141468D 00(  6) 3.839373D 00
(  7) 4.480863D 00(  8) 5.056512D 00(  9) 5.557860D 00( 10) 5.977538D 00( 11) 6.309375D 00( 12) 6.548478D 00
( 13) 6.691279D 00( 14) 6.735450D 00( 15) 6.679431D 00( 16) 6.520348D 00( 17) 6.245545D 00( 18) 5.777987D 00
( 19) 5.380977D 00( 20) 5.024948D 00( 21) 4.698052D 00( 22) 4.395019D 00( 23) 4.113065D 00( 24) 3.850376D 00
( 25) 3.605547D 00( 26) 3.377376D 00( 27) 3.164781D 00( 28) 2.966766D 00( 29) 2.782411D 00( 30) 2.610860D 00
( 31) 2.451318D 00( 32) 2.303045D 00( 33) 2.165353D 00( 34) 2.037604D 00( 35) 1.919204D 00( 36) 1.809604D 00
( 37) 1.708294D 00( 38) 1.614804D 00( 39) 1.528699D 00( 40) 1.449577D 00( 41) 1.377070D 00( 42) 1.310838D 00
( 43) 1.250573D 00( 44) 1.195991D 00( 45) 1.146835D 00( 46) 1.102874D 00( 47) 1.063900D 00( 48) 1.029727D 00
( 49) 1.000190D 00( 50) 9.751485D-01( 51) 9.544785D-01( 52) 9.380776D-01( 53) 9.258621D-01( 54) 9.177674D-01
( 55) 9.137470D-01( 56) 9.137728D-01( 57) 9.178346D-01( 58) 9.259402D-01( 59) 9.381152D-01( 60) 9.544032D-01
( 61) 9.748660D-01( 62) 9.995838D-01( 63) 1.028655D 00( 64) 1.062198D 00( 65) 1.100350D 00( 66) 1.143268D 00
( 67) 1.191131D 00( 68) 1.244137D 00( 69) 1.302510D 00( 70) 1.366494D 00( 71) 1.436359D 00( 72) 1.512402D 00
( 73) 1.594948D 00( 74) 1.684357D 00( 75) 1.781038D 00( 76) 1.885478D 00( 77) 1.998336D 00( 78) 2.120674D 00
( 79) 2.254592D 00( 80) 2.404959D 00( 81) 2.584094D 00( 82) 2.688270D 00( 83) 2.745525D 00( 84) 2.761391D 00
( 85) 2.737195D 00( 86) 2.673664D 00( 87) 2.571800D 00( 88) 2.433086D 00( 89) 2.259513D 00( 90) 2.053568D 00
( 91) 1.818203D 00( 92) 1.556789D 00( 93) 1.273071D 00( 94) 9.711140D-01( 95) 6.552437D-01( 96) 3.299857D-01
( 97) 0.0          (
```

TOTAL INTEGRATED FLUX FOR REGION 1 GROUP 1 = 0.188728D 03

TOTAL INTEGRATED FLUX FOR REGION 2 GROUP 1 = 0.314975D 03

TOTAL INTEGRATED FLUX FOR REGION 3 GROUP 1 = 0.770512D 02

```
PCINT-WISE FLUXES FOR GROUP     2
(  1) 0.0           (  2) 6.815568D-02(  3) 1.353099D-01(  4) 2.004760D-01(  5) 2.626963D-01(  6) 3.210566D-01
(  7) 3.746995D-01(  8) 4.228367D-01(  9) 4.647613D-01( 10) 4.998593D-01( 11) 5.276229D-01( 12) 5.476772D-01
( 13) 5.598620D-01( 14) 5.645441D-01( 15) 5.638710D-01( 16) 5.668471D-01( 17) 6.099298D-01( 18) 6.614340D-01
( 19) 6.521300D-01( 20) 6.223402D-01( 21) 5.867779D-01( 22) 5.507426D-01( 23) 5.160777D-01( 24) 4.833625D-01
( 25) 4.527174D-01( 26) 4.241005D-01( 27) 3.974163D-01( 28) 3.725544D-01( 29) 3.494049D-01( 30) 3.278621D-01
( 31) 3.078269D-01( 32) 2.892067D-01( 33) 2.719152D-01( 34) 2.558722D-01( 35) 2.410033D-01( 36) 2.272395D-01
( 37) 2.145168D-01( 38) 2.027760D-01( 39) 1.919626D-01( 40) 1.820261D-01( 41) 1.729203D-01( 42) 1.646025D-01
( 43) 1.570339D-01( 44) 1.501790D-01( 45) 1.440055D-01( 46) 1.384843D-01( 47) 1.335893D-01( 48) 1.292971D-01
( 49) 1.255872D-01( 50) 1.224416D-01( 51) 1.198450D-01( 52) 1.177844D-01( 53) 1.162494D-01( 54) 1.152317D-01
( 55) 1.147257D-01( 56) 1.147276D-01( 57) 1.152364D-01( 58) 1.162528D-01( 59) 1.177801D-01( 60) 1.198239D-01
( 61) 1.223918D-01( 62) 1.254940D-01( 63) 1.291427D-01( 64) 1.333528D-01( 65) 1.381415D-01( 66) 1.435286D-01
( 67) 1.495364D-01( 68) 1.561900D-01( 69) 1.635171D-01( 70) 1.715481D-01( 71) 1.803161D-01( 72) 1.898561D-01
( 73) 2.002027D-01( 74) 2.113842D-01( 75) 2.234059D-01( 76) 2.362046D-01( 77) 2.495241D-01( 78) 2.625764D-01
( 79) 2.731218D-01( 80) 2.749659D-01( 81) 2.511569D-01( 82) 2.317140D-01( 83) 2.295778D-01( 84) 2.292066D-01
( 85) 2.267902D-01( 86) 2.214282D-01( 87) 2.129685D-01( 88) 2.014760D-01( 89) 1.871016D-01( 90) 1.700478D-01
( 91) 1.505581D-01( 92) 1.289114D-01( 93) 1.054179D-01( 94) 8.041401D-02( 95) 5.425807D-02( 96) 2.732478D-02
( 97) C.0           (

TOTAL INTEGRATED FLUX FOR REGION  1 GROUP  2 = 0.159631D 02

TOTAL INTEGRATED FLUX FOR REGION  2 GROUP  2 = 0.388800D 02

TOTAL INTEGRATED FLUX FOR REGION  3 GROUP  2 = 0.645693D 01

     REGION          NORMALIZED POWER

       1               0.2846943D 01
       2               0.1518759D 01
       3               0.1155555D 01

     TOTAL NORMALIZED POWER =  0.1964788D 01
```

BENCHMARK PROBLEM DELAYED SUPERCRITICAL TRANSIENT

TIME ZONE= 2 STEP NUMBER= 400 TIME=0.200000D 01 TIME STEP=0.250000D-02

TEST POINT	MESH POINT	FREQUENCY	EXP(W*H)
1	9	2.2986D-01	1.000575D 00
2	33	2.2262D-01	1.000557D 00
3	49	1.8154D-01	1.000454D 00
4	65	1.0172D-01	1.000254D 00
5	89	7.1430D-02	1.000179D 00

POINT-WISE FLUXES FOR GROUP 1

(1)	0.0	(2)	9.194184D-01	(3)	1.825324D 00	(4)	2.704401D 00	(5)	3.543730D 00	(6)	4.330974D 00
(7)	5.054563D 00	(8)	5.703860D 00	(9)	6.269321D 00	(10)	6.742633D 00	(11)	7.116834D 00	(12)	7.386408D 00
(13)	7.547328D 00	(14)	7.596972D 00	(15)	7.533584D 00	(16)	7.353926D 00	(17)	7.043731D 00	(18)	6.515997D 00
(19)	6.067810D 00	(20)	5.665826D 00	(21)	5.296681D 00	(22)	4.954431D 00	(23)	4.635937D 00	(24)	4.339151D 00
(25)	4.062488D 00	(26)	3.804590D 00	(27)	3.564236D 00	(28)	3.340303D 00	(29)	3.131749D 00	(30)	2.937607D 00
(31)	2.756980D 00	(32)	2.589029D 00	(33)	2.432976D 00	(34)	2.288099D 00	(35)	2.153726D 00	(36)	2.029234D 00
(37)	1.914044D 00	(38)	1.807623D 00	(39)	1.709476D 00	(40)	1.619146D 00	(41)	1.536213D 00	(42)	1.460290D 00
(43)	1.391023D 00	(44)	1.328087D 00	(45)	1.271188D 00	(46)	1.220059D 00	(47)	1.174457D 00	(48)	1.134167D 00
(49)	1.098997D 00	(50)	1.068778D 00	(51)	1.043365D 00	(52)	1.022632D 00	(53)	1.006476D 00	(54)	9.948142D-01
(55)	9.875838D-01	(56)	9.847420D-01	(57)	9.862654D-01	(58)	9.921503D-01	(59)	1.002412D 00	(60)	1.017086D 00
(61)	1.036226D 00	(62)	1.059907D 00	(63)	1.088222D 00	(64)	1.121286D 00	(65)	1.159235D 00	(66)	1.202224D 00
(67)	1.250434D 00	(68)	1.304064D 00	(69)	1.363341D 00	(70)	1.428514D 00	(71)	1.499858D 00	(72)	1.577677D 00
(73)	1.662306D 00	(74)	1.754114D 00	(75)	1.853522D 00	(76)	1.961034D 00	(77)	2.077332D 00	(78)	2.203515D 00
(79)	2.341762D 00	(80)	2.497123D 00	(81)	2.682382D 00	(82)	2.790085D 00	(83)	2.849133D 00	(84)	2.865275D 00
(85)	2.839893D 00	(86)	2.773746D 00	(87)	2.667877D 00	(88)	2.523824D 00	(89)	2.343653D 00	(90)	2.129942D 00
(91)	1.885752D 00	(92)	1.614575D 00	(93)	1.320293D 00	(94)	1.007116D 00	(95)	6.795260D-01	(96)	3.422117D-01
(97)	0.0	(									

TOTAL INTEGRATED FLUX FOR REGION 1 GROUP 1 = 0.212878D 03

TOTAL INTEGRATED FLUX FOR REGION 2 GROUP 1 = 0.346607D 03

TOTAL INTEGRATED FLUX FOR REGION 3 GROUP 1 = 0.799352D 02

```
POINT-WISE FLUXES FOR GROUP     2
 (   1) 0.0            (   2) 7.688361D-02(   3) 1.526372D-01(   4) 2.261474D-01(   5) 2.963338D-01(   6) 3.621647D-01
 (   7) 4.226727D-01(   8) 4.769684D-01(   9) 5.242544D-01(  10) 5.638378D-01(  11) 5.951458D-01(  12) 6.177558D-01
 (  13) 6.314868D-01(  14) 6.367528D-01(  15) 6.359758D-01(  16) 6.393100D-01(  17) 6.878687D-01(  18) 7.459076D-01
 (  19) 7.353619D-01(  20) 7.017088D-01(  21) 6.615429D-01(  22) 6.208413D-01(  23) 5.816829D-01(  24) 5.447208D-01
 (  25) 5.100910D-01(  26) 4.777459D-01(  27) 4.475776D-01(  28) 4.194616D-01(  29) 3.932735D-01(  30) 3.688939D-01
 (  31) 3.462109D-01(  32) 3.251197D-01(  33) 3.055225D-01(  34) 2.873288D-01(  35) 2.704540D-01(  36) 2.548201D-01
 (  37) 2.403544D-01(  38) 2.269898D-01(  39) 2.146642D-01(  40) 2.033203D-01(  41) 1.929052D-01(  42) 1.833704D-01
 (  43) 1.746714D-01(  44) 1.667675D-01(  45) 1.596217D-01(  46) 1.532002D-01(  47) 1.474729D-01(  48) 1.424127D-01
 (  49) 1.379953D-01(  50) 1.341997D-01(  51) 1.310074D-01(  52) 1.284028D-01(  53) 1.263729D-01(  54) 1.249074D-01
 (  55) 1.239982D-01(  56) 1.236401D-01(  57) 1.238301D-01(  58) 1.245676D-01(  59) 1.258548D-01(  60) 1.276958D-01
 (  61) 1.300977D-01(  62) 1.330696D-01(  63) 1.366233D-01(  64) 1.407733D-01(  65) 1.455366D-01(  66) 1.509327D-01
 (  67) 1.569841D-01(  68) 1.637160D-01(  69) 1.711567D-01(  70) 1.793370D-01(  71) 1.882907D-01(  72) 1.980536D-01
 (  73) 2.086611D-01(  74) 2.201423D-01(  75) 2.325022D-01(  76) 2.456750D-01(  77) 2.593943D-01(  78) 2.728423D-01
 (  79) 2.836940D-01(  80) 2.855205D-01(  81) 2.607280D-01(  82) 2.404972D-01(  83) 2.382448D-01(  84) 2.378315D-01
 (  85) 2.353010D-01(  86) 2.297186D-01(  87) 2.209262D-01(  88) 2.089913D-01(  89) 1.940703D-01(  90) 1.763733D-01
 (  91) 1.561526D-01(  92) 1.336974D-01(  93) 1.093289D-01(  94) 8.339576D-02(  95) 5.626919D-02(  96) 2.833736D-02
 (  97) 0.0            (

TOTAL  INTEGRATED FLUX FOR REGION  1 GROUP  2 = 0.180057D 02

TOTAL  INTEGRATED FLUX FOR REGION  2 GROUP  2 = 0.427845D 02

TOTAL  INTEGRATED FLUX FOR REGION  3 GROUP  2 = 0.669875D 01

        REGION           NORMALIZED POWER

          1                0.3211227D 01
          2                0.2111448D 01
          3                0.1198822D 01

        TOTAL NORMALIZED POWER =  0.2163664D 01
```

```
BENCHMARK PROBLEM DELAYED SUPERCRITICAL TRANSIENT

TIME ZCNE= 2  STEP NUMBER= 800  TIME=0.3CCOCCD 01  TIME STEP=0.250000D-02


TEST POINT       MESH POINT        FREQUENCY         EXP(W*H)
    1                 9            2.1020D-01        1.000526D 00
    2                33            2.0531D-01        1.000513D 00
    3                49            1.7534D-01        1.000438D 00
    4                65            1.1004D-01        1.000275D 00
    5                89            8.2413D-02        1.000206D 00

POINT-WISE FLUXES FOR GROUP    1
 (  1) 0.0            (  2) 1.149721D 00(  3) 2.282538D 00(  4) 3.381793D 00(  5) 4.431324D 00(  6) 5.415700D 00
 (  7) 6.320445D 00(  8) 7.132257D 00(  9) 7.839198D 0C( 10) 8.430870D 00( 11) 8.898570D 00( 12) 9.235398D 00
 ( 13) 9.436324D 00( 14) 9.498073D 00( 15) 9.418454D 00( 16) 9.193428D 00( 17) 8.805172D 00( 18) 8.144696D 00
 ( 19) 7.583631D 00( 20) 7.08C289D 00( 21) 6.617962D 00( 22) 6.189222D 00( 23) 5.790140D 00( 24) 5.418156D 00
 ( 25) 5.071287D 00( 26) 4.747834D 00( 27) 4.446267D 00( 28) 4.165178D 00( 29) 3.903264D 00( 30) 3.659312D 00
 ( 31) 3.432194D 00( 32) 3.220859D 00( 33) 3.C24331D 00( 34) 2.8417C0D 00( 35) 2.672121D 00( 36) 2.514808D 00
 ( 37) 2.369035D C0( 38) 2.234125D 00( 39) 2.109452D 00( 40) 1.994440D 00( 41) 1.888553D 00( 42) 1.791299D 00
 ( 43) 1.702226D 00( 44) 1.620919D 00( 45) 1.546999D 00( 46) 1.480120D 00( 47) 1.419967D 00( 48) 1.366259D 00
 ( 49) 1.318742D 00( 50) 1.277190D 00( 51) 1.241405D 00( 52) 1.211215D 00( 53) 1.186473D 00( 54) 1.167057D 00
 ( 55) 1.152869D 00( 56) 1.143833D C0( 57) 1.139898D 00( 58) 1.141036D 00( 59) 1.147240D 00( 60) 1.158527D 00
 ( 61) 1.174935D 00( 62) 1.196527D 00( 63) 1.223387D 00( 64) 1.255623D 00( 65) 1.293368D 00( 66) 1.336776D 00
 ( 67) 1.386029D C0( 68) 1.441334D 00( 69) 1.502924D 00( 70) 1.571059D 00( 71) 1.646029D 00( 72) 1.728155D 00
 ( 73) 1.817792D 00( 74) 1.915334D 00( 75) 2.021232D 0C( 76) 2.136027D 00( 77) 2.260454D 00( 78) 2.395700D 00
 ( 79) 2.544126D 00( 80) 2.711206D 00( 81) 2.910805D 00( 82) 3.026774D 00( 83) 3.090046D 00( 84) 3.106879D 00
 ( 85) 3.078783D 00( 86) 3.006588D 00( 87) 2.891431D 00( 88) 2.734979D 00( 89) 2.539473D 00( 90) 2.307705D 00
 ( 91) 2.042984D 00( 92) 1.749091D 00( 93) 1.430221D 0C( 94) 1.090928D 00( 95) 7.360571D-01( 96) 3.706751D-01
 ( 97) C.0            (

TOTAL  INTEGRATED  FLUX  FOR  REGION   1  GROUP   1  =  0.266167D  03

TOTAL  INTEGRATED  FLUX  FOR  REGION   2  GROUP   1  =  0.416870D  03

TOTAL  INTEGRATED  FLUX  FOR  REGION   3  GROUP   1  =  0.866450D  02
```

PCINT-WISE FLUXES FCR GROUP 2

(1)	0.0	(2)	9.614179D-02	(3)	1.908700D-01	(4)	2.827917D-01	(5)	3.705554D-01	(6)	4.528707D-01
(7)	5.285272D-01	(8)	5.964127D-01	(9)	6.555296D-01	(10)	7.050114D-01	(11)	7.441421D-01	(12)	7.723928D-01
(13)	7.895378D-01	(14)	7.960947D-01	(15)	7.950908D-01	(16)	7.992188D-01	(17)	8.598661D-01	(18)	9.323328D-01
(19)	9.190535D-01	(20)	8.768818D-01	(21)	8.265634D-01	(22)	7.755704D-01	(23)	7.265018D-01	(24)	6.801738D-01
(25)	6.367562D-01	(26)	5.961894D-01	(27)	5.583380D-01	(28)	5.230461D-01	(29)	4.901577D-01	(30)	4.595234D-01
(31)	4.310023D-01	(32)	4.044632D-01	(33)	3.797832D-01	(34)	3.568485D-01	(35)	3.355527D-01	(36)	3.157974D-01
(37)	2.974910D-01	(38)	2.805489D-01	(39)	2.648924D-01	(40)	2.504488D-01	(41)	2.371513D-01	(42)	2.249379D-01
(43)	2.137518D-01	(44)	2.035409D-01	(45)	1.942575D-01	(46)	1.858583D-01	(47)	1.783038D-01	(48)	1.715585D-01
(49)	1.655906D-01	(50)	1.603717D-01	(51)	1.558771D-01	(52)	1.520849D-01	(53)	1.489769D-01	(54)	1.465376D-01
(55)	1.447547D-01	(56)	1.436187D-01	(57)	1.431233D-01	(58)	1.432648D-01	(59)	1.440424D-01	(60)	1.454581D-01
(61)	1.475169D-01	(62)	1.502265D-01	(63)	1.535976D-01	(64)	1.576437D-01	(65)	1.623813D-01	(66)	1.678300D-01
(67)	1.740126D-01	(68)	1.809548D-01	(69)	1.886859D-01	(70)	1.972382D-01	(71)	2.066471D-01	(72)	2.169504D-01
(73)	2.281856D-01	(74)	2.403832D-01	(75)	2.535481D-01	(76)	2.676080D-01	(77)	2.822734D-01	(78)	2.966567D-01
(79)	3.082352D-01	(80)	3.100344D-01	(81)	2.829684D-01	(82)	2.609140D-01	(83)	2.583970D-01	(84)	2.578903D-01
(85)	2.550981D-01	(86)	2.490057D-01	(87)	2.394418D-01	(88)	2.264795D-01	(89)	2.102884D-01	(90)	1.910958D-01
(91)	1.691748D-01	(92)	1.448382D-01	(93)	1.184333D-01	(94)	9.033722D-02	(95)	6.095116D-02	(96)	3.069474D-02
(97)	0.0	(									

TOTAL INTEGRATED FLUX FOR REGICN 1 GROUP 2 = 0.225128D 02

TOTAL INTEGRATED FLUX FOR REGION 2 GROUP 2 = 0.514575D 02

TOTAL INTEGRATED FLUX FOR REGION 3 GROUP 2 = 0.726131D 01

PRECURSOR CONCENTRATICN FOR DELAYED GROUP 1

(1)	0.0	(2)	1.803788D-04	(3)	3.581517D-04	(4)	5.307505D-04	(5)	6.956817D-04	(6)	8.505627D-04
(7)	9.931559D-04	(8)	1.121402D-03	(9)	1.233448D-03	(10)	1.327679D-03	(11)	1.402748D-03	(12)	1.457625D-03
(13)	1.491740D-03	(14)	1.505514D-03	(15)	1.502474D-03	(16)	1.497864D-03	(17)	1.162755D-03	(18)	7.998326D-04
(19)	7.789400D-04	(20)	7.420754D-04	(21)	7.012570D-04	(22)	6.607910D-04	(23)	6.221540D-04	(24)	5.857889D-04
(25)	5.517652D-04	(26)	5.200211D-04	(27)	4.904529D-04	(28)	4.629466D-04	(29)	4.373903D-04	(30)	4.136774D-04
(31)	3.917084D-04	(32)	3.713907D-04	(33)	3.526384D-04	(34)	3.353725D-04	(35)	3.195200D-04	(36)	3.050138D-04
(37)	2.917927D-04	(38)	2.798007D-04	(39)	2.689872D-04	(40)	2.593065D-04	(41)	2.507174D-04	(42)	2.431838D-04
(43)	2.366736D-04	(44)	2.311592D-04	(45)	2.266173D-04	(46)	2.230284D-04	(47)	2.203774D-04	(48)	2.186527D-04
(49)	2.178470D-04	(50)	2.179567D-04	(51)	2.189819D-04	(52)	2.209269D-04	(53)	2.237994D-04	(54)	2.276115D-04
(55)	2.323788D-04	(56)	2.381213D-04	(57)	2.448627D-04	(58)	2.526313D-04	(59)	2.614593D-04	(60)	2.713837D-04
(61)	2.824459D-04	(62)	2.946922D-04	(63)	3.081737D-04	(64)	3.229467D-04	(65)	3.390731D-04	(66)	3.566204D-04
(67)	3.756617D-04	(68)	3.962769D-04	(69)	4.185520D-04	(70)	4.425795D-04	(71)	4.684588D-04	(72)	4.962942D-04
(73)	5.261916D-04	(74)	5.582477D-04	(75)	5.925184D-04	(76)	6.289355D-04	(77)	6.670750D-04	(78)	7.055304D-04
(79)	7.402049D-04	(80)	7.596703D-04	(81)	1.103691D-03	(82)	1.421156D-03	(83)	1.425157D-03	(84)	1.427759D-03
(85)	1.414465D-03	(86)	1.381925D-03	(87)	1.329740D-03	(88)	1.258448D-03	(89)	1.169027D-03	(90)	1.062753D-03
(91)	9.411546D-04	(92)	8.059854D-04	(93)	6.591940D-04	(94)	5.028971D-04	(95)	3.393485D-04	(96)	1.709065D-04
(97)	0.0	(									

```
PRECURSOR CONCENTRATICN FOR DELAYED GROUP    2
 (  1) 0.0          (  2) 5.202140D-04(  3) 1.032898D-03(  4) 1.530631D-03(  5) 2.006207D-03(  6) 2.452744D-03
 (  7) 2.863777D-03(  8) 3.233357D-03(  9) 3.556137D-03( 10) 3.827455D-03( 11) 4.043421D-03( 12) 4.201067D-03
 ( 13) 4.298755D-03( 14) 4.337696D-03( 15) 4.328029D-03( 16) 4.313528D-03( 17) 3.346854D-03( 18) 2.300653D-03
 ( 19) 2.239344D-03( 20) 2.132259D-03( 21) 2.013911D-03( 22) 1.896660D-03( 23) 1.784739D-03( 24) 1.679410D-03
 ( 25) 1.580864D-03( 26) 1.488915D-03( 27) 1.403259D-03( 28) 1.323560D-03( 29) 1.249491D-03( 30) 1.180738D-03
 ( 31) 1.117011D-03( 32) 1.058036D-03( 33) 1.003563D-03( 34) 9.533580D-04( 35) 9.072072D-04( 36) 8.649130D-04
 ( 37) 8.262944D-04( 38) 7.911862D-04( 39) 7.594381D-04( 40) 7.309139D-04( 41) 7.054914D-04( 42) 6.830614D-04
 ( 43) 6.635275D-04( 44) 6.468056D-04( 45) 6.328235D-04( 46) 6.215206D-04( 47) 6.128478D-04( 48) 6.067670D-04
 ( 49) 6.032510D-04( 50) 6.022838D-04( 51) 6.038598D-04( 52) 6.079844D-04( 53) 6.146737D-04( 54) 6.239546D-04
 ( 55) 6.358649D-04( 56) 6.504537D-04( 57) 6.677811D-04( 58) 6.879190D-04( 59) 7.109509D-04( 60) 7.369727D-04
 ( 61) 7.660927D-04( 62) 7.984325D-04( 63) 8.341269D-04( 64) 8.733250D-04( 65) 9.161906D-04( 66) 9.629030D-04
 ( 67) 1.013657D-03( 68) 1.068666D-03( 69) 1.128158D-03( 70) 1.192382D-03( 71) 1.261602D-03( 72) 1.336098D-03
 ( 73) 1.416154D-03( 74) 1.502027D-03( 75) 1.593868D-03( 76) 1.691493D-03( 77) 1.793760D-03( 78) 1.896890D-03
 ( 79) 1.989872D-03( 80) 2.041990D-03( 81) 2.966455D-03( 82) 3.819502D-03( 83) 3.830079D-03( 84) 3.836930D-03
 ( 85) 3.801086D-03( 86) 3.713542D-03( 87) 3.573225D-03( 88) 3.381587D-03( 89) 3.141249D-03( 90) 2.855642D-03
 ( 91) 2.528875D-03( 92) 2.165655D-03( 93) 1.771217D-03( 94) 1.351248D-03( 95) 9.118008D-04( 96) 4.592101D-04
 ( 97) 0.0          (

PRECURSOR CONCENTRATICN FOR DELAYED GROUP    3
 (  1) 0.0          (  2) 1.669688D-04(  3) 3.315071D-04(  4) 4.912201D-04(  5) 6.437829D-04(  6) 7.869747D-04
 (  7) 9.187114D-04(  8) 1.037075D-03(  9) 1.140345D-03( 10) 1.227019D-03( 11) 1.295849D-03( 12) 1.345883D-03
 ( 13) 1.376598D-03( 14) 1.388380D-03( 15) 1.384455D-03( 16) 1.378700D-03( 17) 1.068238D-03( 18) 7.328779D-04
 ( 19) 7.122372D-04( 20) 6.771659D-04( 21) 6.386074D-04( 22) 6.004748D-04( 23) 5.641021D-04( 24) 5.298817D-04
 ( 25) 4.978663D-04( 26) 4.679896D-04( 27) 4.401475D-04( 28) 4.142275D-04( 29) 3.901191D-04( 30) 3.677175D-04
 ( 31) 3.469245D-04( 32) 3.276485D-04( 33) 3.098047D-04( 34) 2.933144D-04( 35) 2.781048D-04( 36) 2.641088D-04
 ( 37) 2.512646D-04( 38) 2.395153D-04( 39) 2.288091D-04( 40) 2.190984D-04( 41) 2.103402D-04( 42) 2.024955D-04
 ( 43) 1.955294D-04( 44) 1.894108D-04( 45) 1.841123D-04( 46) 1.796100D-04( 47) 1.758834D-04( 48) 1.729157D-04
 ( 49) 1.706929D-04( 50) 1.692046D-04( 51) 1.684433D-04( 52) 1.684049D-04( 53) 1.690882D-04( 54) 1.704952D-04
 ( 55) 1.726311D-04( 56) 1.755039D-04( 57) 1.791251D-04( 58) 1.835092D-04( 59) 1.886740D-04( 60) 1.946408D-04
 ( 61) 2.014340D-04( 62) 2.090817D-04( 63) 2.176157D-04( 64) 2.270715D-04( 65) 2.374883D-04( 66) 2.489097D-04
 ( 67) 2.613833D-04( 68) 2.749613D-04( 69) 2.897005D-04( 70) 3.056621D-04( 71) 3.229121D-04( 72) 3.415203D-04
 ( 73) 3.615575D-04( 74) 3.830884D-04( 75) 4.061500D-04( 76) 4.306948D-04( 77) 4.564325D-04( 78) 4.824023D-04
 ( 79) 5.058079D-04( 80) 5.188490D-04( 81) 7.534894D-04( 82) 9.699449D-04( 83) 9.724587D-04( 84) 9.740579D-04
 ( 85) 9.648415D-04( 86) 9.425220D-04( 87) 9.068278D-04( 88) 8.581271D-04( 89) 7.970855D-04( 90) 7.245729D-04
 ( 91) 6.416308D-04( 92) 5.494526D-04( 93) 4.493651D-04( 94) 3.428091D-04( 95) 2.313182D-04( 96) 1.164976D-04
 ( 97) 0.0          (
```

PRECURSOR CONCENTRATICN FOR DELAYED GROUP 4

(1) 0.0	(2) 1.762669D-04	(3) 3.499543D-04	(4) 5.185206D-04	(5) 6.794989D-04	(6) 8.305336D-04
(7) 9.694144D-04	(8) 1.094109D-03	(9) 1.202794D-03	(10) 1.293880D-03	(11) 1.366050D-03	(12) 1.418298D-03
(13) 1.450074D-03	(14) 1.461787D-03	(15) 1.456808D-03	(16) 1.449618D-03	(17) 1.121670D-03	(18) 7.680740D-04
(19) 7.453076D-04	(20) 7.075710D-04	(21) 6.662817D-04	(22) 6.255158D-04	(23) 5.866574D-04	(24) 5.501077D-04
(25) 5.159133D-04	(26) 4.839976D-04	(27) 4.542447D-04	(28) 4.265305D-04	(29) 4.007333D-04	(30) 3.767377D-04
(31) 3.544355D-04	(32) 3.337258D-04	(33) 3.145147D-04	(34) 2.967153D-04	(35) 2.802466D-04	(36) 2.650341D-04
(37) 2.510085D-04	(38) 2.381061D-04	(39) 2.262682D-04	(40) 2.154408D-04	(41) 2.055747D-04	(42) 1.966246D-04
(43) 1.885496D-04	(44) 1.813126D-04	(45) 1.748803D-04	(46) 1.692230D-04	(47) 1.643143D-04	(48) 1.601313D-04
(49) 1.566543D-04	(50) 1.538666D-04	(51) 1.517547D-04	(52) 1.503080D-04	(53) 1.495189D-04	(54) 1.493824D-04
(55) 1.498969D-04	(56) 1.510631D-04	(57) 1.528849D-04	(58) 1.553689D-04	(59) 1.585247D-04	(60) 1.623646D-04
(61) 1.669041D-04	(62) 1.721617D-04	(63) 1.781587D-04	(64) 1.849199D-04	(65) 1.924734D-04	(66) 2.008505D-04
(67) 2.100861D-04	(68) 2.202188D-04	(69) 2.312910D-04	(70) 2.433488D-04	(71) 2.564422D-04	(72) 2.706243D-04
(73) 2.859490D-04	(74) 3.024657D-04	(75) 3.202024D-04	(76) 3.391206D-04	(77) 3.589920D-04	(78) 3.790626D-04
(79) 3.971398D-04	(80) 4.071088D-04	(81) 5.908811D-04	(82) 7.603349D-04	(83) 7.620803D-04	(84) 7.631499D-04
(85) 7.557759D-04	(86) 7.381648D-04	(87) 7.101038D-04	(88) 6.718819D-04	(89) 6.240200D-04	(90) 5.671984D-04
(91) 5.022315D-04	(92) 4.300519D-04	(93) 3.516960D-04	(94) 2.682892D-04	(95) 1.810292D-04	(96) 9.116927D-05
(97) 0.0	(				

PRECURSOR CONCENTRATICN FOR CELAYEC GROUP 5

(1) 0.0	(2) 2.104079D-05	(3) 4.177242D-05	(4) 6.189025D-05	(5) 8.109869D-05	(6) 9.911549D-05
(7) 1.156759D-04	(8) 1.305366D-04	(9) 1.434793D-04	(10) 1.543143D-04	(11) 1.628837D-04	(12) 1.690679D-04
(13) 1.728016D-04	(14) 1.741331D-04	(15) 1.734624D-04	(16) 1.725023D-04	(17) 1.333391D-04	(18) 9.117195D-05
(19) 8.836489D-05	(20) 8.379432D-05	(21) 7.881093D-05	(22) 7.389645D-05	(23) 6.921388D-05	(24) 6.480993D-05
(25) 6.068941D-05	(26) 5.684254D-05	(27) 5.325496D-05	(28) 4.991136D-05	(29) 4.679677D-05	(30) 4.389697D-05
(31) 4.119863D-05	(32) 3.868931D-05	(33) 3.635741D-05	(34) 3.419218D-05	(35) 3.218359D-05	(36) 3.032235D-05
(37) 2.859986D-05	(38) 2.700813D-05	(39) 2.553979D-05	(40) 2.418803D-05	(41) 2.294658D-05	(42) 2.180965D-05
(43) 2.077197D-05	(44) 1.982869D-05	(45) 1.897540D-05	(46) 1.820810D-05	(47) 1.752318D-05	(48) 1.691742D-05
(49) 1.638794D-05	(50) 1.593220D-05	(51) 1.554803D-05	(52) 1.523353D-05	(53) 1.498716D-05	(54) 1.480767D-05
(55) 1.469409D-05	(56) 1.464577D-05	(57) 1.466235D-05	(58) 1.474374D-05	(59) 1.489016D-05	(60) 1.510211D-05
(61) 1.538037D-05	(62) 1.572601D-05	(63) 1.614043D-05	(64) 1.662529D-05	(65) 1.718258D-05	(66) 1.781461D-05
(67) 1.852401D-05	(68) 1.931373D-05	(69) 2.018709D-05	(70) 2.114774D-05	(71) 2.219968D-05	(72) 2.334719D-05
(73) 2.459466D-05	(74) 2.594609D-05	(75) 2.740368D-05	(76) 2.896405D-05	(77) 3.060770D-05	(78) 3.227059D-05
(79) 3.376670D-05	(80) 3.457745D-05	(81) 5.014022D-05	(82) 6.448000D-05	(83) 6.459725D-05	(84) 6.466282D-05
(85) 6.401706D-05	(86) 6.250782D-05	(87) 6.011713D-05	(88) 5.686948D-05	(89) 5.280895D-05	(90) 4.799304D-05
(91) 4.249052D-05	(92) 3.638005D-05	(93) 2.974907D-05	(94) 2.269244D-05	(95) 1.531112D-05	(96) 7.710721D-06
(97) 0.0	(				

```
PRECURSOR CONCENTRATION FOR DELAYED GROUP   6
 (  1) 0.0          (  2) 3.389853D-06(  3) 6.729870D-06(  4) 9.970947D-06(  5) 1.306543D-05(  6) 1.596783D-05
 (  7) 1.863548D-05(  8) 2.102915D-05(  9) 2.311368D-05( 10) 2.485846D-05( 11) 2.623810D-05( 12) 2.723331D-05
 ( 13) 2.783357D-05( 14) 2.804667D-05( 15) 2.793701D-05( 16) 2.778023D-05( 17) 2.147059D-05( 18) 1.467811D-05
 ( 19) 1.422397D-05( 20) 1.348609D-05( 21) 1.268187D-05( 22) 1.188883D-05( 23) 1.113319D-05( 24) 1.042246D-05
 ( 25) 9.757400D-06( 26) 9.136421D-06( 27) 8.557201D-06( 28) 8.017264D-06( 29) 7.514188D-06( 30) 7.045673D-06
 ( 31) 6.609563D-06( 32) 6.203845D-06( 33) 5.826641D-06( 34) 5.476208D-06( 35) 5.150923D-06( 36) 4.849280D-06
 ( 37) 4.569881D-06( 38) 4.311432D-06( 39) 4.072732D-06( 40) 3.852675D-06( 41) 3.650237D-06( 42) 3.464478D-06
 ( 43) 3.294531D-06( 44) 3.139605D-06( 45) 2.998974D-06( 46) 2.871982D-06( 47) 2.758030D-06( 48) 2.656583D-06
 ( 49) 2.567160D-06( 50) 2.489336D-06( 51) 2.422737D-06( 52) 2.367042D-06( 53) 2.321979D-06( 54) 2.287321D-06
 ( 55) 2.262892D-06( 56) 2.248560D-06( 57) 2.244237D-06( 58) 2.249881D-06( 59) 2.265495D-06( 60) 2.291126D-06
 ( 61) 2.326865D-06( 62) 2.372848D-06( 63) 2.429256D-06( 64) 2.496316D-06( 65) 2.574303D-06( 66) 2.663539D-06
 ( 67) 2.764395D-06( 68) 2.877293D-06( 69) 3.002707D-06( 70) 3.141163D-06( 71) 3.293238D-06( 72) 3.459553D-06
 ( 73) 3.640743D-06( 74) 3.837392D-06( 75) 4.049816D-06( 76) 4.277507D-06( 77) 4.517590D-06( 78) 4.760624D-06
 ( 79) 4.979199D-06( 80) 5.096911D-06( 81) 7.388660D-06( 82) 9.499793D-06( 83) 9.515526D-06( 84) 9.523926D-06
 ( 85) 9.427764D-06( 86) 9.204620D-06( 87) 8.851849D-06( 88) 8.373061D-06( 89) 7.774745D-06( 90) 7.065362D-06
 ( 91) 6.255028D-06( 92) 5.355315D-06( 93) 4.379077D-06( 94) 3.340263D-06( 95) 2.253719D-06( 96) 1.134969D-06
 ( 97) 0.0          (

          REGION          NORMALIZED POWER

             1              0.4015066D 01
             2              0.2539472D 01
             3              0.1299482D 01

          TOTAL NORMALIZED POWER =  0.2605205D 01
 BENCHMARK PROBLEM DELAYED SUPERCRITICAL TRANSIENT
END OF PROBLEM

IHC900I EXECUTION TERMINATING DUE TO ERROR COUNT FOR ERROR NUMBER  217

IHC217I FIOCS - END OF DATA SET ON UNIT    5
```

Appendix Code Listing

```
C     MAIN PROGRAM
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER RTAG
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,OUT,
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT
      REAL*8 IODINE
      REAL*8 LR,NU,NUSIGF,NX
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY
      COMMON /A3/PUNBAL,SORCE,GEOM,NTAG,NUM2,PUNFRS
      COMMON /A4/TIGHT1,TIGHT2,TIGHT3
      COMMON/A5/IN,OUT,NERR
      COMMON/C1/M1,M2,M4,M5,M7
C FOR CONSERVATION OF CORE RECOMPILE MAIN WITH THE FOLLOWING DIMENSIONS
C ALTERED TO ACCOMODATE THE MAXIMUM EXPECTED PROBLEM SIZE.  THE VARIABLE
C IN (   ) INDICATE THE DIMENSION INFORMATION TO BE PUNCHED ON SUBSEQUENT
C CARDS, WHERE,
C     GRP IS THE # OF NEUTRON GROUPS
C     REG IS THE # OF REGIONS
C     DEL IS THE # OF DELAYED GROUP
C     PT IS THE # OF SPACE POINTS
C     NUM IS THE # OF TEST POINTS
C     (PT,GRP+DEL)
      DIMENSION PSI(100,16)
C     (GRP,DEL)  ***** IF DEL EQUALS 0: (GRP,1) *****
      DIMENSION SD(10,6),SDIN(10,6)
C     (GRP)
      DIMENSION CHI(10),NU(10),NX(10),TD(10),V(10),VINV(10)
      DIMENSION SIGCIN(10),SIGFIN(10),SIGTIN(10)
C     (GRP+1,GRP)
      DIMENSION SIGXIN(11,10)
C     (REG)
      DIMENSION POWREG(10),POWORG(10),REGFR(10),WCOEFL(10),WCOEFR(10)
      DIMENSION NCMP(10),FUEL(10),CHANGE(10),SOR(10),CXL(10),CXQ(10),
```

```
     1DR(10),LR(10),PB(10),IPL(10),IPR(10),XL(10),XR(10),RTAG(10),
     2TAGC(10),TAGF(10),TAGT(10),TAGX(10),TI1(10),IODINE(10),XENON(10)
C      (REG,GRP)
      DIMENSION CCL(10,10),CCQ(10,10),CFL(10,10),CFQ(10,10),CTRL(10,10),
     1CTRQ(10,10),SIGC(10,10),SIGF(10,10),SIGT(10,10),NUSIGF(10,10),
     2DNSCAT(10,10),UPSCAT(10,10),SORG(10,10),D(10,10),XABS(10,10),
     3PSIBAR(10,10),PSITOT(10,10),PSI81(10,10),POWER(10,10)
C      (REG,GRP,GRP)
      DIMENSION SIGX(10,10,10)
C      (PT)
      DIMENSION WHZ(100),WZ(100),FF1(100),FF2(100),WCOEF(100)
      DIMENSION DPSI(100),DD(100),DL(100),DU(100),WA(100),GA(100)
C      (PT,GRP)
      DIMENSION SRCE0(100,10),SRCE1(100,10),CM(100,10),CP(100,10)
C      (NUM)
      DIMENSION WPT(50),PSISTO(50)
C      (NUM2)
      DIMENSION STPRN(50)
C      MAXIMUM # OF PRINT TIMES (NUM2) IS FIXED AT 50
C      M1= MAX # OF REGIONS
      M1=10
C      M2= MAX # OF NEUTRON GROUPS
      M2=10
C      M4= MAX # OF DELAYED GROUPS
      M4=6
C      M5= MAX # OF SPACE POINTS
      M5=100
C      M7= MAX # OF TEST POINTS (NUM)
      M7=50
      IN=5
      OUT=6
 100  NERR=0
      CALL INPTA1
      CALL      DIRECT(PSI,SIGC,SIGF,SIGT,SIGX,NU,SD,SDIN,CHI,NCMP,
     1FUEL,XABS,XENON,IODINE,LR,IPL,IPR,PB,XL,XR,DR,WHZ,WZ,WPT,NX,
     2NUSIGF,DNSCAT,UPSCAT,REGFR,WCOEF,WCOEFL,WCOEFR,D,CHANGE,CM,CP,
```

```
3SOR,SORG,SRCEO,SRCE1,STPRN,RTAG,TAGC,TAGF,TAGT,TAGX,CCL,CCQ,CFL,         MAINC073
4CFQ,CTRL,CTRQ,CXL,CXQ,V,VINV,PSITOT,POWREG,POWORG,POWER,PSISTC,          MAINC074
5DD,DL,DU,FF1,FF2,TI1,SIGCIN,SIGFIN,SIGTIN,SIGXIN,PSIB1,TO,               MAINC075
6WA,GA,DPSI,PSIBAR)                                                       MAINC076
 CALL TITLE(4)                                                            MAINC077
 GO TO 100                                                                MAINC078
 END                                                                      MAINC079
```

```
      SUBROUTINE AVRAGE(PSI,PSIBAR,PSITOT,POWER,WCOEF,WCOEFL,WCOEFR,
     1REGFR, IPL,IPR,SIGF,POWREG,POWORG)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CLT,
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT
      INTEGER   RBOUND , RINT
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      COMMON /A9/POWTOT,POWBAR
      COMMON /B2/NPRT,NZ,ISX,STEP,NZSAVE,PRBEND,IPRN
      DIMENSION PSI(PT,GU)
      DIMENSION PSIBAR(REG,GRP)
      DIMENSION PSITOT(REG,GRP)
      DIMENSION POWREG(REG)
      DIMENSION POWORG(REG)
      DIMENSION POWER(REG,GRP)
      DIMENSION IPL(REG),IPR(REG)
      DIMENSION REGFR(REG),WCOEF(PT),WCOEFL(REG),WCOEFR(REG)
      DIMENSION SIGF(REG,GRP)
      DO 120 R=1,REG
      RINT=IPR(R)
      LINT=IPL(R)
      RBOUND=RINT+1
      LBOUND=LINT-1
      DO 120 G=1,GRP
      X=0.0
      DO 110 P=LINT,RINT
  110 X=X+PSI(P,G)*WCOEF(P)
      X=X+PSI(LBOUND,G)*WCOEFL(R)+PSI(RBOUND,G)*WCOEFR(R)
      PSITOT(R,G)=X
      PSIBAR(R,G)=X/REGFR(R)
      POWER(R,G)=SIGF(R,G)*X
  120 CONTINUE
      POWTOT=0.0D0
      DO 130 R=1,REG
```

```
      POWREG(R)=0.0D0
      DO 125 G=1,GRP
      POWREG(R)=POWREG(R)+POWER(R,G)
  125 CONTINUE
      POWTOT=POWTOT+POWREG(R)
      IF(POWORG(R).EQ.0.0D0) GO TO 130
      POWREG(R)=POWREG(R)/POWORG(R)
  130 CONTINUE
      IF(POWBAR.EQ.0.0D0) GO TO 140
      POWTOT=POWTOT/POWBAR
 140  RETURN
      END
```

```
      SUBROUTINE CALC(PSI,WHZ,WZ,NX,NUSIGF,SIGX,SD,SDIN,STPRN,FUEL,WPT,       CALCC001
     1XL,XR,PB,IPL,IPR,VINV,UPSCAT,DNSCAT,SORG,SOR,SRCE0,SRCE1,CP,CM,         CALCC002
     2FF1,FF2,TI1,DU,DL,DD,TD,WA,GA,DPSI)                                     CALCC003
      IMPLICIT REAL*8 (A-H,O-Z)                                               CALCC004
      REAL*8 LR,NU,NUSIGF,NX                                                  CALCC005
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,                   CALCC006
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CUT,      CALCC007
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,        CALCC008
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT       CALCC009
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL                                CALCC010
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY                         CALCC011
      COMMON /A3/PUNBAL,SORCE,GEOM,NTAG,NUM2,PUNFRS                           CALCC012
      COMMON /A7/BETA(6),DECAY(6),BETDCY(6),DECH(6)                           CALCC013
      COMMON /B1/H,HP,TIME,TZ,ZERO,TZO,TIMZ                                   CALCC014
      DIMENSION PSI(PT,GU)                                                    CALCC015
      DIMENSION WHZ(PT)                                                       CALCC016
      DIMENSION SIGX(REG,GRP,GRP)                                             CALCC017
      DIMENSION NX(GRP),NUSIGF(REG,GRP)                                       CALCC018
      DIMENSION SD(GRP,IDEL)                                                  CALCC019
      DIMENSION SDIN(GRP,IDEL)                                                CALCC020
      DIMENSION STPRN(50)                                                     CALCC021
      DIMENSION FUEL(REG)                                                     CALCC022
      DIMENSION WPT(NUM)                                                      CALCC023
      DIMENSION IPL(REG),IPR(REG),PB(REG),XL(REG),XR(REG)                     CALCC024
      DIMENSION VINV(GRP)                                                     CALCC025
      DIMENSION SOR(REG),SORG(REG,GRP),SRCE0(PT,GRP),SRCE1(PT,GRP)            CALCC026
      DIMENSION CM(PT,GRP),CP(PT,GRP)                                         CALCC027
      DIMENSION FF1(PT)                                                       CALCC028
      DIMENSION FF2(PT)                                                       CALCC029
      DIMENSION TI1(REG)                                                      CALCC030
      DIMENSION DD(PT),DL(PT),DU(PT)                                          CALCC031
      DIMENSION DNSCAT(REG,GRP),UPSCAT(REG,GRP)                               CALCC032
      DIMENSION WZ(PT),WA(PT),GA(PT),TD(GRP)                                  CALCC033
      DIMENSION DPSI(PT)                                                      CALCC034
      CALL      FREQ(PSI,WHZ,WZ,FF1,FF2,STPRN,WPT,DPSI,PB)                    CALCC035
      IGONE=0                                                                 CALCC036
```

```
      IF(DEL.EQ.0) GO TO 24
      DO 23 II=1,DEL
23    DECH(II)=DEXP(DECAY(II)*H)
   24 DO 150 G=1,GRP
      DO 115 R=1,REG
      TI1(R)=NX(G)*NUSIGF(R,G)-SIGX(R,G,G)
      IF(GRP.EQ.1) TI1(R)=-SIGX(R,G,G)
115   CONTINUE
      CALL       RHS(G,PSI,FF1,FF2,TI1,NX,NUSIGF,VINV,SIGX ,FUEL,SD,
     1XL,XR,PB,IPL,IPR)
  120 IF (SORCE) 130,140,130
130   CALL       SOURCE(G,PSI,SORG,SOR,SRCE0,SRCE1,XL,XR,PB,IPL,IPR)
140   CALL       LHS(G,DU,DL,DD,CP,CM,TI1,VINV,FF2,XL,XR,IPL,IPR,PB)
      CALL       MATINV(G,PT,GRP,PSI,DU,DL,DD,WA,GA)
  150 CONTINUE
      IF (DEL) 160,180,160
  160 DO 170 G=GL,GU
      CALL       PREC(G,PSI,NUSIGF,FF2,FUEL,XL,XR,PB,IPL,IPR,TD)
  170 CONTINUE
  180 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE COEF1(NX,NUSIGF,CHI,NU,SIGF,SIGC,SIGX,PB,DR,LR,XL,XR,
     1    IPL,IPR,DNSCAT,UPSCAT,WCOEF,WCOEFL,WCOEFR,REGFR)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1           UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CUT,
     2           P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,
     3           SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT
      REAL*8 IODINE
      REAL*8 LR,NU,NUSIGF,NX
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      COMMON /A3/PUNBAL,SORCE,GEOM,NTAG,NUM2,PUNFRS
      COMMON /A7/BETA(6),DECAY(6),BETDCY(6),DECH(6)
C     ..............................................................
      DIMENSION LR(REG),IPL(REG),IPR(REG),PB(REG),XL(REG),XR(REG)
      DIMENSION REGFR(REG),WCOEF(PT),WCOEFL(REG),WCOEFR(REG)
      DIMENSION CHI(GRP)
      DIMENSION DNSCAT(REG,GRP),UPSCAT(REG,GRP)
      DIMENSION NU(GRP)
      DIMENSION NX(GRP),NUSIGF(REG,GRP)
      DIMENSION SIGC(REG,GRP),SIGF(REG,GRP),SIGX(REG,GRP,GRP)
      DIMENSION DR(REG)
      FLOAT(I)=DFLOAT(I)
C
      DO 120 G=1,GRP
      X=0.0
      IF(DEL.EQ.0) GO TO 111
      DO 110 GP=1,DEL
      X=X+BETA(GP)
  110 CONTINUE
  111 NX(G)=CHI(G)*(1.0-X)
  120 CONTINUE
      IF(DEL.EQ.0) GO TO 131
      DO 130 K=1,DEL
 130  BETDCY(K)=BETA(K)/DABS(DECAY(K))
C
  131 DO 150 R=1,REG
```

```
      DO 150 G=1,GRP
      NUSIGF(R,G)=NU(G)*SIGF(R,G)
      SIGX(R,G,G)=SIGC(R,G)+SIGF(R,G)
      X=0.0
      DO 140 GP=1,GRP
  140 X=X+SIGX(R,GP,G)
      SIGX(R,G,G)=X
  150 CONTINUE
C
C     CALCULATION OF SPATIAL INVARIANT IN REGION R
C
      N=1
      DO 160 R=1,REG
      X=PB(R)-N
      DR(R)=LR(R)/X
      N=PB(R)
  160 CONTINUE
      NL=2
      IF(REG.EQ.1) DR(2)=0.0
      N=REG-1
      IF(GEOM-1) 181,182,186
  181 CONTINUE
C
C     REGION INTERFACE WEIGHTING FACTORS, SLAB GEOMETRY
      DO 190 R=1,N
      XL(R)=DR(R)/(DR(R)+DR(R+1))
      XR(R)=DR(R+1)/(DR(R)+DR(R+1))
  190 CONTINUE
C
      GO TO 191
  182 CONTINUE
C
C     REGION INTERFACE WEIGHTING FACTORS, CYLINDRICAL GEOMERTY
C
      RAD=LR(1)
      DO 183 R=1,N
```

```
      X1=1/(DR(R)+DR(R+1))                                              CFI 0073
      X2=1/(4*RAD)                                                      CFI 0074
      XL(R)=DR(R)*X1*(1-DR(R)*X2)                                       CFI 0075
      XR(R)=DR(R+1)*X1*(1+DR(R+1)*X2)                                   CFI 0076
      RAD=RAD+LR(R+1)                                                   CFI 0077
  183 CONTINUE                                                          CFI 0078
      GO TO 191                                                         CFI 0079
C                                                                       CFI 0080
C     REGION INTERFACE WEIGHTING FACTORS, SPHERICAL GEOMETRY            CFI 0081
C                                                                       CFI 0082
  186 RAD=LR(1)                                                         CFI 0083
      DO 184 R=1,N                                                      CFI 0084
      X1=1/(DR(R)+DR(R+1))                                              CFI 0085
      X2=1/(2*RAD)                                                      CFI 0086
      X3=1/(12*RAD**2)                                                  CFI 0087
      XL(R)=DR(R)*X1*(1-DR(R)*X2+(DR(R)**2)*X3)                         CFI 0088
      XR(R)=DR(R+1)*X1*(1+DR(R+1)*X2+(DR(R+1)**2)*X3)                   CFI 0089
  184 CONTINUE                                                          CFI 0090
  191 CONTINUE                                                          CFI 0091
      XL(REG)=1.0                                                       CFI 0092
      IPL(1)=2                                                          CFI 0093
      IPR(1)=PB(1)-1                                                    CFI 0094
      IF (REG.EQ.1) GO TO 210                                           CFI 0095
      DO 200 R=2,REG                                                    CFI 0096
      IPL(R)=PB(R-1)+1                                                  CFI 0097
  200 IPR(R)=PB(R)-1                                                    CFI 0098
  210 CONTINUE                                                          CFI 0099
C     THE ENERGY GROUP BOUNDARIES FOR UP AND DOWN SCATTERING ARE SET    CFI 0100
      DO 330 R=1,REG                                                    CFI 0101
      DO 310 G=1,GRP                                                    CFI 0102
      I2=G-1                                                            CFI 0103
      IF (I2) 220,220,230                                               CFI 0104
  220 DNSCAT(R,G)=0                                                     CFI 0105
      GO TO 260                                                         CFI 0106
  230 DO 240 I=1,I2                                                     CFI 0107
      IF (SIGX(R,G,I)) 240,240,250                                      CFI 0108
```

```
240 CONTINUE                                                  CF1 0109
    I=0                                                       CF1 0110
250 DNSCAT(R,G)=I                                             CF1 0111
260 IF (G-GRP) 280,270,270                                    CF1 0112
270 UPSCAT(R,G)=0                                             CF1 0113
    GO TO 310                                                 CF1 0114
280 I2=G+1                                                    CF1 0115
    I1=0                                                      CF1 0116
    DO 300 I=I2,GRP                                           CF1 0117
    IF (SIGX(R,G,I)) 300,300,290                              CF1 0118
290 I1=I                                                      CF1 0119
300 CONTINUE                                                  CF1 0120
    UPSCAT(R,G)=I1                                            CF1 0121
310 CONTINUE                                                  CF1 0122
    KK=0                                                      CF1 0123
    DO 320 G=1,GRP                                            CF1 0124
320 KK=MAX0(KK,DNSCAT(R,G))                                   CF1 0125
    IF(GRP.EQ.1) GO TO 330                                    CF1 0126
    IF (KK.EQ.0) CALL EXIT                                    CF1 0127
330 CONTINUE                                                  CF1 0128
    IF (GEOM-1) 340,370,400                                   CF1 0129
340 DO 360 R=1,REG                                            CF1 0130
    PR=IPR(R)                                                 CF1 0131
    PL=IPL(R)                                                 CF1 0132
    WCOEFL(R)=DR(R)*0.5                                       CF1 0133
    DO 350 P=PL,PR                                            CF1 0134
350 WCOEF(P)=DR(R)                                            CF1 0135
    WCOEFR(R)=DR(R)*0.5                                       CF1 0136
    REGFR(R)=LR(R)                                            CF1 0137
360 CONTINUE                                                  CF1 0138
    GO TO 430                                                 CF1 0139
370 RAD=0.0                                                   CF1 0140
    DO 390 R=1,REG                                            CF1 0141
    PR=IPR(R)                                                 CF1 0142
    PL=IPL(R)                                                 CF1 0143
    WCOEFL(R)=DR(R)*RAD                                       CF1 0144
```

```
      DO 380 P=PL,PR
      RAD=RAD+DR(R)
  380 WCOEF(P)=2.0*RAD*DR(R)
      WCOEFR(R)=DR(R)*RAD
      RAD=RAD+DR(R)
  390 REGFR(R)=2.0*RAD*LR(R)-LR(R)**2
      GO TO 430
  400 RAD=0.0
      DO 420 R=1,REG
      PR=IPR(R)
      PL=IPL(R)
      WCOEFL(R)=2.0*DR(R)*RAD**2
      DO 410 P=PL,PR
      RAD=RAD+DR(R)
  410 WCOEF(P)=4.0*DR(R)*RAD**2
      RAD=RAD+DR(R)
      WCOEFR(P)=2.0*DR(R)*RAD**2
  420 REGFR(R)=(RAD**3-(RAD-LR(R))**3)*4.0/3.0
  430 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE COEF2(D,SIGT,CHANGE,PB,DR,LR,CM,CP)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CUT,
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT
      REAL*8 IODINE
      REAL*8 LR,NU,NUSIGF,NX
      INTEGER PFIRST,PLAST
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY
      COMMON /A3/PUNBAL,SORCE,GEOM,NTAG,NUM2,PUNFRS
      DIMENSION PB(REG),DR(REG),LR(REG)
      DIMENSION CM(PT,GRP),CP(PT,GRP)
      DIMENSION CHANGE(REG)
      DIMENSION D(REG,GRP)
      DIMENSION SIGT(REG,GRP)
      FLOAT(I)=DFLOAT(I)
      DO 120 R=1,REG
      IF (CHANGE(R).EQ.0) GO TO 120
      DO 110 G=1,GRP
  110 D(R,G)=1.0/(3.0*SIGT(R,G))
  120 CONTINUE
C
C     CALCULATION OF DIFFERENCE COEFICIENTS - CP AND CM
C
      IF (GEOM-1) 130,170,220
C
C     SLAB GEOMETRY
C
  130 CONTINUE
      PFIRST=2
      DO 160 R=1,REG
      IF (CHANGE(R).EQ.0) GO TO 160
C
C     NON BOUNDARY POINTS - SLAB
```

```
C
      PLAST=PB(R)-1
      DO 140 P=PFIRST,PLAST
      DO 140 G=1,GRP
      CM(P,G)=D(R,G)/DR(R)**2
      CP(P,G)=CM(P,G)
  140 CONTINUE
      IF(R.EQ.1) GO TO 144
      IF(R.NE.REG) GO TO 143
  157 IF(BCR.EQ.1) GO TO 151
      DO 152 G=1,GRP
      CP(PT,G)=0.0
  152 CM(PT,G)=0.0
      GO TO 160
  151 DO 154 G=1,GRP
      CP(PT,G)=0.0
  154 CM(PT,G)=2*D(REG,G)/(DR(REG)**2)
  153 GO TO 160
C
C     LEFT BOUNDARY
C
  144 IF(BCL.EQ.1) GO TO 145
      DO 146 G=1,GRP
      CP(1,G)=0.
  146 CM(1,G)=0.
      IF(R.EQ.REG) GO TO 157
      GO TO 143
  145 DO 148 G=1,GRP
      CP(1,G)=2*D(1,G)/(DR(1)**2)
  148 CM(1,G)=0.
      IF(R.EQ.REG) GO TO 157
      GO TO 143
C
C     INTERFACE POINTS  SLAB GEOM.
C
  143 P=PB(R)
```

```
      X=(DR(R+1)+DR(R))*0.5
      DO 150 G=1,GRP
      CP(P,G)=D(R+1,G)/(DR(R+1)*X)
      CM(P,G)=D(R,G)/(DR(R)*X)
  150 CONTINUE
  160 PFIRST=PB(R)+1
      GO TO 270
C
C     CYLINDICAL GEOMETRY
C
  170 RAD=0.0
      PFIRST=2
      IF( CHANGE(1).EQ.0 ) GO TO 173
      IF(BCL.EQ.1) GO TO 171
      DO 172 G=1,GRP
      CM(1,G)=0.
  172 CP(1,G)=0.
      GO TO 173
  171 DO 174 G=1,GRP
      CM(1,G)=0.
  174 CP(1,G)=4*D(1,G)/(DR(1)**2)
  173 CONTINUE
      DO 210 R=1,REG
      IF (CHANGE(R).EQ.1) GO TO 180
      RAD=RAD+LR(R)
      GO TO 210
C
C     NON BOUNDARY POINTS - CYLINDER
C
  180 PLAST=PB(R)-1
      DO 190 P=PFIRST,PLAST
      RAD=RAD+DR(R)
      X=1.0/(DR(R)**2)
      Y=1.0/(2.0*RAD*DR(R))
      DO 190 G=1,GRP
      CM(P,G)=D(R,G)*(X-Y)
```

```
      CP(P,G)=D(R,G)*(X+Y)
  190 CONTINUE
C
C     BOUNDARY POINT - CYLINDER
C
      IF(R.EQ.REG) GO TO 201
      P=PB(R)
      RAD=RAD+DR(R)
      RADP=RAD+0.5*DR(R)
      RADM=RAD-0.5*DR(R)
      X=RAD*(DR(R+1)+DR(R))*0.5
      DO 200 G=1,GRP
      CP(P,G)=D(R+1,G)*RADP/(DR(R+1)*X)
      CM(P,G)=D(R,G)*RADM/(DR(R)*X)
  200 CONTINUE
      GO TO 210
  201 IF(BCR.EQ.1) GO TO 202
      DO 203 G=1,GRP
      CM(PT,G)=0.0
  203 CP(PT,G)=0.0
      GO TO 210
  202 RAD=RAD+DR(REG)
      X=2/(DR(REG)**2)*(1-DR(REG)/(2*RAD))/(1-DR(REG)/(4*RAD))
      DO 204 G=1,GRP
      CP(PT,G)=0
  204 CM(PT,G)=D(REG,G)*X
  210 PFIRST=PB(R)+1
      GO TO 270
C
C     SPHERICAL GEOMETRY
C
  220 RAD=0.0
      PFIRST=2
      DO 260 R=1,REG
      IF (CHANGE(R).EQ.1) GO TO 230
      RAD=RAD+LR(R)
```

```
      GC TC 260
C
C     NCN BOUNDARY PCINTS - SPHERE
C
  230 PLAST=PB(R)-1
      DO 240 P=PFIRST,PLAST
      RAD=RAC+CR(R)
      X=1.C/(DR(R)**2)
      Y=1.0/(RAD*DR(R))
      X1=1/(1+.083333*(DR(R)/RAD)**2)
      DC 241 G=1,GRP
      CM(P,G)=D(R,G)*(X-Y)*X1
  241 CP(P,G)=C(R,G)*(X+Y)*X1
  240 CCNTINUE
      IF(R.EC.REG) GC TC 251
C
C     BCUNCARY POINTS - SPHERE
C
      P=PB(R)
      RAC=RAC+CR(R)
      X=RAD**2*(DR(R)+CR(R+1))*0.5
      RADP2=(RAD+0.5*CR(R))**2
      RADM2=(RAD-0.5*CR(R))**2
      DC 250 G=1,GRP
      CP(P,G)=D(R+1,G)*RACP2/(DR(R+1)*X)
      CM(P,G)=D(R,G)*RACM2/(DR(R)*X)
  250 CCNTINUE
      GO TC 260
  251 IF(BCR.EQ.1) GC TO 252
      DO 253 G=1,GRP
      CP(PT,G)=0.
  253 CM(PT,G)=0.
      GC TO 260
  252 RAD=RAC+CR(REG)
      X1=CR(REG)/RAD
      X2=(CR(REG)/(2*RAC))**2
```

```
      X3=(1-X1+X2)/(1-C.5*X1+X2)                                        CF2 C181
      X4=2*X3/(DR(REG)**2)                                              CF2 0182
      DC 254 G=1,GRP                                                    CF2 0183
      CP(PT,G)=0.                                                       CF2 C184
  254 CM(PT,G)=D(REG,G)*X4                                              CF2 0185
  260 PFIRST=PB(R)+1                                                    CF2 0186
  270 CCNTINUE                                                          CF2 C187
      RETURN                                                            CF2 C188
      END                                                               CF2 0189
```

```
      FUNCTION DEN(M,N,K,PSI,NUSIGF)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CUT,
     2          P,PL,PR,PB, PRBENC , PT , PUNBAL , PUNFRS , R,REG,SOR,
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT
      REAL*8 LR,NU,NUSIGF,NX
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      COMMON /A7/BETA(6),DECAY(6),BETDCY(6),DECH(6)
      DIMENSION PSI(PT,GRP)
      DIMENSION NUSIGF(REG,GRP)
C     THIS FUNCTION CALCULATES THE PRECURSOR CONCENTRATION AT POINT M,
C     IN REGION N, AND GROUP K AND TIME CT
      T1=0.0
      DO 110 I=1,GRP
  110 T1=T1+NUSIGF(N,I)*PSI(M,I)
      DEN=T1*BETDCY(K)
      RETURN
      END
```

```
      SUBROUTINE DIRECT(PSI,SIGC,SIGF,SIGT,SIGX,NU,SD,SDIN,CHI,NCMP,        DIRTC001
     1FUEL,XABS,XENON,IODINE,LR,IPL,IPR,PB,XL,XR,CR,WHZ,WZ,WPT,NX,          DIRTC002
     2NUSIGF,DNSCAT,UPSCAT,REGFR,WCOEF,WCOEFL,WCOEFR,D,CHANGE,CM,CP,        DIRTC003
     3SCR,SORG,SRCE0,SRCE1,STPRN,RTAG,TAGC,TAGF,TAGT,TAGX,CCL,CCQ,CFL,      DIRTC004
     4CFQ,CTRL,CTRQ,CXL,CXQ,V,VINV,PSITOT,POWREG,POWCRG,POWER,PSISTO,       DIRTC005
     5DD,DL,DU,FF1,FF2,TII,SIGCIN,SIGFIN,SIGTIN,SIGXIN,PSIB1,TD,            DIRTC006
     6WA,GA,DPSI,PSIBAR)                                                    DIRTC007
      IMPLICIT REAL*8 (A-H,O-Z)                                             DIRTC008
      REAL*8 IODINE                                                         DIRTC009
      REAL*8 LR,NU,NUSIGF,NX                                                DIRTC010
      INTEGER GF,GRPLUS                                                     DIRTC011
      INTEGER RTAG                                                          DIRTC012
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,                 DIRTC013
     1          UPSCAT,WPT, FUEL,G,GECM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CUT,    DIRTC014
     2P,PL,PR,PB,PRBEND,PT,PUNBAL,PUNFRS,R,REG,SCR,                         DIRTC015
     3          SORCE , SORG , SCZ , STEADY , STEP , TAGC , TAGF , TAGT     DIRTC016
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL                              DIRTC017
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY                       DIRTC018
      COMMON /A3/PUNBAL,SORCE,GECM,NTAG,NUM2,PUNFRS                         DIRTC019
      COMMON /A4/TIGHT1,TIGHT2,TIGHT3                                       DIRTC020
      COMMON/A5/IN,OUT,NERR                                                 DIRTC021
      COMMON/A6/EP1,EP2,EP3,TSTINC,IEP4,IEP6                                DIRTC022
      COMMON /A7/BETA(6),DECAY(6),BETDCY(6),DECH(6)                         DIRTC023
      COMMON /A8/GAMAX,GAMAI                                                DIRTC024
      COMMON /A9/POWTOT,POWBAR                                              DIRTC025
      COMMON /B1/H,HP,TIME,TZ,ZERO,TZO,TIMZ                                 DIRTC026
      COMMON /B2/NPRT,NZ,ISX,STEP,NZSAVE,PRBEND,IPRN                        DIRTC027
       COMMON /C2/GF,GRPLUS                                                 DIRTC028
      DIMENSION PSI(PT,GU)                                                  DIRTC029
      DIMENSION SIGC(REG,GRP),SIGF(REG,GRP),SIGT(REG,GRP),                  DIRTC030
     1SIGX(REG,GRP,GRP)                                                     DIRTC031
      DIMENSION NU(GRP)                                                     DIRTC032
      DIMENSION SD(GRP,IDEL)                                                DIRTC033
      DIMENSION SDIN(GRP,IDEL)                                              DIRTC034
      DIMENSION CHI(GRP)                                                    DIRTC035
      DIMENSION NCMP(REG)                                                   DIRTC036
```

```
      DIMENSION FUEL(REG)                                                DIRTC037
      DIMENSION XABS(REG,GRP)                                            DIRTC038
      DIMENSION XENON(REG),IODINE(REG)                                   DIRTC039
      DIMENSION LR(REG),IPL(REG),IPR(REG),PB(REG),XL(REG),XR(REG)        DIRTC040
      DIMENSION WHZ(PT)                                                  DIRTC041
      DIMENSION WZ(PT)                                                   DIRTC042
      DIMENSION WPT(NUM)                                                 DIRTC043
      DIMENSION NX(GRP),NUSIGF(REG,GRP)                                  DIRTC044
      DIMENSION DNSCAT(REG,GRP),UPSCAT(REG,GRP)                          DIRTC045
      DIMENSION REGFR(REG),WCOEF(PT),WCOEFL(REG),WCOEFR(REG)             DIRTC046
      DIMENSION D(REG,GRP)                                               DIRTC047
      DIMENSION CHANGE(REG)                                              DIRTC048
      DIMENSION CM(PT,GRP),CP(PT,GRP)                                    DIRTC049
      DIMENSION SOR(REG),SORG(REG,GRP),SRCE0(PT,GRP),SRCE1(PT,GRP)       DIRTC050
      DIMENSION STPRN(50)                                                DIRTC051
      DIMENSION RTAG(REG)                                                DIRTC052
      DIMENSION TAGC(REG),TAGF(REG),TAGT(REG),TAGX(REG)                  DIRTC053
      DIMENSION CCL(REG,GRP),CCQ(REG,GRP),CFL(REG,GRP),CFQ(REG,GRP),     DIRTC054
     1CTRL(REG,GRP),CTRQ(REG,GRP),CXL(REG),CXQ(REG)                      DIRTC055
      DIMENSION V(GRP)                                                   DIRTC056
      DIMENSION VINV(GRP)                                                DIRTC057
      DIMENSION PSIBAR(REG,GRP)                                          DIRTC058
      DIMENSION PSITOT(REG,GRP)                                          DIRTC059
      DIMENSION POWREG(REG)                                              DIRTC060
      DIMENSION POWER(REG,GRP)                                           DIRTC061
      DIMENSION DR(REG)                                                  DIRTC062
      DIMENSION POWORG(REG)                                              DIRTC063
      DIMENSION PSISTC(NUM)                                              DIRTC064
      DIMENSION DC(PT),DL(PT),DU(PT)                                     DIRTC065
      DIMENSION FF1(PT),FF2(PT)                                          DIRTC066
      DIMENSION TI1(REG)                                                 DIRTC067
      DIMENSION SIGCIN(GRP),SIGFIN(GRP),SIGTIN(GRP)                      DIRTC068
      DIMENSION SIGXIN(GRPLUS,GRP)                                       DIRTC069
      DIMENSION PSIB1(REG,GRP)                                           DIRTC070
      DIMENSION TD(GRP)                                                  DIRTC071
      DIMENSION WA(PT),GA(PT),DPSI(PT)                                   DIRTC072
```

```
      TIME=0.0
      TIMZ=0.
      TZ=0.0
      TZO=0.0
      STEP=0
      NZ=1
      NZSAVE=1
      ZERO=1.0D-10
      PRBEND=0
      POWBAR=0.0D0
      DO 30 R=1,REG
   30 POWCRG(R)=0.0D0
      DO 50 P=1,PT
      WZ(P)=0.0
      WHZ(P)=1.0
      DO 50 G=1,GU
   50 PSI(P,G)=1.0D0
      CALL       INPTA2(PSI,SIGF,SIGC,SIGT,SIGX,NU,SC,SDIN,CHI,VINV,V,
     1NCMP,FUEL,XABS,XENON,IODINE,PB,LR,WPT,SIGCIN,SIGFIN,SIGTIN,SIGXIN)
      CALL       COEF1(NX,NUSIGF,CHI,NU,SIGF,SIGC,SIGX,PB,DR,LR,XL,XR,
     1    IPL,IPR,DNSCAT,UPSCAT,WCOEF,WCOEFL,WCOEFR,REGFR)
      DO 120 I=1,REG
  120 CHANGE(I)=1
      CALL       COEF2(D,SIGT,CHANGE,PB,DR,LR,CM,CP)
      CALL       INPUTB(SCR,SORG,SRCE0,SRCE1,STPRN,IPL,IPR,RTAG,TAGX,
     1TAGT,TAGF,TAGC,CXL,CXQ,CTRL,CTRQ,CCL,CCQ,CFL,CFQ)
      CALL       INEDA(PSI,WPT,PB,LR,DR,V,NU,CHI,SD,NCMP,D,SIGC,SIGF,
     1SIGX,XENON,IODINE)
      CALL       INEDB(TAGX,TAGT,TAGC,TAGF,CXL,CXQ,CTRL,CTRQ,CCL,CCQ,
     1CFL,CFQ,SOR,SORG,SRCE0,SRCE1,IPL,IPR)
      IF (NERR.EQ.1) CALL EXIT
      IF (STEADY.LT.1) GO TO 130
      CALL       SETUP(PSI,WPT,NU,NUSIGF,CM,CP,SIGX,PB,IPR,IPL,XL,XR,
     1FUEL,NX,SDIN,UPSCAT,DNSCAT,PSISTO,DD,DL,DU,WA,GA)
  130 CONTINUE
       DO 131 P=1,PT
```

```
 131  DPSI(P)=PSI(P,THG)                                                    DIRTC1C9
      CALL        AVRAGE(PSI,PSIBAR,PSITOT,POWER,WCOEF,WCCEFL,WCCEFR,       DIRT0110
     1REGFR, IPL,IPR,SIGF,POWREG,POWORG)                                    DIRTC111
      DO 140 I=1,REG                                                        DIRTC112
      POWORG(I)=POWREG(I)                                                   DIRT0113
      IF(POWREG(I).EQ.0.0D0) GO TO 140                                      DIRT0114
      POWREG(I)=POWREG(I)/POWTOT                                            DIRTC115
 140  CONTINUE                                                              DIRT0116
      POWBAR=POWTOT                                                         DIRT0117
      IF(POWTOT.NE.0.0D0) POWTOT=1.0                                        DIRTC118
      WRITE(OUT,121)                                                        DIRT0119
      WRITE(OUT,122)(R,POWREG(R),R=1,REG)                                   DIRT0120
      WRITE(OUT,123)POWTOT                                                  DIRTC121
 121 FORMAT(1H0,10X,'REGION',10X,'FRACTIONAL POWER',/)                      DIRTC122
 122 FORMAT(13X,I2,12X,E14.7)                                               DIRT0123
 123 FORMAT(1H0,10X,'TOTAL NORMALIZED POWER = ',E14.7)                      DIRTC124
      IF (STEADY.LT.1) GO TO 300                                            DIRTC125
      CALL        UPDAT(TAGT,TAGX,TAGC,TAGF,CHANGE,NUSIGF,PSIBAR,IODINE,    DIRTC126
     1XABS,XENON, CTRL,CTRQ,CXL,CXQ,CCL,CCQ,CFL,CFQ,SIGT,SIGX,SIGF,         DIRTC127
     2SIGC,PSIB1,NU,FUEL)                                                   DIRTC128
      CALL        COEF2(D,SIGT,CHANGE,PB,DR,LR,CM,CP)                       DIRTC129
      GO TO 300                                                             DIRT0130
 200  IF((DABS(TIME-TZ)).GT.ZERO) GO TO 220                                 DIRTC131
      CALL        INPUTB(SOR,SORG,SRCE0,SRCE1,STPRN,IPL,IPR,RTAG,TAGX,      DIRT0132
     1TAGT,TAGF,TAGC,CXL,CXQ,CTRL,CTRQ,CCL,CCQ,CFL,CFQ)                     DIRTC133
      CALL        INEDB(TAGX,TAGT,TAGC,TAGF,CXL,CXQ,CTRL,CTRQ,CCL,CCQ,      DIRTC134
     1CFL,CFQ,SOR,SORG,SRCE0,SRCE1,IPL,IPR)                                 DIRTC135
220   CALL        UPDAT(TAGT,TAGX,TAGC,TAGF,CHANGE,NUSIGF,PSIBAR,IODINE,    DIRTC136
     1XABS,XENON, CTRL,CTRQ,CXL,CXQ,CCL,CCQ,CFL,CFQ,SIGT,SIGX,SIGF,         DIRTC137
     2SIGC,PSIB1,NU,FUEL)                                                   DIRTC138
      CALL        COEF2(D,SIGT,CHANGE,PB,DR,LR,CM,CP)                       DIRTC139
      IF (NERR.EQ.1) CALL EXIT                                              DIRTC140
 300  CALL        CALC(PSI,WHZ,WZ,NX,NUSIGF,SIGX,SC,SCIN,STPRN,FUEL,WPT,    DIRTC141
     1XL,XR,PB,IPL,IPR,VINV,UPSCAT,DNSCAT,SORG,SOR,SRCE0,SRCE1,CP,CM,       DIRTC142
     2FF1,FF2,TI1,DU,CL,DC,TD,WA,GA,DPSI)                                   DIRT0143
      CALL        AVRAGE(PSI,PSIBAR,PSITOT,POWER,WCOEF,WCOEFL,WCCEFR,       DIRTC144
```

```
1REGFR, IPL,IPR,SIGF,POWREG,POWORG)                                    CIRT0145
 CALL       TEST(STPRN,PSI,PSITOT,POWREG,WPT,WZ,WHZ)                    CIRT0146
 IF (PRBEND.NE.1) GO TO 200                                             CIRT0147
 IF(PUNFRS.EQ.1) CALL PUN(PSI,NU,SIGF,SIGC,SIGT,SIGX,XENCN,ICDINE)      CIRT0148
 RETURN                                                                 CIRT0149
 END                                                                    CIRT0150
```

```
      SUBROUTINE EQPREC(PSI,FUEL,NUSIGF,IPL,IPR,XL,XR)                  EQPC0001
      IMPLICIT REAL*8 (A-H,O-Z)                                         EQPC0002
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,             EQPC0003
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,OUT, EQPC0004
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,   EQPC0005
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT  EQPC0006
      REAL*8 LR,NU,NUSIGF,NX                                            EQPC0007
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL                          EQPC0008
      DIMENSION PSI(PT,GU)                                              EQPC0009
      DIMENSION IPL(REG),IPR(REG),XL(REG),XR(REG)                       EQPC0010
      DIMENSION FUEL(REG)                                               EQPC0011
      DIMENSION NUSIGF(REG,GRP)                                         EQPC0012
C     THIS ROUTINE CALCULATES THE EQUILIBRIUM PRECURSOR CONCENTRATIONS  EQPC0013
      DO 110 G=GL,GU                                                    EQPC0014
      DO 110 P=1,PT                                                     EQPC0015
 110  PSI(P,G)=0.0                                                      EQPC0016
  120 DO 190 R=1,REG                                                    EQPC0017
      IF (FUEL(R)) 190,190,130                                          EQPC0018
  130 PL=IPL(R)                                                         EQPC0019
      IF (R.EQ.1) PL=1                                                  EQPC0020
      PR=IPR(R)                                                         EQPC0021
      IF (R.EQ.REG) PR=PT                                               EQPC0022
      DO 180 G=GL,GU                                                    EQPC0023
      JG=G-GRP                                                          EQPC0024
      DO 140 P=PL,PR                                                    EQPC0025
      PSI(P,G)=DEN(P,R,JG,PSI,NUSIGF)                                   EQPC0026
  140 CONTINUE                                                          EQPC0027
  160 M=PL-1                                                            EQPC0028
      IF(R.NE.1) PSI(M,G)=PSI(M,G)+DEN(M,R,JG,PSI,NUSIGF)*XR(R-1)       EQPC0029
  170 M=PR+1                                                            EQPC0030
      IF(R.NE.REG) PSI(M,G)=PSI(M,G)+DEN(M,R,JG,PSI,NUSIGF)*XL(R)       EQPC0031
  180 CONTINUE                                                          EQPC0032
  190 CONTINUE                                                          EQPC0033
  200 CONTINUE                                                          EQPC0034
      RETURN                                                            EQPC0035
      END                                                               EQPC0036
```

```
      SUBROUTINE ERR(SUB,TYPE,N1,N2)
      INTEGER SUB,TYPE
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1          UPSCAT,WPT, FUEL,G,GECM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,OUT,
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT
      COMMON/A5/IN,OUT,NERR
      NERR=1
      GO TO (110,150,170), TYPE
 110  WRITE(OUT,120)
 120  FORMAT(25HOERROR FOUND IN SUB INPUT)
  130 WRITE (OUT,140) N1,N2
  140 FORMAT (7HOCARD  ,I3,9H   WORD  ,I3)
      GO TO 220
  150 WRITE (OUT,160) N1
  160 FORMAT (15HO PT>MAXPT, PT=,I6)
      GO TO 220
  170 WRITE (OUT,180) N1,N2
  180 FORMAT (23HOERROR IN SIGX INPUT G=,I3,4H  I=I3)
      GO TO 220
  220 RETURN
C
      END
```

```
      SUBROUTINE FEDBKX(PSIBAR,SIGF,XABS,XENON,IODINE,PSIB1,FUEL)          FDBKC001
      IMPLICIT REAL*8 (A-H,O-Z)                                            FDBKC002
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,                FDBKC003
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GC,GL,GU,GRP,GPU,CUT,   FDBKC004
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,     FDBKC005
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT    FDBKC006
      REAL*8 IODINE                                                        FDBKC007
      REAL*8 LR,NU,NUSIGF,NX                                               FDBKC008
      REAL LAMDAI,LAMDAX                                                   FDBKC009
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL                             FDBKC010
      COMMON /A8/GAMAX,GAMAI                                               FDBKC011
      COMMON /B1/H,HP,TIME,TZ,ZERO,TZO,TIMZ                                FDBKC012
      DIMENSION PSIBAR(REG,GRP)                                            FDBKC013
      DIMENSION PSIB1(REG,GRP)                                             FDBKC014
      DIMENSION XENON(REG),IODINE(REG)                                     FDBKC015
      DIMENSION XABS(REG,GRP)                                              FDBKC016
      DIMENSION FUEL(REG)                                                  FDBKC017
      DIMENSION SIGF(REG,GRP)                                              FDBKC018
      EXP(X)=DEXP(X)                                                       FDBKC019
      FLOAT(I)=DFLOAT(I)                                                   FDBKC020
      DATA LAMDAI, LAMDAX / 2.874E-5, 2.093E-5/                            FDBKC021
C                                                                          FDBKC022
C     THIS ROUTINE CALCULATES THE FEEDBACK,BY REGIONS,FOR XENON            FDBKC023
C                                                                          FDBKC024
C     CALCULATION OF VOLUME WEIGHTED,REGION AVERAGED FLUX                  FDBKC025
C                                                                          FDBKC026
      DO 130 R=1,REG                                                       FDBKC027
      IF(FUEL(R).EQ.0) GO TO 130                                           FDBKC028
      SBAR=0.0                                                             FDBKC029
      ALPHAX=LAMDAX                                                        FDBKC030
      DO 120 G=1,GRP                                                       FDBKC031
      SBAR=SBAR+SIGF(R,G)*(PSIB1(R,G)+PSIBAR(R,G))*0.5                     FDBKC032
      ALPHAX=ALPHAX+XABS(R,G)*PSIBAR(R,G)                                  FDBKC033
  120 CONTINUE                                                             FDBKC034
      Z1=ALPHAX-LAMDAI                                                     FDBKC035
      Z2=(GAMAX+GAMAI)/ALPHAX                                              FDBKC036
```

```
      Y1=(-LAMDAI)*H
      X1=0.0
      IF (Y1.GT.(-88.0)) X1=EXP(Y1)
      Y2=(-ALPHAX)*H
      X2=0.0
      IF (Y2.GT.(-88.0)) X2=EXP(Y2)
C
      IODINE(R)=X1*IODINE(R)+((1.0-X1)/LAMDAI)*GAMAI*SBAR
C
      XENON(R)=X2*XENON(R)+((X1-X2)/Z1)*(LAMDAI*IODINE(R)-GAMAI*SBAR)+Z2
     1*(1.0-X2)*SBAR
  130 CONTINUE
      DO 110 R=1,REG
      DO 110 G=1,GRP
  110 PSIB1(R,G)=PSIBAR(R,G)
      RETURN
      END
```

```
      SUBROUTINE FREQ(PSI,WHZ,WZ,FF1,FF2,STPRN,WPT,DPSI,PB)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CUT,
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT
      REAL*8 LR,NU,NUSIGF,NX
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY
      COMMON /A3/PUNBAL,SORCE,GEOM,NTAG,NUM2,PUNFRS
      COMMON/A6/EP1,EP2,EP3,TSTINC,IEP4,IEP6
      COMMON /B1/H,HP,TIME,TZ,ZERO,TZO,TIMZ
      COMMON /B2/NPRT,NZ,ISX,STEP,NZSAVE,PRBEND,IPRN
      DIMENSION PSI(PT,GU)
      DIMENSION DPSI(PT)
      DIMENSION FF1(PT)
      DIMENSION FF2(PT)
      DIMENSION PB(REG)
      DIMENSION WZ(PT)
      DIMENSION WHZ(PT)
      DIMENSION WPT(NUM)
      DIMENSION STPRN(50)
      ISY=0
      IF(IEP4.EQ.1) GO TO 311
      PL=1
      IF(BCL.EQ.0) PL=2
      PR= PB(REG)-1
      IF(BCR.EQ.0) GO TO 277
      PR=PB(REG)
  277 DO 278 P=PL,PR
      WHZ(P)=PSI(P,THG)/DPSI(P)
      DPSI(P)=WZ(P)
      WZ(P)=(DLOG(WHZ(P)))/H
  278  CONTINUE
      IF(BCL.EQ.0) WHZ(1)=1.0
      IF(BCR.EQ.0) WHZ(PT)=1.0
```

```
311   CONTINUE
      H=HP
      TIMEP=TIME+H
      IF((TZ-TIMEP).GT.ZERO) GO TO 1
      H =TZ-TIME
      ISY=1
  1   CONTINUE
      IF(NUM2.EQ.0) GO TO 2
      TIMEP=TIME+H
      IF((STPRN(NPRT)-TIMEP).GT.ZERO) GO TO 2
      ISY=1
      H =STPRN(NPRT)-TIME
  2   CONTINUE
      IF(ISY.EQ.1) GO TO 397
      IF(IEP6.EQ.1) GO TO 401
      T1=WZ(2)
      T2=WZ(2)
      PL=3
      PR=PT-1
      DO 300 P=PL,PR
      IF(WZ(P).GT.T1) T1=WZ(P)
      IF(WZ(P).LT.T2)  T2=WZ(P)
300   CONTINUE
      T4=T1*H
      T5=T2*H
      IF(T1.NE.0.0.AND.T2.NE.0.0) GO TO 303
      ES=EP2
      GO TO 310
303   IF(T1.GT.0.0) GO TO 305
      T3=1.0-T1/T2
      IF(T3.EQ.0.0   ) T3=0.001D0
      ES=EP2/T3
       GO TO 310
305   T3=1.0-T2/T1
      IF(T3.EQ.0.0   ) T3=0.001D0
      ES=EP2/T3
```

```
 310  T3=0.0                                                          FREC0073
      DO 315 N=1,NUM                                                  FREC0074
      P=WPT(N)                                                        FREC0075
      T1=WZ(P)                                                        FREC0076
      T2=DPSI(P)                                                      FREC0077
      T8=T1                                                           FREC0078
      T9=T2                                                           FREC0079
      IF(T1.NE.0.0.AND.T2.NE.0.0) GO TO 319                           FREC0080
      ET=EP1                                                          FREC0081
      GO TO 339                                                       FREC0082
 319  IF(DABS(T1).GT.DABS(T2)) GO TO 321                              FREC0083
      T2=1.0-T1/T2                                                    FREC0084
      GO TO 323                                                       FREC0085
 321  T2=1.0-T2/T1                                                    FREC0086
 323  IF(T2.GT.T3) T3=T2                                              FREC0087
 315   CONTINUE                                                       FREC0088
      ET=EP1/T3                                                       FREC0089
 339  CONTINUE                                                        FREC0090
 340   EX=DMIN1(ES,ET)                                                FREC0091
      EX=DMAX1(EX,EP1)                                                FREC0092
      T6=DMAX1(DABS(T4),DABS(T5))                                     FREC0093
      IF(T6.GT.EX) GO TO 370                                          FREC0094
      T1=2.0*T6                                                       FREC0095
      IF(T1.LT.EX) GO TO 360                                          FREC0096
 394  HP=H                                                            FREC0097
      GO TO 398                                                       FREC0098
360   HP=H*TSTINC                                                     FREC0099
      GO TO 398                                                       FREC0100
 370  IF(T6.LT.EP3) GO TO 394                                         FREC0101
      T7=DMAX1(EX,EP3)                                                FREC0102
      H=T7*H/T6                                                       FREC0103
 401  HP=H                                                            FREC0104
 397  CONTINUE                                                        FREC0105
 398  CONTINUE                                                        FREC0106
      DO 30 P=1,PT                                                    FREC0107
      IF(DABS(WZ(P)*H).LT.1.0D-5) GO TO 10                            FREC0108
```

```
      WHZ(P)=DEXP(WZ(P)*H)                                              FREQ0109
      FF1(P)=(WHZ(P)-1.0)/WZ(P)                                         FREQ0110
      FF2(P)=FF1(P)/WHZ(P)                                              FREQ0111
      GO TO 30                                                          FREQ0112
   10 FF1(P)=H                                                          FREQ0113
      FF2(P)=H                                                          FREQ0114
      WZ(P)=0.0D0                                                       FREQ0115
      WHZ(P)=1.0D0                                                      FREQ0116
   30 CONTINUE                                                          FREQ0117
      DO 700 P=1,PT                                                     FREQ0118
  700 DPSI(P)=PSI(P,THG)                                                FREQ0119
  602  RETURN                                                           FREQ0120
      END                                                               FREQ0121
```

```
      SUBROUTINE INEDA(PSI,WPT,PB,LR,DR,V,NU,CHI,SD,NCMP,D,SIGC,SIGF,       IEDAC001
     1SIGX,XENON,IODINE)                                                    IEDAC002
      IMPLICIT REAL*8 (A-H,O-Z)                                             IEDAC003
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,                 IEDAC004
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,OUT,    IEDAC005
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,      IEDAC006
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT     IEDAC007
      INTEGER  RBCND                                                        IEDAC008
      REAL*8 IODINE                                                         IEDAC009
      REAL*8 LR,NU,NUSIGF,NX                                                IEDAC010
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL                              IEDAC011
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY                       IEDAC012
      COMMON /A3/PUNBAL,SORCE,GEOM,NTAG,NUM2,PUNFRS                         IEDAC013
      COMMON/A5/IN,OUT,NERR                                                 IEDAC014
      COMMON /A8/GAMAX,GAMAI                                                IEDAC015
      DIMENSION PSI(PT,GU)                                                  IEDAC016
      DIMENSION XENON(REG),IODINE(REG)                                      IEDAC017
      DIMENSION V(GRP)                                                      IEDAC018
      DIMENSION PB(REG),DR(REG),LR(REG)                                     IEDAC019
      DIMENSION CHI(GRP)                                                    IEDAC020
      DIMENSION D(REG,GRP)                                                  IEDAC021
      DIMENSION NCMP(REG)                                                   IEDAC022
      DIMENSION SD(GRP,IDEL)                                                IEDAC023
      DIMENSION WPT(NUM)                                                    IEDAC024
      DIMENSION NU(GRP)                                                     IEDAC025
      DIMENSION SIGC(REG,GRP),SIGF(REG,GRP),SIGX(REG,GRP,GRP)               IEDAC026
      DIMENSION NOTE1(9),NOTE2(2),NOTE3(6)                                  IEDAC027
      DATA NOTE1/4H    ,4H    ,4HSLAB,4H CYL,4HINDR,4HICAL,                 IEDAC028
     14H   S,4HPHER,4HICAL/                                                 IEDA0029
      DATA NOTE4/4H  I=/                                                    IEDAC030
      DATA NOTE2/4H NO ,4H YES/                                             IEDAC031
      DATA NOTE3/4HZERO,4H    ,4H    ,4HSYMM,4HETRY,4H    /                 IEDAC032
      DATA NOTE5/4H GP=/                                                    IEDAC033
C                                                                           IEDAC034
      CALL TITLE (2)                                                        IEDAC035
      WRITE (6,300) GRP,DEL,REG,NCOMP                                       IEDAC036
```

```
      NG=GEOM*3+1                                                       IEDAC0037
      LBOND=1+3*BCL                                                     IEDAC0038
      RBOND=1+3*BCR                                                     IEDAC0039
      NPUN=1+PUNFRS                                                     IEDAC0040
      NBAL=1+PUNBAL                                                     IEDAC0041
      WRITE (6,310) NOTE1(NG),NOTE1(NG+1),NOTE1(NG+2),NOTE3(LBOND),     IEDAC0042
     1NOTE3(LBOND+1),NOTE3(LBOND+2),NOTE3(RBOND),NOTE3(RBOND+1),        IEDAC0043
     2NOTE3(RBOND+2),NOTE2(NPUN),NOTE2(NBAL)                            IEDAC0044
      WRITE (6,320) (WPT(N),N=1,NUM)                                    IEDAC0045
      WRITE (6,330) THG                                                 IEDAC0046
      WRITE (6,340)                                                     IEDAC0047
      N1=1                                                              IEDAC0048
      DO 110 R=1,REG                                                    IEDAC0049
      WRITE (6,350) R,N1,PB(R)                                          IEDAC0050
  110 N1=PB(R)                                                          IEDAC0051
      WRITE (6,360)                                                     IEDAC0052
      WRITE (6,370) ( R,LR(R),DR(R) ,R=1,REG)                           IEDAC0053
      WRITE (6,290)                                                     IEDAC0054
      IF (DEL) 120,120,130                                              IEDAC0055
  120 WRITE (6,380)                                                     IEDAC0056
      GO TO 150                                                         IEDAC0057
  130 WRITE (6,390) ( NOTE4,I ,I=1,DEL)                                 IEDAC0058
      DO 140 G=1,GRP                                                    IEDAC0059
      WRITE (6,400)  G,(SD(G,GP),GP=1,DEL)                              IEDAC0060
  140 CONTINUE                                                          IEDAC0061
      WRITE (6,290)                                                     IEDAC0062
  150 WRITE (6,410)                                                     IEDAC0063
      WRITE (6,420) ( G,V(G),NU(G),CHI(G) ,G=1,GRP)                     IEDAC0064
      WRITE (6,290)                                                     IEDAC0065
C                                                                       IEDAC0066
C     CROSS SECTIONS BY COMPOSITION ORDER                               IEDAC0067
C                                                                       IEDAC0068
      N=1                                                               IEDAC0069
  160 DO 200 R=1,REG                                                    IEDAC0070
      IF (NCMP(R).NE.N) GO TO 200                                       IEDAC0071
      WRITE (6,430) N                                                   IEDAC0072
```

```
      WRITE (6,440) ( G,C(R,G),SIGC(R,G),SIGF(R,G) ,G=1,GRP)
      WRITE (6,290)
      WRITE (6,450)
      L1=1
      L2=GRP
  170 L3=GRP
      IF (L2.LE.9) GC TO 180
      L2=L2-9
      L3=L1+8
  180 WRITE (6,460) ( NCTE5,G ,G=L1,L3)
      DC 190 GP=1,GRP
  190 WRITE (6,520) GP,(SIGX(R,GP,G),G=L1,L3)
      IF (L3.EQ.GRP) GO TC 210
      L1=L3+1
      GC TC 170
  200 CCNTINUE
      CALL ERR (3,0,C,0)
  210 IF (N.EC.NCCMP) GC TO 220
      N=N+1
      GO TO 160
  220 CCNTINUE
      WRITE (6,290)
      WRITE (6,470)
      WRITE (6,480) ( R,NCMP(R) ,R=1,REG)
      WRITE (6,290)
      IF (XEN.NE.0) GC TO 230
      WRITE (6,490)
      GC TC 240
  230 CCNTINUE
      WRITE (6,500)
C
      WRITE (6,510) ( R,XENCN(R),IODINE(R),GAMAX,GAMAI ,R=1,REG)
  240 CONTINUE
      WRITE (6,290)
      N1=1
      IF (STEADY.GT.C) N1=2
```

```
      WRITE (6,530) NOTE2(N1)                                           IEDA0109
      IF (STEADY.EQ.2) GO TO 280                                        IEDA0110
      WRITE (6,540)                                                     IEDA0111
      DO 250 G=1,GRP                                                    IEDA0112
 250  WRITE (6,550) (P,PSI(P,G),P=1,PT)                                 IEDA0113
      IF (STEADY.EQ.0) GO TO 260                                        IEDA0114
      WRITE (6,560)                                                     IEDA0115
      GO TO 280                                                         IEDA0116
  260 WRITE (6,570)                                                     IEDA0117
      DO 270 G=GL,GU                                                    IEDA0118
 270  WRITE (6,550) (P,PSI(P,G),P=1,PT)                                 IEDA0119
  280 CONTINUE                                                          IEDA0120
C                                                                       IEDA0121
C                                                                       IEDA0122
  290 FORMAT (1H0)                                                      IEDA0123
  300 FORMAT (1H0/25X,18H*** INPUT EDIT ***//3X,I2,19H NEUTRON GROUP(S)  IEDA0124
     1,,3X,I2,19H DELAYED GROUP(S) ,,3X,I2,12H REGION(S) ,,3X,I2,15H COM IEDA0125
     2POSITION(S)/)                                                     IEDA0126
  310 FORMAT(2X,3A4,11H GEOMETRY ,,3X,14HLEFT BOUNDARY ,3A4,3X, 15HRIGHT IEDA0127
     1 BOUNDARY ,3A4//2X,45HIS THERE TO BE END OF PROBLEM PUNCHED OUTPUT IEDA0128
     2 ,A4,3X,1H,/43H0ARE THE STEADY STATE FLUXES TO BE PUNCHED ,A4,2X) IEDA0129
  320 FORMAT (38H0TEST POINTS FOR FREQUENCY CALCULATION,3X,15I5/(48X,15I IEDA0130
     15))                                                               IEDA0131
  330 FORMAT (8H0GROUP  ,I3,61H IS SPECIFIED AS THE TEST GROUP FOR THE F IEDA0132
     1REQUENCY CALCULATION/)                                            IEDA0133
  340 FORMAT (1H0/33H  REGION    MESH POINT BOUNDARIES/26H  NUMBER       IEDA0134
     1 LEFT  RIGHT)                                                     IEDA0135
  350 FORMAT (4X,I3,8X,I3,4X,I3)                                        IEDA0136
  360 FORMAT (1H0/4X,6HREGION,4X,6HLENGTH,4X,12HMESH SPACING/4X,6HNUMBER IEDA0137
     1,5X,4H(CM),9X,4H(CM))                                             IEDA0138
  370 FORMAT (5X,I3,4X,F10.4,4X,F8.4)                                   IEDA0139
  380 FORMAT (19H0 NO DELAYED GROUPS)                                   IEDA0140
  390 FORMAT (59H0FRACTIONAL YIELD FROM DELAYED GROUP I INTO NEUTRON GRO IEDA0141
     1UP G/2X,5HGROUP,3X,10(3X,A4,I2,1X))                               IEDA0142
  400 FORMAT (3X,I3,4X,10(2X,F8.5))                                     IEDA0143
  410 FORMAT (4X,5HGROUP,5X,15HAVERAGE NEUTRON,6X,12HNEUTRONS PER,6X,7HF IEDA0144
```

```
     1ISSION/4X,6HNUMBER,4X,14HSPEED (CM/SEC),8X,7HFISSION,11X,5HYIELD)      IEDA0145
  420 FORMAT (5X,I3,6X,E12.6,7X,E12.6,5X,E12.6)                              IEDA0146
  430 FORMAT (14HOCOMPOSITION  ,I2/6X,5HGROUP,4X,9HDIFFUSION,6X,30HGROUP     IEDA0147
     1 DEPENDENT CROSS SECTIONS/6X,19HNUMBER  COEFFICIENT,6X,9H(CAPTURE)     IEDA0148
     2,4X,9H(FISSION))                                                       IEDA0149
  440 FORMAT (7X,I3,4X,E12.6,2X,E12.6,2X,E12.6)                              IEDA0150
  450 FORMAT (7X,97HSCATTERING MATRIX  GP INTO G  (THE TOTAL REMOVAL IS      IEDA0151
     1COMPUTED AND STORED AS THE DIAGONAL ELEMENTS))                         IEDA0152
  460 FORMAT (4H (G),1X,9(6X,A4,I2))                                         IEDA0153
  470 FORMAT (34HOCOMPOSITION ASSIGNMENT TO REGIONS/22H   REGION  COMPOS     IEDA0154
     1ITION)                                                                 IEDA0155
  480 FORMAT (5X,I2,8X,I2)                                                   IEDA0156
  490 FORMAT (43HONO XENON BUILDUP CONSIDERD IN THIS PROBLEM)                IEDA0157
  500 FORMAT (7HOREGION,7X,14HCONCENTRATIONS,10X,13HFISSION YIELD/7H NUM     IEDA0158
     1BER,4X,5HXENON,8X,6HIODINE,7X,5HXENON,8X,6HIODINE)                     IEDA0159
  510 FORMAT (3X,I2,1X,4(3X,E10.5))                                          IEDA0160
  520 FORMAT (2X,I2,3X,9E12.6)                                               IEDA0161
  530 FORMAT (48HOARE STEADY STATE CONDITIONS TO BE CALCULATED ? ,A4)        IEDA0162
  540 FORMAT (24HOINPUT FLUX DISTRIBUTION)                                   IEDA0163
  550 FORMAT ((2X,6(1H(,I3,2H) ,1PE12.6)))                                   IEDA0164
  560 FORMAT (92HOTHE INITIAL PRECURSOR CONCENTRATIONS ARE CALCULATED FR     IEDA0165
     1OM THE STEADY STATE FLUX DISTRIBUTION)                                 IEDA0166
  570 FORMAT (60HOTHE INITIAL PRECURSOR CONCENTRATIONS ARE READ IN FROM      IEDA0167
     1CARDS)                                                                 IEDA0168
      RETURN                                                                 IEDA0169
      END                                                                    IEDA0170
```

```
      SUBROUTINE INEDB(TAGX,TAGT,TAGC,TAGF,CXL,CXQ,CTRL,CTRQ,CCL,CCQ,
     1CFL,CFQ,SOR,SORG,SRCE0,SRCE1,IPL,IPR)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CUT,
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,
     3          SCRCE , SORG , SCZ , STEADY , STEP , TAGC , TAGF , TAGT
      REAL*8 IODINE
      REAL*8 LR,NU,NUSIGF,NX
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      COMMON /A3/PUNBAL,SORCE,GEOM,NTAG,NUM2,PUNFRS
      COMMON/A5/IN,OUT,NERR
      COMMON/A6/EP1,EP2,EP3,TSTINC,IEP4,IEP6
      COMMON /B1/H,HP,TIME,TZ,ZERO,TZO,TIMZ
      COMMON /B2/NPRT,NZ,ISX,STEP,NZSAVE,PRBEND,IPRN
C     ...................................................................
C
      DIMENSION IPL(REG),IPR(REG)
      DIMENSION SOR(REG),SORG(REG,GRP),SRCE0(PT,GRP),SRCE1(PT,GRP)
      DIMENSION TAGC(REG),TAGF(REG),TAGT(REG),TAGX(REG)
      DIMENSION CCL(REG,GRP),CCQ(REG,GRP),CFL(REG,GRP),CFQ(REG,GRP),
     1CTRL(REG,GRP),CTRQ(REG,GRP),CXL(REG),CXQ(REG)
      DIMENSION NOTE2(2)
      DATA NOTE2(1),NOTE2(2) /4H  NO,4H YES /
      N1=1
      IF (NTAG.NE.0) N1=2
      WRITE (6,250) NOTE2(N1)
      IF (NTAG.EQ.0) GO TO 180
      WRITE (6,300)
      DO 170 R=1,REG
      IF (TAGX(R).EQ.0) GO TO 110
      WRITE (OUT,270) NZ,R,CXL(R),CXQ(R)
  110 IF (TAGT(R).EQ.0) GO TO 130
      DO 120 G=1,GRP
      IF ((CTRL(R,G).NE.0).OR.(CTRQ(R,G).NE.0)) WRITE (OUT,260) NZ,G,R,C
     1TRL(R,G),CTRQ(R,G)
```

```
  120 CONTINUE                                                          IEDBC037
  130 IF (TAGC(R).EQ.0) GO TO 150                                       IEDBC038
      DO 140 G=1,GRP                                                    IEDBC039
      IF ((CCL(R,G).NE.0.0).OR.(CCQ(R,G).NE.0.0)) WRITE (OUT,280) NZ,G,R IEDBC040
     1,CCL(R,G),CCQ(R,G)                                                IEDBC041
  140 CONTINUE                                                          IEDBC042
  150 IF (TAGF(R).EQ.0) GO TO 170                                       IEDBC043
      DO 160 G=1,GRP                                                    IEDBC044
      IF ((CFL(R,G).NE.0.0).OR.(CFQ(R,G).NE.0.0)) WRITE (OUT,290) NZ,G,R IEDBC045
     1,CFL(R,G),CFQ(R,G)                                                IEDBC046
  160 CONTINUE                                                          IEDBC047
  170 CONTINUE                                                          IEDBC048
  180 CONTINUE                                                          IEDBC049
C     EDIT OF SOURCE INPUT                                              IEDBC050
      N1=1                                                              IEDBC051
      IF (SORCE.NE.0) N1=2                                              IEDBC052
      WRITE (6,310) NOTE2(N1)                                           IEDBC053
      IF (SORCE.EQ.0) GO TO 240                                         IEDBC054
      WRITE (6,320)                                                     IEDBC055
      WRITE (6,330)                                                     IEDBC056
      DO 230 R=1,REG                                                    IEDBC057
      IF (SOR(R)-1) 230,210,190                                         IEDBC058
  190 CONTINUE                                                          IEDBC059
C     SPACE DEPENDENT SOURCE ACROSS THE REGION                          IEDBC060
      PL=IPL(R)                                                         IEDBC061
      PR=IPR(R)                                                         IEDBC062
      DO 200 G=1,GRP                                                    IEDBC063
      IF (SORG(R,G).EQ.0) GO TO 200                                     IEDBC064
      WRITE (6,340) NZ,R,G                                              IEDBC065
      WRITE (6,350) (II,SRCE0(II,G),II=PL,PR)                           IEDBC066
      WRITE (6,360) (II,SRCE1(II,G),II=PL,PR)                           IEDBC067
  200 CONTINUE                                                          IEDBC068
      GO TO 230                                                         IEDBC069
  210 CONTINUE                                                          IEDBC070
C     CONSTANT SOURCE FOR THE REGION                                    IEDBC071
      II=IPR(R)                                                         IEDBC072
```

```
      DO 220 G=1,GRP
      IF (SORG(R,G).EQ.0) GO TO 220
      WRITE (6,370) NZ,R,G,SRCE0(II,G),SRCE1(II,G)
  220 CONTINUE
  230 CONTINUE
  240 CONTINUE
      RETURN
C
  250 FORMAT (44H0ARE THERE ANY TIME DEPENDENT CHANGES IN THE/21H CROSS
     1SECTION DATA  A4)
  260 FORMAT (2X,I2,7X,9HTRANSPORT,5X,I2,6X,I2,8X,E11.5,4X,E11.5)
  270 FORMAT (2X,I2,7X,9HTRANSFER ,13X,I2,8X,E11.5,4X,E11.5)
  280 FORMAT (2X,I2,7X,9H CAPTURE ,5X,I2,6X,I2,8X,E11.5,4X,E11.5)
  290 FORMAT (2X,I2,7X,9H FISSION ,5X,I2,6X,I2,8X,E11.5,4X,E11.5)
  300 FORMAT (71H0TIME   CROSS SECTION   GROUP   REGION   TOTAL LINEAR
     1 TOTAL QUADRATIC/5H ZONE,21X,1H ,7X,1H ,9X,6HCHANGE,8X,6HCHANGE)
  310 FORMAT (40H0ARE THERE ANY TIME DEPENDENT SOURCES ? ,A4)
  320 FORMAT (21H0 SOURCE DISTRIBUTION/61H    A - UNIFORM SOURCE FOR ALL
     1 SPACE POINTS WITHIN THE REGION/49H    B - SPACE DEPENDENT SOURCES
     2 WITHIN THE REGION)
  330 FORMAT (36H0TIME   REGION  GROUP   DISTRIBUTION/5H ZONE)
  340 FORMAT (2X,I2,6X,I2,5X,I2,8X,3H(A))
  350 FORMAT (43X,14HINITIAL SOURCE4(1X,1H(,I2,1H),E10.5 )/(57X,4(1X,1H(
     1,I2,1H),E10.5)))
  360 FORMAT (38X,19HTIME RATE OF CHANGE,4(1X,1H(,I2,1H),E10.5)/(57X,4(1
     1X,1H(,I2,1H),E10.5)))
  370 FORMAT (2X,I2,6X,I2,5X,I2,8X,3H(B),17H  INITIAL SOURCE=,E10.5/27X,
     120HTIME RATE OF CHANGE=)
      END
```

```
      SUBROUTINE INPTA1
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CUT,
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT
      INTEGER GF,GRPLUS
      REAL*8 LR,NU,NUSIGF,NX
      REAL*8 IODINE
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY
      COMMON /A3/PUNBAL,SORCE,GEOM,NTAG,NUM2,PUNFRS
      COMMON /A4/TIGHT1,TIGHT2,TIGHT3
      COMMON/A5/IN,OUT,NERR
      COMMON/C1/M1,M2,M4,M5,M7
      COMMON /C2/GF,GRPLUS
      DIMENSION IC(14)
      ABS(X)=DABS(X)
      FLOAT(I)=DFLOAT(I)
C     ******************** CARD   1   *****************************
      CALL TITLE (1)
      WRITE (OUT,390)
      CALL TITLE (3)
C     ******************** CARD   2   *****************************
      READ (IN,350) GRP,THG,GF,DEL,REG,NUM,NCOMP,GEOM,BCL,BCR,MTZ,XEN
      WRITE (OUT,400) GRP,THG,GF,DEL,REG,NUM,NCOMP,GEOM,BCL,BCR,MTZ,XEN
      IF ((GRP.LT.1).OR.(GRP.GT.M2)) CALL ERR (1,1,2,1)
      IF ((THG.LT.1).OR.(THG.GT.GRP)) CALL ERR (1,1,2,2)
      IF ((GF.LT.0).OR.(GF.GT.GRP)) CALL ERR (1,1,2,3)
      IF ((DEL.LT.0).OR.(DEL.GT.M4)) CALL ERR (1,1,2,4)
      IF ((REG.LT.1).OR.(REG.GT.M1)) CALL ERR (1,1,2,5)
      IF ((NUM.LT.1).OR.(NUM.GT.M7)) CALL ERR (1,1,2,6)
      IF(NUM.LT.REG) CALL ERR(1,1,2,6)
      IF (NCOMP.LT.1) CALL ERR (1,1,2,7)
      IF ((GEOM.LT.0).OR.(GEOM.GT.2)) CALL ERR (1,1,2,8)
      IF ((BCL.NE.0).AND.(BCL.NE.1)) CALL ERR (1,1,2,9)
```

```
      IF ((BCR.NE.0).AND.(BCR.NE.1)) CALL ERR (1,1,2,10)
      IF (MTZ.EQ.0) CALL ERR (1,1,2,11)
      IF ((XEN.NE.0).AND.(XEN.NE.1)) CALL ERR (1,1,2,12)
C
      PUNFRS=1
      IF (MTZ.LT.0) PUNFRS=0
      NTZ=IABS(MTZ)
      GL=GRP+1
      GU=DEL+GRP
      GRPLUS=GRP+1
      IDEL=DEL
      IF(DEL.EQ.0)IDEL=1
C     ******************** CARD   3   *****************************
      READ  (IN ,380) STEADY,PUNBAL,TIGHT1,TIGHT2,TIGHT3,PT
      WRITE (OUT,410) STEADY,PUNBAL,TIGHT1,TIGHT2,TIGHT3,PT
      DO 1 I=1,4
      IF (STEADY.EQ.(I-1)) GO TO 2
    1 CONTINUE
      CALL ERR(1,1,3,1)
    2 CONTINUE
      IF ((PUNBAL.NE.0).AND.(PUNBAL.NE.1)) CALL ERR (1,1,3,2)
      IF (TIGHT1.LT.0) CALL ERR (1,1,3,3)
      IF (TIGHT2.LT.0) CALL ERR (1,1,3,4)
      IF (TIGHT3.LT.0) CALL ERR (1,1,3,5)
      RETURN
  350 FORMAT (12I6)
 380  FORMAT (2I6,3E12.6,I6)
  390 FORMAT (10H1CARD  01 )
  400 FORMAT (10H0CARD  02 ,2X,12I6)
  410 FORMAT (10H0CARD  03 ,2X,2I6,3E12.6,I6)
      END
```

```
      SUBROUTINE INPTA2(PSI,SIGF,SIGC,SIGT,SIGX,NU,SD,SDIN,CHI,VINV,V,        IPA2C001
     1NCMP,FUEL,XABS,XENON,IODINE,PB,LR,WPT,SIGCIN,SIGFIN,SIGTIN,SIGXIN)      IPA2C002
      IMPLICIT REAL*8 (A-H,O-Z)                                               IPA2C003
      INTEGER  GF,GPLUS,GFPLUS,GRPLUS                                         IPA2C004
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,                   IPA2C005
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,OUT,      IPA2C006
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,        IPA2C007
     3          SCRCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT       IPA2C008
      REAL*8 IODINE                                                           IPA2C009
      REAL*8 LR,NU,NUSIGF,NX                                                  IPA2C010
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL                                IPA2C011
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY                         IPA2C012
      COMMON /A4/TIGHT1,TIGHT2,TIGHT3                                         IPA2C013
      COMMON/A5/IN,OUT,NERR                                                   IPA2C014
      COMMON/A6/EP1,EP2,EP3,TSTINC,IEP4,IEP6                                  IPA2C015
      COMMON /A7/BETA(6),DECAY(6),BETDCY(6),DECH(6)                           IPA2C016
      COMMON /A8/GAMAX,GAMAI                                                  IPA2C017
      COMMON /B1/H,HP,TIME,TZ,ZERO,TZO,TIMZ                                   IPA2C018
      COMMON /C2/GF,GRPLUS                                                    IPA2C019
      DIMENSION PSI(PT,GU)                                                    IPA2C020
      DIMENSION XABS(REG,GRP)                                                 IPA2C021
      DIMENSION XENON(REG),IODINE(REG)                                        IPA2C022
      DIMENSION VINV(GRP)                                                     IPA2C023
      DIMENSION V(GRP)                                                        IPA2C024
      DIMENSION PB(REG),LR(REG)                                               IPA2C025
      DIMENSION CHI(GRP)                                                      IPA2C026
      DIMENSION FUEL(REG)                                                     IPA2C027
      DIMENSION NCMP(REG)                                                     IPA2C028
      DIMENSION SD(GRP,IDEL)                                                  IPA2C029
      DIMENSION SDIN(GRP,IDEL)                                                IPA2C030
      DIMENSION WPT(NUM)                                                      IPA2C031
      DIMENSION NU(GRP)                                                       IPA2C032
      DIMENSION SIGC(REG,GRP),SIGF(REG,GRP),SIGT(REG,GRP),                    IPA2C033
     1SIGX(REG,GRP,GRP)                                                       IPA2C034
      DIMENSION SIGCIN(GRP),SIGFIN(GRP),SIGTIN(GRP)                           IPA2C035
      DIMENSION SIGXIN(GRPLUS,GRP)                                            IPA2C036
```

```
      DIMENSION IC(14)                                                  IPA2C037
      ABS(X)=DABS(X)                                                    IPA2C038
      FLOAT(I)=DFLOAT(I)                                                IPA2C039
C     ******************** CARD   4   *****************************     IPA2C040
      READ (IN,350) (PB(R),R=1,REG)                                     IPA2C041
      WRITE (OUT,420) (PB(R),R=1,REG)                                   IPA2C042
      IF (REG.EQ.1) GO TO 120                                           IPA2C043
      N=REG-1                                                           IPA2C044
      DO 110 R=1,N                                                      IPA2C045
      IF (PB(R).GE.PB(R+1)) CALL ERR (1,1,4,R)                          IPA2C046
  110 CONTINUE                                                          IPA2C047
C                                                                       IPA2C048
C                                                                       IPA2C049
 120  IF(PT.NE.PB(REG).OR.PT.LT.1) CALL ERR(1,1, 3,6)                   IPA2C050
C     ******************** CARD   5   *****************************     IPA2C051
      READ (IN,360) (LR(R),R=1,REG)                                     IPA2C052
      WRITE (OUT,430) (LR(R),R=1,REG)                                   IPA2C053
      DO 130 R=1,REG                                                    IPA2C054
      IF (LR(R).LE.0.0) CALL ERR (1,1,5,R)                              IPA2C055
  130 CONTINUE                                                          IPA2C056
C     ******************** CARD   6   *****************************     IPA2C057
      READ (IN,350) (WPT(N),N=1,NUM)                                    IPA2C058
      WRITE (OUT,440) (WPT(N),N=1,NUM)                                  IPA2C059
      DO 140 N=1,NUM                                                    IPA2C060
  140 IF (WPT(N).GT.PT) CALL ERR (1,2,WPT(N),0)                         IPA2C061
C                                                                       IPA2C062
      IF (DEL.EQ.0) GO TO 180                                           IPA2C063
C     ******************** CARD   7   *****************************     IPA2C064
      READ (IN,360) (BETA(GP),GP=1,DEL)                                 IPA2C065
      WRITE (OUT,450) (BETA(GP),GP=1,DEL)                               IPA2C066
C                                                                       IPA2C067
C     ******************** CARD   8   *****************************     IPA2C068
      DO 150 G=1,GRP                                                    IPA2C069
      READ (IN,360) (SDIN(G,I),I=1,DEL)                                 IPA2C070
      WRITE (OUT,460) (SDIN(G,I),I=1,DEL)                               IPA2C071
  150 CONTINUE                                                          IPA2C072
```

```
C       ******************** CARD   9   ****************************
        READ (IN,360) (DECAY(GP),GP=1,DEL)
        WRITE (OUT,470) (DECAY(I),I=1,DEL)
        DO 170 GP=1,DEL
        DO 160 G=1,GRP
  160   SD(G,GP)=ABS(SDIN(G,GP)*DECAY(GP))
  170   DECAY(GP)=-ABS(DECAY(GP))
C
  180   CONTINUE
C       ******************** CARD   10  ****************************
        READ (IN,360) (CHI(G),G=1,GRP)
        WRITE (OUT,480) (CHI(G),G=1,GRP)
C
C       ******************** CARD   11  ****************************
        READ (IN,360) (V(G),G=1,GRP)
        WRITE (OUT,490) (V(G),G=1,GRP)
        DO 190 G=1,GRP
  190   VINV(G)=1.0/V(G)
C       ******************** CARD   12  ****************************
        READ  (IN ,660) EP1,EP2,EP3,IEP4,IEP6,TSTINC
        WRITE (OUT,700) EP1,EP2,EP3,IEP4,IEP6,TSTINC
        IF(EP1.LE.0.0) CALL ERR (1,1,12,1)
        IF(EP2.LE.0.0) CALL ERR (1,1,12,2)
        IF(IEP4.NE.0.AND.IEP4.NE.1) CALL ERR(1,1,12,5)
        IF(IEP6.NE.0.AND.IEP6.NE.1) CALL ERR(1,1,12,6)
        GFPLUS=GF+1
C       ******************** CARD   13  ****************************
        READ (IN,350) (NCMP(R),R=1,REG)
        WRITE (OUT,510) (NCMP(R),R=1,REG)
        DO 310 I=1,NCOMP
        DO 200 G=1,GRP
        SIGCIN(G)=0.0
        SIGFIN(G)=0.0
        SIGTIN(G)=0.0
        DO 200 GP=1,GRP
  200   SIGXIN(GP,G)=0.0
```

```
C      ******************** CARD   14  ****************************
       READ (IN,370) NUCNAM,(ID(K),K=1,14),I1,I2,I3
       WRITE (OUT,520) NUCNAM,(ID(K),K=1,14),I1,I2,I3
C      ******************** CARD   15  ****************************
       DO 210 G=1,GRP
       READ (IN,360) NU(G),SIGFIN(G),SIGCIN(G),SIGTIN(G),XX,SIGXIN(G+1,G)
       WRITE (OUT,530) NU(G),SIGFIN(G),SIGCIN(G),SIGTIN(G),XX,SIGXIN(G+1,
      1G)
  210 CONTINUE
       INDX=I2+1
       GO TO (270,220,250), INDX
  220 CONTINUE
C      FAST MATRIX
       IF (GF.EQ.0) GO TO 270
       DO 240 G=1,GF
       GPLUS=G+1
       IF (GPLUS.GT.GRP) GO TO 230
C      ******************** CARD   16  ****************************
       READ (IN,360) (SIGXIN(GP,G),GP=GPLUS,GFPLUS)
       WRITE (OUT,540) (SIGXIN(GP,G),GP=GPLUS,GFPLUS)
       GO TO 240
  230 READ (IN,360) XX
  240 CONTINUE
       GO TO 270
  250 DO 260 G=1,GRP
C      ******************** CARD   17  ****************************
       READ (IN,360) (SIGXIN(GP,G),GP=1,GRP)
       WRITE (OUT,550) (SIGXIN(GP,G),GP=1,GRP)
  260 CONTINUE
  270 CONTINUE
C
C      ASSIGNMENT OF COMPOSITIONS TO REGIONS
C
       DO 300 R=1,REG
       IF (NCMP(R).NE.I) GO TO 300
       DO 290 G=1,GRP
```

```
      SIGF(R,G)=SIGFIN(G)
      SIGC(R,G)=SIGCIN(G)
      SIGT(R,G)=SIGTIN(G)
      DO 280 GP=1,GRP
  280 SIGX(R,GP,G)=SIGXIN(GP,G)
  290 CONTINUE
  300 CONTINUE
  310 CONTINUE
C
C     SET FUEL(R)=0 FOR NON FISSION REGIONS
C
      DO 311 R=1,REG
      FUEL(R)=0
      DO 311 G=1,GRP
      IF( ABS(SIGF(R,G)).GT.ZERO ) FUEL(R)=1
  311 CONTINUE
C
      IF (XEN.EQ.0) GO TO 330
C     ******************** CARD   18  *****************************
      READ (IN,360) GAMAX,GAMAI
      WRITE (OUT,560) GAMAX,GAMAI
C     ******************** CARD   19  *****************************
      DO 320 R=1,REG
      READ ( IN,360) XENON(R),IODINE(R),(XABS(R,G),G=1,GRP)
      WRITE(OUT,570) XENON(R),IODINE(R),(XABS(R,G),G=1,GRP)
  320 CONTINUE
  330 CONTINUE
      IF (STEADY.EQ.2) GO TO 345
      IPP=GRP
      IF (STEADY.EQ.0) IPP=GU
      DO 340 G=1,IPP
C     ******************** CARD   20  *****************************
      READ ( IN,360) (PSI(P,G),P=1,PT)
      WRITE (OUT,580) (PSI(P,G),P=1,PT)
  340 CONTINUE
 345  CONTINUE
```

```
      RETURN                                                            IPA20181
C                                                                       IPA20182
  350 FORMAT (12I6)                                                     IPA20183
  360 FORMAT (6E12.5)                                                   IPA20184
  370 FORMAT(15A4,3I4)                                                  IPA20185
  420 FORMAT (10H0CARD  04,2X,12I6/(12X,12I6))                          IPA20186
  430 FORMAT (10H0CARD  05 ,2X,6E12.6/(12X,6E12.6))                     IPA20187
  440 FORMAT (10H0CARD  06 ,2X,12I6/(12X,12I6))                         IPA20188
  450 FORMAT (10H0CARD  07 ,2X,6E12.6/(12X,6E12.6))                     IPA20189
  460 FORMAT (10H0CARD  08 ,2X,6E12.6/(12X,6E12.6))                     IPA20190
  470 FORMAT (10H0CARD  09 ,2X,6E12.6/(12X,6E12.6))                     IPA20191
  480 FORMAT (10H0CARD  10 ,2X,6E12.6/(12X,6E12.6))                     IPA20192
  490 FORMAT (10H0CARD  11 ,2X,6E12.6/(12X,6E12.6))                     IPA20193
  510 FORMAT (10H0CARD  13 ,2X,12I6/(12X,12I6))                         IPA20194
  520 FORMAT (10H0CARD  14 ,2X,15A4,3I4)                                IPA20195
  530 FORMAT (10H0CARD  15 ,2X,6E12.6)                                  IPA20196
  540 FORMAT (10H0CARD  16 ,2X,6E12.6/(12X,6E12.6))                     IPA20197
  550 FORMAT (10H0CARD  17 ,2X,6E12.6/(12X,6E12.6))                     IPA20198
  560 FORMAT (10H0CARD  18 ,2X,6E12.6)                                  IPA20199
  570 FORMAT (10H0CARD  19 ,2X,6E12.6)                                  IPA20200
  580 FORMAT (10H0CARD  20 ,2X,6E12.6/(12X,6E12.6))                     IPA20201
 660  FORMAT (3E12.5,2I12,E12.5)                                        IPA20202
 700  FORMAT (10H0CARD  12 ,2X,3E12.6,2I12,E12.6)                       IPA20203
C                                                                       IPA20204
      END                                                               IPA20205
```

```
      SUBROUTINE INPUTB(SOR,SORG,SRCEO ,SRCE1,STPRN,IPL,IPR,RTAG,TAGX,IN        IPB 0001
     1TAGT,TAGF,TAGC,CXL,CXQ,CTRL,CTRQ,CCL,CCQ,CFL,CFQ)                 IN        IPB 0002
      IMPLICIT REAL*8 (A-H,O-Z)                                          IN        IPB 0003
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,              IN        IPB 0004
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CUT,           IPB 0005
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,IN           IPB 0006
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CUT,           IPB 0007
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,             IPB 0008
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT            IPB 0009
      INTEGER RTAG                                                                 IPB 0010
      REAL*8 IODINE                                                                IPB 0011
      REAL*8 LR,NU,NUSIGF,NX                                                       IPB 0012
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL                                     IPB 0013
      COMMON /A3/PUNBAL,SORCE,GEOM,NTAG,NUM2,PUNFRS                                IPB 0014
      COMMON/A5/IN,OUT,NERR                                                        IPB 0015
      COMMON/A6/EP1,EP2,EP3,TSTINC,IEP4,IEP6                                       IPB 0016
      COMMON /B1/H,HP,TIME,TZ,ZERO,TZO,TIMZ                                        IPB 0017
      COMMON /B2/NPRT,NZ,ISX,STEP,NZSAVE,PRBEND,IPRN                               IPB 0018
      DIMENSION IPL(REG),IPR(REG)                                                  IPB 0019
      DIMENSION STPRN(50)                                                          IPB 0020
      DIMENSION SOR(REG),SORG(REG,GRP),SRCEO(PT,GRP),SRCE1(PT,GRP)                 IPB 0021
      DIMENSION RTAG(REG)                                                          IPB 0022
      DIMENSION TAGC(REG),TAGF(REG),TAGT(REG),TAGX(REG)                            IPB 0023
      DIMENSION CCL(REG,GRP),CCQ(REG,GRP),CFL(REG,GRP),CFQ(REG,GRP),               IPB 0024
     1CTRL(REG,GRP),CTRQ(REG,GRP),CXL(REG),CXQ(REG)                                IPB 0025
      FLOAT(I)=DFLOAT(I)                                                           IPB 0026
      TZO=TZ                                                                       IPB 0027
      STEP=0                                                                       IPB 0028
      NPRT=1                                                                       IPB 0029
      DO 11 R=1,REG                                                                IPB 0030
      TAGX(R)=0                                                                    IPB 0031
      TAGT(R)=0                                                                    IPB 0032
      TAGC(R)=0                                                                    IPB 0033
      TAGF(R)=0                                                                    IPB 0034
      CXQ(R)=0.0                                                                   IPB 0035
      DO 11 G=1,GRP                                                                IPB 0036
```

```
      CTRQ(R,G)=0.0
      CCQ(R,G)=0.0
   11 CFQ(R,G)=0.0
      WRITE (OUT,510) NZ
C     ******************** CARD   21  ******************************
      READ  (IN,650) HBEGIN,IH,TZ,IPRN,NUM2,NTAG,SORCE,IEP4,IEP6
      WRITE(OUT,670) HBEGIN,IH,TZ,IPRN,NUM2,NTAG,SORCE,IEP4,IEP6
      IF(IH.NE.0.AND.IH.NE.1) CALL ERR(1,1,21,2)
      IF(NZ.EQ.1.AND.IH.NE.1) CALL ERR(1,1,21,2)
      IF(IH.EQ.0) GO TO 15
      H=HBEGIN
      HP=HBEGIN
  15  CONTINUE
      ISX=0
      IF(TZ.LE.0.0D0) ISX=1
      TZ=DABS(TZ)
      IF (TZ.LT.TZ0) CALL ERR (1,1,21,3)
      IF (IPRN.LT.0) CALL ERR (1,1,21,4)
      IF(IABS(NUM2).GT.50)  CALL ERR (1,1,21,5)
      IF ((NTAG.LT.-2).OR.(NTAG.GT.REG)) CALL ERR (1,1,21,6)
      IF ((SORCE.LT.-2).OR.(SORCE.GT.REG)) CALL ERR (1,1,21,7)
C
      IF (NUM2) 110,140,120
  110 NUM2=-NUM2
C     ******************** CARD   22  ******************************
      READ (IN,490) (STPRN(N),N=1,NUM2)
      WRITE (OUT,530) (STPRN(N),N=1,NUM2)
      STPRN(NUM2+1)=TZ
      GO TO 160
 120  X=(TZ-TZ0)/NUM2
      STPRN(1)=TZ0+X
      DO 130 N=2,NUM2
  130 STPRN(N)=STPRN(N-1)+X
      GO TO 160
  140 CONTINUE
      DO 150 N=1,50
```

```
  150 STPRN(N)=0.0                                                    IPB 0073
  160 CONTINUE                                                        IPB 0074
      DO 170 R=1,REG                                                  IPB 0075
  170 RTAG(R)=1                                                       IPB 0076
      IF (NTAG) 270,240,180                                           IPB 0077
  180 CONTINUE                                                        IPB 0078
      DO 230 II=1,NTAG                                                IPB 0079
C     ******************** CARD   23  ****************************    IPB 0080
      READ (IN,480) R,TAGX(R),TAGT(R),TAGC(R),TAGF(R)                 IPB 0081
      WRITE (OUT,540) R,TAGX(R),TAGT(R),TAGC(R),TAGF(R)               IPB 0082
      RTAG(R)=-1                                                      IPB 0083
      IF (TAGX(R).EQ.0) GO TO 190                                     IPB 0084
C     ******************** CARD   24  ****************************    IPB 0085
      READ (IN,490) CXL(R),CXQ(R)                                     IPB 0086
      WRITE (OUT,550) CXL(R),CXQ(R)                                   IPB 0087
C     ******************** CARD   25  ****************************    IPB 0088
  190 IF (TAGT(R).EQ.0) GO TO 200                                     IPB 0089
      IF(TAGT(R).EQ.3)GO TO 195                                       IPB 0090
      READ (IN,490) (CTRL(R,G),G=1,GRP)                               IPB 0091
      WRITE (OUT,560) (CTRL(R,G),G=1,GRP)                             IPB 0092
C     ******************** CARD   26  ****************************    IPB 0093
  195 IF (TAGT(R).LT.2) GO TO 200                                     IPB 0094
      READ (IN,490) (CTRQ(R,G),G=1,GRP)                               IPB 0095
      WRITE (OUT,570) (CTRQ(R,G),G=1,GRP)                             IPB 0096
C     ******************** CARD   27  ****************************    IPB 0097
  200 IF (TAGC(R).EQ.0) GO TO 210                                     IPB 0098
      IF(TAGC(R).EQ.3)GO TO 205                                       IPB 0099
      READ (IN,490) (CCL(R,G),G=1,GRP)                                IPB 0100
      WRITE (OUT,580) (CCL(R,G),G=1,GRP)                              IPB 0101
C     ******************** CARD   28  ****************************    IPB 0102
  205 IF (TAGC(R).LT.2) GO TO 210                                     IPB 0103
      READ (IN,490) (CCQ(R,G),G=1,GRP)                                IPB 0104
      WRITE (OUT,610) (CCQ(R,G),G=1,GRP)                              IPB 0105
C     ******************** CARD   29  ****************************    IPB 0106
  210 IF (TAGF(R).EQ.0) GO TO 220                                     IPB 0107
      IF(TAGF(R).EQ.3)GO TO 215                                       IPB 0108
```

```
      READ (IN,490) (CFL(R,G),G=1,GRP)
      WRITE (OUT,620) (CFL(R,G),G=1,GRP)
C     ******************** CARD   30  *****************************
  215 IF (TAGF(R).LT.2) GO TO 220
      READ (IN,490) (CFQ(R,G),G=1,GRP)
      WRITE (OUT,630) (CFQ(R,G),G=1,GRP)
  220 CONTINUE
  230 CONTINUE
  240 DO 260 R=1,REG
      IF (RTAG(R).LT.0) GO TO 260
      TAGX(R)=0
      TAGT(R)=0
      TAGC(R)=0
      TAGF(R)=0
      CXL(R)=0.0
      CXQ(R)=0.0
      DO 250 G=1,GRP
      CTRL(R,G)=0.0
      CTRQ(R,G)=0.0
      CCL(R,G)=0.0
      CCQ(R,G)=0.0
      CFL(R,G)=0.0
      CFQ(R,G)=0.0
  250 CONTINUE
  260 CONTINUE
  270 CONTINUE
      DO 280 R=1,REG
  280 RTAG(R)=1
      IF (SORCE) 430,440,290
  290 DO 400 N=1,SORCE
C     ******************** CARD   31  *****************************
      READ (IN,480) R,SOR(R)
      WRITE (OUT,640) R,SOR(R)
      RTAG(R)=-1
      PL=IPL(R)
      PR=IPR(R)
```

```
      IF (SOR(R)-1) 340,300,320
C     ******************** CARD   32  ****************************
  300 DO 310 G=1,GRP
      READ (IN,490) ( SRCE0(P,G),SRCE1(P,G) ,P=PL,PR)
      WRITE (OUT,590) ( SRCE0(P,G),SRCE1(P,G) ,P=PL,PR)
  310 CONTINUE
      GO TO 370
  320 K=PL
C     ******************** CARD   33  ****************************
      READ (IN,490) ( SRCE0(K,G),SRCE1(K,G) ,G=1,GRP)
      WRITE (OUT,600) ( SRCE0(K,G),SRCE1(K,G) ,G=1,GRP)
      DO 330 P=PL,PR
      DO 330 G=1,GRP
      SRCE0(P,G)=SRCE0(K,G)
      SRCE1(P,G)=SRCE1(K,G)
  330 CONTINUE
      GO TO 370
  340 CONTINUE
      DO 350 P=PL,PR
      DO 350 G=1,GRP
  350 SRCE1(P,G)=0.0
      DO 360 G=1,GRP
  360 SORG(R,G)=0.0
      GO TO 400
  370 DO 390 G=1,GRP
      SORG(R,G)=0.0
      DO 380 P=PL,PR
  380 IF ((SRCE0(P,G).NE.0).OR.(SRCE1(P,G).NE.0)) SORG(R,G)=1
  390 CONTINUE
  400 CONTINUE
      DO 420 R=1,REG
      IF (RTAG(R).LT.0) GO TO 420
      PL=IPL(R)
      PR=IPR(R)
      DO 410 G=1,GRP
      SORG(R,G)=0
```

```
      DO 410 P=PL,PR
      SRCE0(P,G)=0.0
  410 SRCE1(P,G)=0.0
  420 CONTINUE
  430 RETURN
  440 DO 470 G=1,GRP
      DO 450 P=1,PT
      SRCE0(P,G)=0.0
  450 SRCE1(P,G)=0.0
      DO 460 R=1,REG
  460 SCRG(R,G)=0
  470 CONTINUE
      RETURN
C
  480 FORMAT (12I6)
  490 FORMAT (6E12.5)
  510 FORMAT (1H1,24X,28H*** INPUT EDIT FOR TIME ZONE,I2,4H ***)
  530 FORMAT (10H0CARD  22 ,2X,6E12.6/(12X,6E12.6))
  540 FORMAT (10H0CARD  23 ,2X,12I6)
  550 FORMAT (10H0CARD  24 ,2X,2E12.6)
  560 FORMAT (10H0CARD  25 ,2X,6E12.6/(12X,6E12.6))
  570 FORMAT (10H0CARD  26 ,2X,6E12.6/(12X,6E12.6))
  580 FORMAT (10H0CARD  27 ,2X,6E12.6/(12X,6E12.6))
  590 FORMAT (10H0CARD  32 ,2X,6E12.6/(12X,6E12.6))
  600 FORMAT (10H0CARD  33 ,2X,2E12.6/(12X,2E12.6))
  610 FORMAT (10H0CARD  28 ,2X,6E12.6/(12X,6E12.6))
  620 FORMAT (10H0CARD  29 ,2X,6E12.6/(12X,6E12.6))
  630 FORMAT (10H0CARD  30 ,2X,6E12.6/(12X,6E12.6))
  640 FORMAT (10H0CARD  31 ,2X,2I6)
 650  FORMAT (E12.5,I12,E12.5,6I6)
 670  FORMAT (10H0CARD  21 ,2X,E12.6,I12,E12.6,6I6)
      END
```

```
      SUBROUTINE ITER(PSI,CM,CP,SIGX,PB,IPL,IPR,XL,XR,SDIN,FUEL,
     1NX,NUSIGF,UPSCAT,DNSCAT,DD,DL,DU,WA,GA)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GC,GL,GU,GRP,GPU,OUT,
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT
      REAL*8 LR,NU,NUSIGF,NX
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY
      COMMON /A7/BETA(6),DECAY(6),BETDCY(6),DECH(6)
      COMMON /B2/NPRT,NZ,ISX,STEP,NZSAVE,PRBEND,IPRN
      DIMENSION PSI(PT,GRP)
      DIMENSION IPL(REG),IPR(REG),PB(REG),XL(REG),XR(REG)
      DIMENSION CM(PT,GRP),CP(PT,GRP)
      DIMENSION DD(PT),DL(PT),DU(PT)
      DIMENSION SIGX(REG,GRP,GRP)
      DIMENSION FUEL(REG),NX(GRP)
      DIMENSION SDIN(GRP,IDEL)
      DIMENSION NUSIGF(REG,GRP),UPSCAT(REG,GRP),DNSCAT(REG,GRP)
      DIMENSION WA(PT),GA(PT)
C     THIS ROUTINE PERFORMS 1 FLUX ITERATION
      DO 500 G=1,GRP
  200 BAR=0.0
      IF(DEL.EQ.0) GO TO 204
      DO 203 I=1,DEL
203   BAR=BAR+BETA(I)*SDIN(G,I)
204   BAR=BAR+NX(G)
      DO 110 P=1,PT
      DD(P)=CM(P,G)+CP(P,G)
      DU(P)=-CP(P,G)
  110 DL(P)=-CM(P,G)
      IF(BCL.EQ.1) GO TO 120
      DD(1)=1.0D0
      DU(1)=0.0
      GO TO 130
```

```
120   DD(1)=DD(1)+SIGX(1,G,G)
 130 Z=SIGX(1,G,G)
      PL=2
      PR=IPR(1)
      DO 140 P=PL,PR
140   DD(P)=DD(P)+Z
      I2=PB(1)
      DD(I2)=DD(I2)+Z*XL(1)
      IF(REG-1) 190,190,150
 150 DO 170 R=2,REG
      Z=SIGX(R,G,G)
      I1=PB(R-1)
      DD(I1)=DD(I1)+Z*XR(R-1)
      I1=PB(R)
      DD(I1)=DD(I1)+Z*XL(R)
      PL=IPL(R)
      PR=IPR(R)
      DO 160 P=PL,PR
160   DD(P)=DD(P)+Z
 170 CONTINUE
      IF(BCR.EQ.1) GO TO 180
      DD(PT)=1.0D0
      DL(PT)=0.0
      GO TO 190
180   DD(PT)=DD(PT)+SIGX(REG,G,G)
190   CONTINUE
      PL=1
      IF(BCL.EQ.0) PL=2
      DO 450 R=1,REG
      PR=IPR(R)
      IF((R.EQ.REG).AND.(BCR.EQ.1)) PR=PT
      DO 400 P=PL,PR
      PSI(P,G)=PRCD(P, R ,G,PSI,NUSIGF,SIGX,FUEL,UPSCAT,DNSCAT,BAR)
400   CONTINUE
      PL=PR+2
450   CONTINUE
```

```
      IF(REG.EQ.1) GO TO 460                                            ITER0073
      DO 455 R=2,REG                                                    ITER0074
      P=PB(R-1)                                                         ITER0075
      JR1=R-1                                                           ITER0076
  455 PSI(P,G)=PROD(P,JR1,G,PSI,NUSIGF,SIGX,FUEL,UPSCAT,DNSCAT,BAR)     ITER0077
     1*XL(R-1)+PROD(P, R ,G,PSI,NUSIGF,SIGX,FUEL,UPSCAT,DNSCAT,BAR)*    ITER0078
     2XR(R-1)                                                           ITER0079
  460 CONTINUE                                                          ITER0080
      IF(BCL.EQ.0) PSI(1,G)=0.0                                         ITER0081
      IF(BCR.EQ.0) PSI(PT,G)=0.0                                        ITER0082
      CALL       MATINV(G,PT,GRP,PSI,DU,DL,DD,WA,GA)                    ITER0083
  500 CONTINUE                                                          ITER0084
      RETURN                                                            ITER0085
      END                                                               ITER0086
```

```
      SUBROUTINE LHS(G,DU,DL,DD,CP,CM,TI1,VINV,FF2,XL,XR,IPL,IPR,PB)
C     THIS ROUTINE EVALUATES THE TRI-DIAGONAL MATRIX FOR THE LEFT-HAND
C     SIDE OF THE ALGORITHM FOR GROUP G
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CUT,
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT
      REAL*8 LR,NU,NUSIGF,NX
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY
      DIMENSION FF2(PT)
      DIMENSION VINV(GRP)
      DIMENSION TI1(REG)
      DIMENSION IPL(REG),IPR(REG),XL(REG),XR(REG)
      DIMENSION PB(REG)
      DIMENSION CM(PT,GRP),CP(PT,GRP)
      DIMENSION DD(PT),DL(PT),DU(PT)
      PL=2
      DO 1 R=1,REG
      PR=IPR(R)
      T1=TI1(R)
      DO 2 P=PL,PR
      DU(P)=-CP(P,G)*FF2(P+1)
      DL(P)=-CM(P,G)*FF2(P-1)
      DD(P)=VINV(G)+(CM(P,G)+CP(P,G)-T1)*
     1FF2(P)
 2    CONTINUE
 1    PL=PR+2
      DO 3 R=1,REG
      IF(R-1) 5,4,5
 4    IF(BCL.EQ.1) GO TO 65
      DD(1)=VINV(G)
      DU(1)=0.0
      GO TO 5
 65   DD(1)=VINV(G)+(CM(1,G)+CP(1,G)-
```

```
     1TI1(1))*FF2(1)
      DU(1)=-CP(1,G)*FF2(2)
5     IF(R.EQ.REG) GO TO 3
      P=PB(R)
      T1=TI1(R)*XL(R)+TI1(R+1)*XR(R)
      DD(P)=VINV(G)+(CM(P,G)+CP(P,G)-T1)*FF2(P)
      DU(P)=-CP(P,G)*FF2(P+1)
      DL(P)=-CM(P,G)*FF2(P-1)
3     CONTINUE
      IF(BCR.EQ.1) GO TO 33
      DD(PT)=VINV(G)
      DL(PT)=0.0
      GO TO 605
33    DD(PT)=VINV(G)+(CP(PT,G)+CM(PT,G)-
     1TI1(REG))*FF2(PT)
      DL(PT)=-CM(PT,G)*FF2(PT)
605   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE MATINV(G,PT,GRP,PSI,DU,DL,DD,WA,GA)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER P,G,PT,GRP,PL
      DIMENSION PSI(PT,GRP)
      DIMENSION DD(PT),DL(PT),DU(PT)
      DIMENSION WA(PT),GA(PT)
C     THIS ROUTINE EVALUATES THE FUNCTION AT THE NEW TIME BY INVERTING
C     THE LEFT-HAND SIDE MATRIX. MATRIX FACTORZATION IS USED.
C     FIRST THE FORWARD ELIMINATION
      WA(1)=DU(1)/DD(1)
      GA(1)=PSI(1,G)/DD(1)
      DO 110 P=2,PT
      T1=1.0D0/(DD(P)-DL(P)*WA(P-1))
      IF(P.EQ.PT)GO TO 150
      WA(P)=DU(P)*T1
 150  GA(P)=(PSI(P,G)-DL(P)*GA(P-1))*T1
  110 CONTINUE
C     NOW THE BACK SUBSTITUTION
      PSI(PT,G)=GA(PT)
      PL=PT-1
      DO 120 J=1,PL
      P=PT-J
      PSI(P,G)=GA(P)-WA(P)*PSI(P+1,G)
  120 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE PREC(G,PSI,NUSIGF,FF2,FUEL,XL,XR,PB,IPL,IPR,TD)            PREC0001
      IMPLICIT REAL*8 (A-H,O-Z)                                             PREC0002
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,                 PREC0003
     1          UPSCAT,WPT, FUEL,G,GECM,GP,GPL,GPR,GD,GL,GU,GRP,GPL,CLT,    PREC0004
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,      PREC0005
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT     PREC0006
      REAL*8 LR,NU,NUSIGF,NX                                                PREC0007
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL                              PREC0008
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY                       PREC0009
      COMMON /A7/BETA(6),DECAY(6),BETDCY(6),DECH(6)                         PREC0010
      DIMENSION PSI(PT,GU)                                                  PREC0011
      DIMENSION FF2(PT)                                                     PREC0012
      DIMENSION IPL(REG),IPR(REG),PB(REG),XL(REG),XR(REG)                   PREC0013
      DIMENSION FUEL(REG)                                                   PREC0014
      DIMENSION TD(GRP)                                                     PREC0015
      DIMENSION NUSIGF(REG,GRP)                                             PREC0016
C     THIS ROUTINE CALCULATES THE PRECURSOR CONCENTRATIONS IN THE           PREC0017
C     INTERIOR OF EACH REGION FOR PRECURSOR GROUP G                         PREC0018
      J=G-GRP                                                               PREC0019
      X5=DECAY(J)                                                           PREC0020
      X6=DECH(J)                                                            PREC0021
      DO 17 R=1,REG                                                         PREC0022
      PL=IPL(R)                                                             PREC0023
      IF (R.EQ.1) PL=1                                                      PREC0024
      PR=IPR(R)                                                             PREC0025
      IF (R.EQ.REG) PR=PT                                                   PREC0026
      IF(FUEL(R)) 13,11,13                                                  PREC0027
   11 DO 12 P=PL,PR                                                         PREC0028
      PSI(P,G)=0.0                                                          PREC0029
   12 CONTINUE                                                              PREC0030
      GO TO 17                                                              PREC0031
   13 DO 14 GP=1,GRP                                                        PREC0032
   14 TD(GP)=NUSIGF(R,GP)*BETA(J)                                           PREC0033
      DO 16 P=PL,PR                                                         PREC0034
      T1=0.0                                                                PREC0035
      T2=0.0                                                                PREC0036
```

```
      DO 15 GP=1,GRP                                                    PRECC037
      Y=FF2(P)                                                          PRECC038
      T2=T2+TD(GP)*PSI(P,GP)*Y                                          PRECC039
   15 CONTINUE                                                          PRECC040
      PSI(P,G)=X6*PSI(P,G)+T2                                           PRECC041
   16 CONTINUE                                                          PRECC042
   17 CONTINUE                                                          PRECC043
      IF(BCL.EQ.0) PSI(1,G)=0.0                                         PRECC044
      IF(BCR.EQ.0) PSI(PT,G)=0.0                                        PRECC045
C     THIS ROUTINE CALCULATES THE PRECURSOR CONCENTRATIONS AT THE       PRECC046
C     BOUNDARY POINTS OF THE REGIONS IN PRECURSOR GROUP G               PRECC047
      X8=BETA(J)                                                        PRECC048
      IP=REG-1                                                          PRECC049
      DO 160 R=1,IP                                                     PRECC050
      P=PB(R)                                                           PRECC051
      IF (FUEL(R)) 130,110,130                                          PRECC052
  110 IF (FUEL(R+1)) 130,120,130                                        PRECC053
  120 PSI(P,G)=0.0                                                      PRECC054
      GO TO 160                                                         PRECC055
  130 X1=XL(R)                                                          PRECC056
      X2=XR(R)                                                          PRECC057
      DO 140 GP=1,GRP                                                   PRECC058
      TD(GP)=(NUSIGF(R,GP)*X1+NUSIGF(R+1,GP)*X2)*X8                     PRECC059
  140 CONTINUE                                                          PRECC060
      T1=0.0                                                            PRECC061
      T2=0.0                                                            PRECC062
      Y=FF2(P)                                                          PRECC063
      DO 150 GP=1,GRP                                                   PRECC064
      T2=T2+TD(GP)*PSI(P,GP)*Y                                          PRECC065
  150 CONTINUE                                                          PRECC066
      PSI(P,G)=X6*PSI(P,G)+T2                                           PRECC067
  160 CONTINUE                                                          PRECC068
      RETURN                                                            PRECC069
      END                                                               PRECC070
```

```
      SUBROUTINE PRINTA(PSI,PSITOT,POWREG,WPT,WZ,WHZ)                    PRINC001
      IMPLICIT REAL*8 (A-H,O-Z)                                          PRINC002
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,             PRINC003
     1        UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,OUT,  PRINC004
     2        P,PL,PR,PB, PRBENC , PT , PUNBAL , PUNFRS , R,REG,SOR,    PRINC005
     3        SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT   PRINC006
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL                           PRINC007
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY                    PRINC008
      COMMON/A5/IN,OUT,NERR                                              PRINC009
      COMMON /A9/POWTOT,POWBAR                                           PRINC010
      COMMON /B1/H,HP,TIME,TZ,ZERO,TZO,TIMZ                              PRINC011
      COMMON /B2/NPRT,NZ,ISX,STEP,NZSAVE,PRBENC,IPRN                     PRINC012
      DIMENSION PSI(PT,GU)                                               PRINC013
      DIMENSION PSITOT(REG,GRP)                                          PRINC014
      DIMENSION POWREG(REG)                                              PRINC015
      DIMENSION WHZ(PT)                                                  PRINC016
      DIMENSION WZ(PT)                                                   PRINC017
      DIMENSION WPT(NUM)                                                 PRINC018
      WRITE (OUT,140)                                                    PRINC019
      CALL TITLE (2)                                                     PRINC020
      WRITE (OUT,130) NZ,STEP,TIME,HP                                    PRINC021
      TPRT=TIME                                                          PRINC022
      WRITE (OUT,150)                                                    PRINC023
      DO 110 N=1,NUM                                                     PRINC024
      P=WPT(N)                                                           PRINC025
  109 WRITE (OUT,240)    N,P,WZ(P),WHZ(P)                                PRINC026
  110 CONTINUE                                                           PRINC027
      IGPT=GU                                                            PRINC028
      IF((DABS(TIME-TZ)).LE.ZERO) GO TO 2                                PRINC029
      IF(ISX.GT.0) IGPT=GRP                                              PRINC030
    2 CONTINUE                                                           PRINC031
      DO 120 G=1,IGPT                                                    PRINC032
      IF(G.LE.GRP) GO TO 111                                             PRINC033
      IG9=G-GRP                                                          PRINC034
      WRITE (OUT,221) IG9                                                PRINC035
      GO TO 112                                                          PRINC036
```

```
 111 WRITE (OUT,220) G
112  WRITE (OUT,230) (P,PSI(P,G),P=1,PT)
     IF(G.GT.GRP) GO TO 120
     WRITE (OUT,222) (R,G,PSITOT(R,G),R=1,REG)
 120 CONTINUE
     WRITE(OUT,121)
     WRITE(OUT,122)(R,POWREG(R),R=1,REG)
     WRITE(OUT,123)POWTOT
 121 FORMAT(1H0,10X,'REGION',10X,'NORMALIZED POWER',/)
 122 FORMAT(13X,I2,12X,E14.7)
 123 FORMAT(1H0,10X,'TOTAL NORMALIZED POWER = ',E14.7)
 130 FORMAT (12H0 TIME ZONE=I2,14H  STEP NUMBER=I4,7H  TIME=,E12.6,12H
    1 TIME STEP=,E12.6)
 140 FORMAT (1H0)
 150 FORMAT (1H0/11H TEST POINT,6X,10HMESH POINT,6X,9HFREQUENCY,9X,8HEX
    1P(W*H),1H )
 220 FORMAT (30H0POINT-WISE FLUXES FOR GROUP  ,I3)
 221 FORMAT(44H0PRECURSOR CONCENTRATION FOR DELAYED GROUP   ,I2)
 222 FORMAT(34H0TOTAL INTEGRATED FLUX FOR REGION ,I2,7H GROUP ,I2,
    13H = ,E12.6)
 230 FORMAT ((2X,6(1H(,I3,2H) ,1PE12.6)))
240  FORMAT(4X,I3,13X,I3,9X,1P1E11.4,6X,1P1E13.6,14X,I3)
     RETURN
     END
```

```
      FUNCTION PROD(P, R ,G,PSI,NUSIGF,SIGX,FUEL,UPSCAT,DNSCAT,BAR)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CUT,
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SCR,
     3          SORCE , SORG , SCZ , STEADY , STEP , TAGC , TAGF , TAGT
      REAL*8 LR,NUSIGF
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      DIMENSION PSI(PT,GRP)
      DIMENSION DNSCAT(REG,GRP),UPSCAT(REG,GRP)
      DIMENSION FUEL(REG)
      DIMENSION NUSIGF(REG,GRP)
      DIMENSION SIGX(REG,GRP,GRP)
      X=0.0
      IF(FUEL(R).EQ.0) GO TO 215
  205 IF(BAR.EQ.0.0) GO TO 215
      DO 210 GP=1,GRP
  210 X=X+BAR*NUSIGF(R,GP)*PSI(P,GP)
  215 IF(UPSCAT(R,G)) 220,250,220
  220 GPL=G+1
      GPU=UPSCAT(R,G)
      DO 230 GP=GPL,GPU
  230 X=X+SIGX(R,G,GP)*PSI(P,GP)
  250 IF(DNSCAT(R,G)) 255,270,255
  255 GPL=DNSCAT(R,G)
      GPU=G-1
      DO 260 GP=GPL,GPU
  260 X=X+SIGX(R,G,GP)*PSI(P,GP)
  270 PROD=X
      RETURN
      END
```

```
      SUBROUTINE PUN(PSI,NU,SIGF,SIGC,SIGT,SIGX,XENON,IODINE)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1           UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPL,CUT,
     2           P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,
     3           SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT
      REAL*8 IODINE
      REAL*8 LR,NU,NUSIGF,NX
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY
      DIMENSION PSI(PT,GU)
      DIMENSION NU(GRP)
      DIMENSION XENON(REG),IODINE(REG)
      DIMENSION SIGC(REG,GRP),SIGF(REG,GRP),SIGT(REG,GRP),
     1SIGX(REG,GRP,GRP)
      XX=0.0
      I1=0
      I2=2
      I3=0
      ASSIGN 120 TO NSWTCH
      IF (GRP.EQ.1) ASSIGN 160 TO NSWTCH
      NGRP=GRP-1
      DO 180 R=1,REG
      PUNCH 110, R,I1,I2,I3
  110 FORMAT (10H  REGION  ,I3,47X,3I4)
      GO TO NSWTCH, (120,160)
  120 DO 150 G=1,NGRP
      PUNCH 190, NU(G),SIGF(R,G),SIGC(R,G),SIGT(R,G),XX,SIGX(R,G+1,G)
      DO 130 K=1,GRP
  130 SIGX(R,K,K)=0.0
      DO 140 K=1,GRP
  140 PUNCH 190, (SIGX(R,GP,K),GP=1,GRP)
  150 CONTINUE
      PUNCH 190, NU(GRP),SIGF(R,GRP),SIGC(R,GRP),SIGT(R,GRP),XX,XX
      PUNCH 190, (SIGX(R,GP,GRP),GP=1,NGRP),XX
      GO TO 170
```

```
160 PUNCH 190, NU(1),SIGF(R,1),SIGC(R,1),SIGT(R,1),XX,XX                PUN C037
    PUNCH 190, XX                                                       PUN C038
170 CONTINUE                                                            PUN C039
180 CCNTINUE                                                            PUN 0040
190 FORMAT (6E12.7)                                                     PUN C041
    IF (XEN.EQ.0) GC TC 22C                                             PUN C042
    DO 210 R=1,REG                                                      PUN C043
    IF ((XENCN(R).NE.0.0).OR.(ICDINE(R).NE.C.C)) PUNCH 2CC, R,XENCN(R)  PUN C044
   1,ICDINE(R)                                                          PUN C045
200 FORMAT (I6,6X,2E12.7)                                               PUN C046
210 CONTINUE                                                            PUN 0047
220 DO 230 G=1,GU                                                       PUN C048
    PUNCH 190, (PSI(P,G)    ,P=1,PT)                                    PUN C049
230 CONTINUE                                                            PUN 0050
    RETURN                                                              PUN C051
    END                                                                 PUN CC52
```

```
      SUBROUTINE RESCAL(X,PSI)                                          RESC0001
      IMPLICIT REAL*8 (A-H,O-Z)                                         RESC0002
      INTEGER G,GRP,REG,PT,GL,GU,DEL,THG,IDEL,P                         RESC0003
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL                          RESC0004
      DIMENSION PSI(PT,GRP)                                             RESC0005
      CALL       SCALE(Y,PSI)                                           RESC0006
      Y=X/Y                                                             RESC0007
      DO 110 G=1,GRP                                                    RESC0008
      DO 110 P=1,PT                                                     RESC0009
  110 PSI(P,G)=PSI(P,G)*Y                                               RESC0010
      RETURN                                                            RESC0011
      END                                                               RESC0012
```

```
      SUBROUTINE RHS(G,PSI,FF1,FF2,TI1,NX,NUSIGF,VINV,SIGX ,FLEL,SD,          RHS 0001
     1XL,XR,PB,IPL,IPR)                                                        RHS 0002
      IMPLICIT REAL*8 (A-H,O-Z)                                                RHS 0003
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,                    RHS 0004
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CUT,       RHS 0005
     2          P,PL,PR,PB, PRBENC , PT , PUNBAL , PUNFRS , R,REG,SOR,         RHS 0006
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT        RHS 0007
      REAL*8 LR,NU,NUSIGF,NX                                                   RHS 0008
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL                                 RHS 0009
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY                          RHS 0010
      DIMENSION PSI(PT,GU)                                                     RHS 0011
      DIMENSION FF1(PT)                                                        RHS 0012
      DIMENSION FF2(PT)                                                        RHS 0013
      DIMENSION VINV(GRP)                                                      RHS 0014
      DIMENSION TI1(REG)                                                       RHS 0015
      DIMENSION IPL(REG),IPR(REG),PB(REG),XL(REG),XR(REG)                      RHS 0016
      DIMENSION FUEL(REG)                                                      RHS 0017
      DIMENSION SD(GRP,IDEL)                                                   RHS 0018
      DIMENSION NX(GRP),NUSIGF(REG,GRP)                                        RHS 0019
      DIMENSION SIGX(REG,GRP,GRP)                                              RHS 0020
C     THIS ROUTINE EVALUATES THE RHS OF THE ALGORITHM AT ALL INTERIOR          RHS 0021
C     POINTS OF  EACH REGION IN A GIVEN GROUP                                  RHS 0022
      X3=NX(G)                                                                 RHS 0023
      PL=1                                                                     RHS 0024
      IF (BCL.EQ.0) PL=2                                                       RHS 0025
      DO 20 R=1,REG                                                            RHS 0026
      PR=IPR(R)                                                                RHS 0027
      IF((R.EQ.REG).AND.(BCR.EQ.1))  PR=PT                                     RHS 0028
      DO 19 P=PL,PR                                                            RHS 0029
      T1=0.0                                                                   RHS 0030
      T2=0.0                                                                   RHS 0031
      IF(GRP.EQ.1) T2=X3*NUSIGF(R,G)*PSI(P,G)                                  RHS 0032
      IF(G.EQ.1) GO TO 12                                                      RHS 0033
      GPU=G-1                                                                  RHS 0034
      DO 11 GP=1,GPU                                                           RHS 0035
   11 T1=T1+(X3*NUSIGF(R,GP)+SIGX(R,G,GP))                                     RHS 0036
```

```
     1*PSI(P,GP)
   12 IF(G.EQ.GRP) GO TO 14
      GPL=G+1
      DO 13 GP=GPL,GRP
 13   T2=T2+(X3*NUSIGF(R,GP)+SIGX(R,G,GP))*
     1PSI(P,GP)
C     NOW ADD DELAY CONTRIBUTIONS
   14 T3=0.0
      IF(DEL) 18,18,15
   15 IF(FUEL(R)) 16,18,16
   16 DO 17 GP=GL,GU
      GD=GP-GRP
      T3=T3+SD(G,GD)*PSI(P,GP)
   17 CONTINUE
      T1=T1*FF2(P)
      T2=T2*FF1(P)
      T3=T3*FF1(P)
  18  T4=T1+T2+T3
       PSI(P,G)=VINV(G)*PSI(P,G)+T4
   19 CONTINUE
      PL=PR+2
   20 CONTINUE
C     THIS ROUTINE EVALUATES THE RHS OF THE ALGORITHM AT ALL REGION
C     BOUNDARY POINTS IN GROUP G
      IP=REG-1
      IF (IP) 220,220,110
  110 DO 210 R=1,IP
      JRP=R+1
      P=PB(R)
      X1=XL(R)
      X2=XR(R)
      T1=0.0
      T2=0.0
      IF(GRP.EQ.1) T2=X3*(NUSIGF(R,G)*X1+NUSIGF(R+1,G)*X2)*PSI(P,G)
      IF (G.EQ.1) GO TO 130
      GPU=G-1
```

```
      DO 120 GP=1,GPU
  120 T1=T1+(X3*(NUSIGF(R,GP)*X1+NUSIGF(R+1,GP)
     1*X2)+SIGX(R,G,GP)*X1+SIGX(R+1,G,GP)*
     2X2)*PSI(P,GP)
  130 IF (G.EQ.GRP) GO TO 150
      GPL=G+1
      DO 140 GP=GPL,GRP
  140 T2=T2+(X3*(NUSIGF(R,GP)*X1+NUSIGF(R+1,GP)
     1*X2)+SIGX(R,G,GP)*X1+SIGX(R+1,G,GP)*
     2X2)*PSI(P,GP)
C     THEN ADD PRECURSOR CONTRIBUTIONS
  150 T3=0.
      IF (DEL) 200,200,160
C     WE CHECK FOR ANY FUEL AT THE BOUNDARY POINT
  160 IF (FUEL(R)) 180,170,180
  170 IF (FUEL(R+1)) 180,200,180
  180 DO 190 GP=GL,GU
      GD=GP-GRP
      T3=T3+SD(G,GD)*PSI(P,GP)
  190 CONTINUE
      T1=T1*FF2(P)
      T2=T2*FF1(P)
      T3=T3*FF1(P)
  200 T4=T1+T2+T3
      PSI(P,G)=VINV(G)*PSI(P,G)+T4
  210 CONTINUE
  220 RETURN
      END
```

```
      SUBROUTINE SCALE(Y,PSI)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER G,GRP,REG,PT,GL,GU,DEL,THG,IDEL,P
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      DIMENSION PSI(PT,GRP)
C     THIS FUNCTION FINDS THE LENGTH OF THE FLUX VECTOR
      X=0.0D0
      DO 110 G=1,GRP
      DO 110 P=1,PT
  110 X=X+PSI(P,G)*PSI(P,G)
      Y=DSQRT(X)
      RETURN
      END
```

```
      SUBROUTINE SETUP(PSI,WPT,NU,NUSIGF,CM,CP,SIGX,PB,IPR,IPL,XL,XR,
     1FUEL,NX,SDIN,UPSCAT,DNSCAT,PSISTO,DD,DL,DU,WA,GA)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1           UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CLT,
     2P,PL,PR,PB,PRBEND,PT,PUNBAL,PUNFRS,R,REG,SCR,
     3           SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT
      REAL*8 IODINE
      REAL*8 LR,NU,NUSIGF,NX
      REAL*8 KEFF
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY
      COMMON /A3/PUNBAL,SORCE,GEOM,NTAG,NUM2,PUNFRS
      COMMON /A4/TIGHT1,TIGHT2,TIGHT3
      COMMON/A5/IN,OUT,NERR
C     THIS ROUTINE CORRECTS THE INITIAL ESTIMATES TO AN EXACTLY CRITICAL
C     PROBLEM AND CALCULATES THE PRECURSOR CONCENTRATIONS
      DIMENSION PSI(PT,GU)
      DIMENSION WPT(NUM)
      DIMENSION PSISTO(NUM)
      DIMENSION NU(GRP)
      DIMENSION NUSIGF(REG,GRP)
      DIMENSION CM(PT,GRP),CP(PT,GRP)
      DIMENSION SIGX(REG,GRP,GRP)
      DIMENSION  PB(REG),IPL(REG),IPR(REG),XL(REG),XR(REG)
      DIMENSION FUEL(REG)
      DIMENSION NX(GRP)
      DIMENSION SDIN(GRP,IDEL)
      DIMENSION  UPSCAT(REG,GRP),DNSCAT(REG,GRP)
      DIMENSION DD(PT),DL(PT),DU(PT),WA(PT),GA(PT)
      ABS(X)=DABS(X)
      SQRT(X)=DSQRT(X)
      FLOAT(I)=DFLOAT(I)
      IF (STEADY.EQ.3) GO TO 201
      KEFF=0.
      XKK=0.0
```

```
      Y=0.                                                              SET C037
      INDX=0                                                            SET C038
      CALL        SCALE(X,PSI)                                          SET C039
  110 CONTINUE                                                          SET CC40
      DO 130 N=1,NUM                                                    SET C041
      P=WPT(N)                                                          SET C042
      PSISTO(N)=PSI(P,THG)                                              SET C043
  130 CONTINUE                                                          SET C044
      CALL        ITER(PSI,CM,CP,SIGX,PB,IPL,IPR,XL,XR,SDIN,FUEL,       SET C045
     1NX,NUSIGF,UPSCAT,DNSCAT,DD,DL,DU,WA,GA)                           SET C046
      CALL        SCALE(Y,PSI)                                          SET C047
      KEFF=Y/X                                                          SET C048
      CALL        RESCAL(X,PSI)                                         SET C049
      IF (XKK) 140,140,150                                              SET CC50
  140 XKK=KEFF                                                          SET C051
      INDX=1                                                            SET CC52
      GC TC 110                                                         SET CC53
  150 IF (ABS(KEFF/XKK-1.0)-TIGHT1) 160,160,14C                         SET CC54
  160 CONTINUE                                                          SET C055
      IF (ABS(KEFF-1.0)-TIGHT2) 190,190,170                             SET C056
  170 DO 180 G=1,GRP                                                    SET CC57
      NU(G)=NU(G)/KEFF                                                  SET C058
      DO 180 R=1,REG                                                    SET C059
      NUSIGF(R,G)=NUSIGF(R,G)/KEFF                                      SET CC60
  180 CONTINUE                                                          SET C061
      INDX=2                                                            SET C062
      GC TC 110                                                         SET C063
  190 CONTINUE                                                          SET CC64
      INDX=3                                                            SET C065
      DO 200 N=1,NUM                                                    SET C066
      P=WPT(N)                                                          SET CC67
      IF(DABS(PSISTO(N)/PSI(P,THG)-1.0)-TIGHT3) 2C0,2CC,110             SET C068
  200 CONTINUE                                                          SET C069
 201  CONTINUE                                                          SET CC7C
      CALL        EQPREC(PSI,FUEL,NUSIGF,IPL,IPR,XL,XR)                 SET C071
      II=GL                                                             SET C072
```

```
      IF (STEADY.EQ.3) WRITE (OUT,330)                                  SET C073
      IF (STEADY.EQ.3) GO TO 210                                        SET C074
      II=1                                                              SET C075
      WRITE (OUT,270) (G,NU(G),G=1,GRP)                                 SET C076
      WRITE (OUT,280)                                                   SET C077
  210  CONTINUE                                                         SET C078
      DO 220 G=II,GU                                                    SET C079
 220  WRITE (OUT,300) (P,PSI(P,G),P=1,PT)                               SET C080
      IF (PUNBAL.EQ.1) GO TO 225                                        SET C081
      RETURN                                                            SET C082
 225  CONTINUE                                                          SET C083
      DO 230 G=1,GRP                                                    SET C084
  230 PUNCH 310,NU(G)                                                   SET C085
      WRITE (OUT,290)                                                   SET C086
      DO 240 G=1,GU                                                     SET C087
 240  PUNCH 310,(PSI(P,G),P=1,PT)                                       SET C088
      RETURN                                                            SET C089
  270 FORMAT (19H0 EQUILIBRIUM NU(G),3X,4(1H(,I3,1H),E14.7)/22X,(4(1H(,I SET C090
     13,1H),E14.7)))                                                    SET C091
  280 FORMAT (20H0 EQUILIBRIUM FLUXES)                                  SET C092
  290 FORMAT (53H0 EQUILIBRIUM NU(G) AND FLUX DISTRIBUTION ARE PUNCHED) SET C093
  300 FORMAT (6(1H(,I3,1H),E13.7))                                      SET C094
  310 FORMAT (6E12.7)                                                   SET C095
  330 FORMAT (33H0INITIAL PRECURSOR CONCENTRATIONS)                     SET C096
      END                                                               SET C097
```

```
      SUBROUTINE SOURCE(G,PSI,SORG,SOR,SRCEO,SRCE1,XL,XR,PB,IPL,IPR)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GL,GRP,GPL,CLT,
     2P,PL,PR,PB,PRBEND,PT,PUNBAL,PUNFRS,R,REG,SCR,
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT
      REAL*8 LR,NU,NUSIGF,NX
      INTEGER PLB,PRB
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY
      COMMON /A3/PUNBAL,SORCE,GEOM,NTAG,NUM2,PUNFRS
      COMMON /B1/H,HP,TIME,TZ,ZERO,TZO,TIMZ
      DIMENSION PSI(PT,GU)
      DIMENSION IPL(REG),IPR(REG),PB(REG),XL(REG),XR(REG)
      DIMENSION SOR(REG),SORG(REG,GRP),SRCEO(PT,GRP),SRCE1(PT,GRP)
      FLOAT(I)=DFLOAT(I)
C     THIS ROUTINE EVALUATES THE CONTRIBUTION OF EXTERNAL SOURCES
      TI=0.0
      DO 320 R=1,REG
      IF (SORG(R,G).EQ.0) GO TO 320
      IF (R-1) 110,110,140
  110 IF (BCL.EQ.1) GO TO 120
      PL=2
      GO TO 130
  120 PL=1
  130 PLB=0
      GO TO 150
  140 PLB=PB(R-1)
      PL=PLB+1
  150 PR=IPR(R)
      PRB=PR+1
      IF (R-REG) 170,160,160
  160 IF (BCR.EQ.1) PR=PT
      PRB=0
  170 CONTINUE
  180 X1=H
```

```
      X2=H*H/2.0
      GO TO 200
200   X3=TIME-TI+H/2.0
      IF (SOR(R)-1) 320,270,210
  210 LP=PT-1
      X4=H*(SRCE0(LP,G)+SRCE1(LP,G)*X3)
      DO 220 P=PL,PR
  220 PSI(P,G)    =PSI(P,G)    +X4
      IF (PLB) 230,240,230
230   PSI(PLB,G)=PSI(PLB,G)+X4*XL(R)
  240 IF (PRB) 250,260,250
250   PSI(PRB,G)=PSI(PRB,G)+X4*XR(R)
  260 GO TO 320
  270 DO 280 P=PL,PR
      X4=H*(SRCE0(P,G)+SRCE1(P,G)*X3)
      PSI(P,G)=PSI(P,G)+X4
  280 CONTINUE
      IF (PLB) 290,300,290
290   X4=H*(SRCE0(PLB,G)+SRCE1(PLB,G)*X3)
      PSI(PLB,G)=PSI(PLB,G)+X4*XL(R)
  300 IF (PRB) 310,320,310
310   X4=H*(SRCE0(PLB,G)+SRCE1(PLB,G)*X3)
      PSI(PRB,G)=PSI(PRB,G)+X4*XR(R)
  320 CONTINUE
  330 RETURN
      END
```

```
      SUBROUTINE TEST(STPRN,PSI,PSITOT,POWREG,WPT,WZ,WHZ)                   TESTC001
      IMPLICIT REAL*8 (A-H,O-Z)                                             TESTC002
      REAL*8 IODINE                                                         TESTC003
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,                 TESTC004
     1          UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GD,GL,GU,GRP,GPU,CUT,    TESTC005
     2          P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SCR,      TESTC006
     3          SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT     TESTC007
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL                              TESTC008
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY                       TESTC009
      COMMON /A3/PUNBAL,SORCE,GEOM,NTAG,NUM2,PUNFRS                         TESTC010
      COMMON /B1/H,HP,TIME,TZ,ZERO,TZO,TIMZ                                 TESTC011
      COMMON /B2/NPRT,NZ,ISX,STEP,NZSAVE,PRBEND,IPRN                        TESTC012
      DIMENSION STPRN(50)                                                   TESTC013
      DIMENSION PSI(PT,GU)                                                  TESTC014
      DIMENSION PSITOT(REG,GRP),POWREG(REG)                                 TESTC015
      DIMENSION WHZ(PT),WZ(PT),WPT(NUM)                                     TESTC016
      IFLAG=0                                                               TESTC017
      STEP=STEP+1                                                           TESTC018
      TIME=TIME+H                                                           TESTC019
      IF (NUM2.EQ.0) GO TO 120                                              TEST0020
      IF((DABS(TIME-STPRN(NPRT))).GT.ZERO) GO TO 120                        TESTC021
      NPRT=NPRT+1                                                           TESTC022
      IFLAG=1                                                               TEST0023
  120 IF((DABS(TIME-TZ)).LT.ZERO) GO TO 150                                 TESTC024
      IF(IPRN.EQ.0) GO TO 125                                               TESTC025
      IF ((MOD(STEP,IPRN)).EQ.0) GO TO 140                                  TESTC026
  125 IF(IFLAG.EQ.1) GO TO 140                                              TESTC027
  130 RETURN                                                                TESTC028
  140 CALL       PRINTA(PSI,PSITOT,POWREG,WPT,WZ,WHZ)                       TESTC029
      GO TO 130                                                             TESTC030
  150 CALL PRINTA(PSI,PSITOT,POWREG,WPT,WZ,WHZ)                             TESTC031
      NZ=NZ+1                                                               TESTC032
      IF(NZ.GT.NTZ) PRBEND=1                                                TESTC033
      GO TO 130                                                             TESTC034
      END                                                                   TESTC035
```

```
      SUBROUTINE TITLE (K)
      INTEGER OUT
      COMMON/A5/IN,OUT,NERR
C     READS AND PRINTS CASE TITLE
C     K=1  TITLE IS READ IN
C     K=2  TITLE IS WRITTEN OUT AT THE TOP OF A NEW PAGE
C     K=3  TITLE IS WRITTEN OUT, NO NEW PAGE
C
 100  FORMAT (15H END OF PROBLEM)
C
  110 FORMAT (72H
     1                   )
  120 FORMAT (1H1)
C
C
      GO TO (130,140,150,145),K
  130 READ (IN,110)
      GO TO 160
 140  WRITE (6,120)
      GO TO 150
 145  WRITE (6,110)
      WRITE (6,100)
      GO TO 160
 150  WRITE (6,110)
  160 RETURN
      END
```

```
      SUBROUTINE UPCAT(TAGT,TAGX,TAGC,TAGF,CHANGE,NUSIGF,PSIBAR,IODINE,
     1XABS,XENON, CTRL,CTRQ,CXL,CXQ,CCL,CCQ,CFL,CFQ,SIGT,SIGX,SIGF,
     2SIGC,PSIB1,NU,FUEL)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER BCL,BCR,CHANGE,DEL,DNSCAT,TAGX,TESTS,THG,XEN,
     1           UPSCAT,WPT, FUEL,G,GEOM,GP,GPL,GPR,GC,GL,GU,GRP,GPU,OUT,
     2           P,PL,PR,PB, PRBEND , PT , PUNBAL , PUNFRS , R,REG,SOR,
     3           SORCE , SORG , SOZ , STEADY , STEP , TAGC , TAGF , TAGT
      REAL*8 IODINE
      REAL*8 LR,NU,NUSIGF,NX
      COMMON /A1/GRP,REG,PT,GL,GU,DEL,THG,IDEL
      COMMON /A2/NUM,NCOMP,BCL,BCR,MTZ,NTZ,XEN,STEADY
      COMMON /B1/H,HP,TIME,TZ,ZERO,TZO,TIMZ
      COMMON /B2/NPRT,NZ,ISX,STEP,NZSAVE,PRBEND,IPRN
      DIMENSION CHANGE(REG)
      DIMENSION TAGC(REG),TAGF(REG),TAGT(REG),TAGX(REG)
      DIMENSION NUSIGF(REG,GRP)
      DIMENSION SIGC(REG,GRP),SIGF(REG,GRP),SIGT(REG,GRP),
     1SIGX(REG,GRP,GRP)
      DIMENSION CCL(REG,GRP),CCQ(REG,GRP),CFL(REG,GRP),CFQ(REG,GRP),
     1CTRL(REG,GRP),CTRQ(REG,GRP),CXL(REG),CXQ(REG)
      DIMENSION XENON(REG)
      DIMENSION NU(GRP)
      DIMENSION PSIBAR(REG,GRP),PSIB1(REG,GRP)
      DIMENSION XABS(REG,GRP)
      DIMENSION IODINE(REG)
      DIMENSION FUEL(REG)
      T=TZO
   20 Y=(TIME-TIMZ)/(TZ-T)
      YSQ=Y*(TIME+TIMZ-2*T)/(TZ-T)
      TIMZ=TIME
      IF(XEN.EQ.0) GO TO 40
      CALL         FEDBKX(PSIBAR,SIGF,XABS,XENON,IODINE,PSIB1,FUEL)
   40 CONTINUE
      DO 350 R=1,REG
C
```

```
      IF (TAGT(R)-1) 160,110,130
  110 DO 120 G=1,GRP
  120 SIGT(R,G)=SIGT(R,G)+CTRL(R,G)*Y
      GO TO 150
C
  130 DO 140 G=1,GRP
  140 SIGT(R,G)=SIGT(R,G)+CTRL(R,G)*Y+CTRQ(R,G)*YSQ
  150 CHANGE(R)=1
      GO TO 170
  160 CHANGE(R)=0
C
  170 IF (TAGX(R)-1) 220,180,210
  180 X=CXL(R)*Y
  190 DO 200 G=1,GRP
      DO 200 GP=1,GRP
  200 SIGX(R,G,GP)=SIGX(R,G,GP)*(1.0+X)
      CHANGE(R)=2
      GO TO 220
C
  210 X=CXL(R)*Y+CXQ(R)*YSQ
      GO TO 190
C
  220 IF (TAGC(R)-1) 270,230,250
  230 DO 240 G=1,GRP
  240 SIGC(R,G)=SIGC(R,G)+CCL(R,G)*Y
      CHANGE(R)=2
      GO TO 270
C
  250 DO 260 G=1,GRP
  260 SIGC(R,G)=SIGC(R,G)+CCL(R,G)*Y+CCQ(R,G)*YSQ
      CHANGE(R)=2
C
  270 IF (TAGF(R)-1) 320,280,300
  280 DO 290 G=1,GRP
      SIGF(R,G)=SIGF(R,G)+CFL(R,G)*Y
      NUSIGF(R,G)=NU(G)*SIGF(R,G)
```

```
  290 CONTINUE                                                            UPDTC073
      CHANGE(R)=2                                                         UPDTC074
      GO TO 320                                                           UPDTC075
C                                                                         UPDTC076
  300 DO 310 G=1,GRP                                                      UPDTC077
  310 SIGF(R,G)=SIGF(R,G)+CFL(R,G)*Y+CFQ(R,G)*YSQ                         UPDTC078
      CHANGE(R)=2                                                         UPDTC079
  320 IF (((TAGF(R).EQ.0).AND.(TAGC(R).EQ.0)).AND.(TAGX(R).EQ.0)) GO TO   UPDTC080
     1350                                                                 UPDTC081
      DO 340 G=1,GRP                                                      UPDTC082
      SIGX(R,G,G)=SIGF(R,G)+SIGC(R,G)                                     UPDTC083
      X=0.0                                                               UPDTC084
      DO 330 GP=1,GRP                                                     UPDTC085
  330 X=X+SIGX(R,GP,G)                                                    UPDTC086
      SIGX(R,G,G)=X                                                       UPDTC087
  340 CONTINUE                                                            UPDTC088
C                                                                         UPDTC089
      IF (XEN.EQ.0) GO TO 350                                             UPDTC090
      DO 345 G=1,GRP                                                      UPDTC091
      Z=XABS(R,G)*XENON(R)                                                UPDTC092
      SIGX(R,G,G)=SIGX(R,G,G)+Z                                           UPDTC093
 345  SIGC(R,G)=SIGC(R,G)+Z                                               UPDTC094
  350 CONTINUE                                                            UPDTC095
  370 RETURN                                                              UPDTC096
      END                                                                 UPDTC097
```

References

1. Hansen, K.F. and Johnson, S.R., GAKIN, A One Dimensional Multigroup Kinetics Code, USAEC Report GA-7543, August 1967.

2. Henry, A.F., Notes for MIT Course 22.22, "Nuclear Reactor Kinetics," Spring 1972.

3. Richtmyer, R.D. and Morton, K.W., Difference Methods for Initial Value Problems, John Wiley and Sons, New York 1967.

4. Vargas, R.S., Matrix Iterative Analysis, Prentis-Hall Inc., New Jersey, 1962, Chapter 3.

5. Hansen K.F., Koen, B.V., and Little, W.W., Jr., "Stable Numerical Solutions of the Reactor Kinetics Equations", Nuclear Science and Engineering, Vol. 22, Number 1, May, 1965.

6. Ferguson, D.R. and Hansen, K.F., "Improved Temporal Truncation Error in Space-Dependent Kinetics Calculations," Transactions of the American Nuclear Society, 15, Number 2, November, 1972, P. 790.

7. American Nuclear Society Benchmark Kinetics Problems.