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KENO - A MULTIGROUP MONTE CARLO CRITICALITY PROGRAM

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ABSTRACT

KENO is a multigroup Monte Carlo criticality program written in Fortran IV, level H, for the IBM 360-65 and 360-75 computers. It contains a special geometry package which allows easy description of systems composed of cylinders, spheres, and cuboids (rectangular parallelepipeds) arranged in any order with only one restriction. This restriction is that each geometrical region must be described as completely enclosing all regions interior to it. For systems not describable using this special geometry package, the program can use the generalized geometry package (GEOM) developed for the O5R Monte Carlo code. It allows any system that can be described by a collection of planes and/or quadric surfaces, arbitrarily oriented and intersecting in arbitrary fashion. Rectangular arrays of fissile units are allowed with or without external reflector regions.

The scattering treatment used in KENO assumes that the differential neutron scattering cross section can be represented by a P_1 Legendre polynomial. Absorption of neutrons in KENO is not allowed. Instead, at each collision point of a neutron tracking history the weight of the neutron is reduced by the absorption probability. When the neutron weight has been reduced below a specified point for the region in which the collision occurs, Russian roulette is played to determine if the neutron's history is to be terminated at that point or if the neutron is to survive with an increased weight. Splitting of high weight neutrons is allowed in order to minimize the variance in k_{eff} for systems with regions of widely varying average weights.

Output from KENO consists of k_{eff} for the system plus an estimate of its standard deviation and the leakage, absorption, and fissions for each energy group plus the totals for all groups.

INTRODUCTION

The need to accurately determine the criticality condition of systems of fissile materials in irregular geometrical shapes prompted the development of a Monte Carlo program for this purpose. While S_n type programs such as ANISN[1] and DOT[2] have been used extensively for criticality calculations, they are restricted to fairly simple geometries. KENO was developed to satisfy the need for a more general geometrical treatment. A primary consideration at all times in the code development was to be able to use input data, particularly cross sections, in a form as nearly like that used by the S_n programs as possible. This consideration arises from a good understanding of the accuracy of certain cross section sets, such as the Hansen-Roach[3] set, when used with the S_n programs.

The ease of describing the geometry of a system was another important consideration in the development of KENO. It was essential that the geometrical input be simple enough that input data errors be minimized. Also, most common geometrical arrangements should be handled readily. Decisions made in developing the geometry package were constantly tempered by the amount of computer time required to determine if and where a boundary crossing took place. The idea for the type of geometry package developed for KENO was suggested by the GEM[4] Monte Carlo program geometry package. This package allows a simple description of systems whose geometrical boundaries can be described as spheres, cylinders, cubes, or cuboids in any order so long as each geometrical surface completely encloses the surface interior to it. In order to evaluate storage problems involving arrays of fissile systems, the

package allows the simple description of rectangular arrays. These arrays may be reflected on any or all faces by any number of regions subject only to the restriction that each bounding surface must completely enclose all surfaces interior to it. It is apparent that the compromise arrived at for a simple, easy-to-use geometry package could not cover all possible geometrical situations. To provide for the description of more complicated systems, the generalized GEOM package from the O5R[5] program was implemented as an option of KENO. While the input to this package is considerably more difficult than that of the one just described, it does allow description of all the geometrical shapes one is likely to encounter.

The computer time required to solve a given problem depends on many factors, with the major consideration being the number of collisions a neutron undergoes before its tracking history is terminated by either leakage from the system or by death through a procedure called Russian roulette. Russian roulette is the procedure by which low weight neutrons are either killed or have their weight increased in such a manner as to preserve neutron weight. Russian roulette is used when the neutron's weight has been reduced to some prescribed minimum value, WTLOW. Two examples which will give some indication of how many neutron histories are followed per unit time and the accuracy in k_{eff} to be expected are: 1) a highly enriched uranium metal sphere - 20,000 neutron histories in one minute with a standard deviation of .006; 2) a sphere containing a solution of highly enriched uranyl nitrate (H/U^{235} = 1300) - 10,000 neutron histories in eleven minutes with a standard deviation of .0075.

(The running times given are for an IBM 360/75 computer.) Systems containing thick reflectors will, in general, not run as rapidly as example 2.

SOLUTION STRATEGY

To carry out the calculation, neutrons, each of statistical weight 1.0, comprising the initial "batch" or "generation" are started from a specified spatial distribution with isotropic velocity vectors. The energies of these neutrons are determined by sampling from the multigroup fission spectrum. Collision points for the source neutrons are determined by selecting the number of mean free paths from an exponential distribution, which when multiplied by the mean free path for the region in which the neutron starts, gives the distance along the initial direction which the neutron travels from its starting point. At a collision point the statistical weight of a neutron, WT, is reduced by the scattering probability according to the following equation:

$$WT_{new} = WT_{old} \times \beta \tag{1}$$

where: WT_{old} is the weight before the collision and WT_{new} is the weight after the collision,

β is the scattering probability modified to include (n,2n) and (n,3n) reactions.

If the region in which the collision occurs contains fissionable material, the fission weight is generated according to equation (2).

$$\text{Fission Weight} = WT_{old} \times \frac{\nu\Sigma_f}{\Sigma_t} \tag{2}$$

where: ν is the average number of neutrons born per fission, and

Σ_f is the macroscopic fission cross section.

The fission weight is accumulated (as TFISW and TOFIS) to be used in calculating k_{eff}. When a prescribed amount of fission weight, AKBAR, is exceeded by the addition of fission weight generated at a given collision point, a neutron birth position is recorded and TFISW is reduced by AKBAR. The tracking of the neutron is continued, repeating the above process at each collision point, until the neutron leaks from the system or until its weight, WT, is reduced below a specified value, WTLOW, for the region in which the collision occurred. At that time Russian roulette is played to determine if the neutron survives or is killed; surviving neutrons are given a weight of WTAVG. The probability for survival when Russian roulette is played depends upon the values chosen for WTLOW and WTAVG with the mean probability of survival being WTLOW/WTAVG.

Splitting, the division of one neutron with a high weight into two or more with lower weights, is allowed in order to reduce the variance due to a high weight neutron traveling from a low importance, high average weight region to a high importance, low average weight region. The neutron is split if it is determined that its weight after a collision in the region exceeds WTHIGH for the region. A neutron with half the weight is stored until the tracking of the neutron with the other half of the weight has been completed. Storage is provided for several successive splittings of the same neutron, if required. If this storage space is insufficient, an indicative message is printed and the neutron is allowed to continue with no further splitting. Thus the calculation is allowed to proceed with the only possible disadvantage being an increase in the variance.

Each neutron in the first batch is tracked in turn as described above. The number of neutrons followed in the first batch is only one-fourth the specified number per batch and the second batch is only one-half the specified number per batch. These reductions for the first two batches are made to minimize the computer time usage required to follow neutrons starting from the initial source distribution, which may be a poor representation of the actual distribution.

When all neutrons for the first batch have been processed, the fission points for the neutrons in the second batch are selected from the fission points generated by the previous batch. If more fission points have been generated than there are neutrons to be started, a random selection from those available is made. If too few points are generated, a random selection is made of points at which more than one neutron will be started. The generation of approximately the proper number of fission points in a batch to be used in starting the following batch is accomplished by varying AKBAR, the amount of fission weight accumulation required to generate a fission point. For the first three batches AKBAR is set equal to 1.0; thereafter, the average k_{eff} for all previous batches is calculated and AKBAR is assigned that value. Thus, if the k_{eff} of a given batch is exactly equal to the average of the k_{eff}'s for all previous batches, there will be exactly enough fission points generated for the next batch.

To determine the k_{eff} for a batch, the fission weight from all collisions is summed as TOFIS, and this quantity is divided by the product of the total number of neutrons started in that batch times their initial weight to yield k_{eff}. Mathematically, k_{eff} is given by

the expression

$$k_{eff} = \frac{\sum_{j=1}^{NPB} \sum_{i=1}^{NCOLL} WT_{ij} \frac{\nu\Sigma_f}{\Sigma_t}}{\sum_{j=1}^{NPB} WT_{oj}} , \qquad (3)$$

where: NPB = number of neutrons per batch,

NCOLL = number of collisions for each neutron, and

WT_{ij} = statistical weight for the j^{th} neutron at the i^{th} collision.

Since all neutrons start with a WT_o of unity, the denominator of equation (3) reduces to the number of neutrons per batch.

WTAVG, WTLOW, AND WTHIGH

The values of WTAVG, WTLOW, and WTHIGH which should be used depend on a number of variables such as the importance of neutrons in a given region and the relative cost of following a low weight neutron to that of starting a new neutron. For the core region, experience has shown that the use of the default options yield the minimum variance per unit computer time. The default options which are incorporated in KENO are:

(1) If WTAVG is blank or zero, WTAVG is set to 0.5.

(2) If WTLOW is blank or zero, WTLOW is set to WTAVG/3.0.

(3) If WTHIGH is blank or zero, WTHIGH is set to WTAVG X 3.0.

The justification for these values, particularly WTLOW, was obtained in the study of a system which emphasized the effect of the value used for WTLOW. The system used was one in which the neutrons encounter a very large number of collisions before being absorbed or escaping from the system. The curve shown in Figure 1 shows the effect on the estimated deviation for a fixed amount of computer time as a function of WTLOW. Each point represents the average of three independent runs which were made in order to reduce the variance in the estimated standard deviation. From the curve it is obvious that the deviation does not vary greatly with the value of WTLOW chosen. The important thing to note is the number of neutrons tracked during a fixed amount of computer time as a function of WTLOW. This relationship has been tabulated as follows:

WTLOW	# Neutrons
.02	10,000
.10	14,400
.20	17,800
.30	20,300

The variation in the number of neutrons processed per unit time emphasizes the fact that the number of neutrons tracked per unit time is a rather poor criteria for determining the efficiency of a given calculation. A better criteria is the estimated standard deviation of the answer per unit computer time. The major point which must be considered as far as the number of neutrons followed is concerned is that enough batches must be run to insure that the final answer is not affected by a poor initial source distribution.

Since reflectors often consist of materials with a low probability of absorption, it is often possible for a neutron to undergo many collisions before returning to the core, leaking, or being killed by Russian roulette. To reduce the computing time for a reflected system, a judgment must be made about the relative importance of a neutron in the reflector to the average neutron in the system. The time spent following a neutron should be a direct function of its importance. Since the importance of a neutron in the reflector will usually vary as a function of distance from the core, it is desirable to apply a space dependent weighting function to reduce the amount of computer time required to track neutrons in the reflector. This is accomplished in KENO by varying WTAVG as a function

of distance from the core-reflector interface. Since KENO allows only geometrically region dependent values for WTAVG, it is necessary to insert artificial boundaries to accomplish the desired weighting. Values for weighting functions are generally obtained through an intuitive feel for the worth of a neutron in a given reflector, supported by calculations investigating the adverse effects of various weighting functions. However, an excellent means of obtaining the function is to use the adjoint solution of the criticality problem solved with the S_n type programs for a similar (usually simplified) problem. In the adjoint solution, the "flux" as a function of energy and position, is the relative contribution of a neutron at that energy and position to the total fissions in the system. The value function for weighting purposes in KENO is therefore proportional to the reciprocal of the adjoint flux. While such a function can be difficult to obtain, the savings gained over the usual intuitive guess usually makes the extra effort worthwhile.

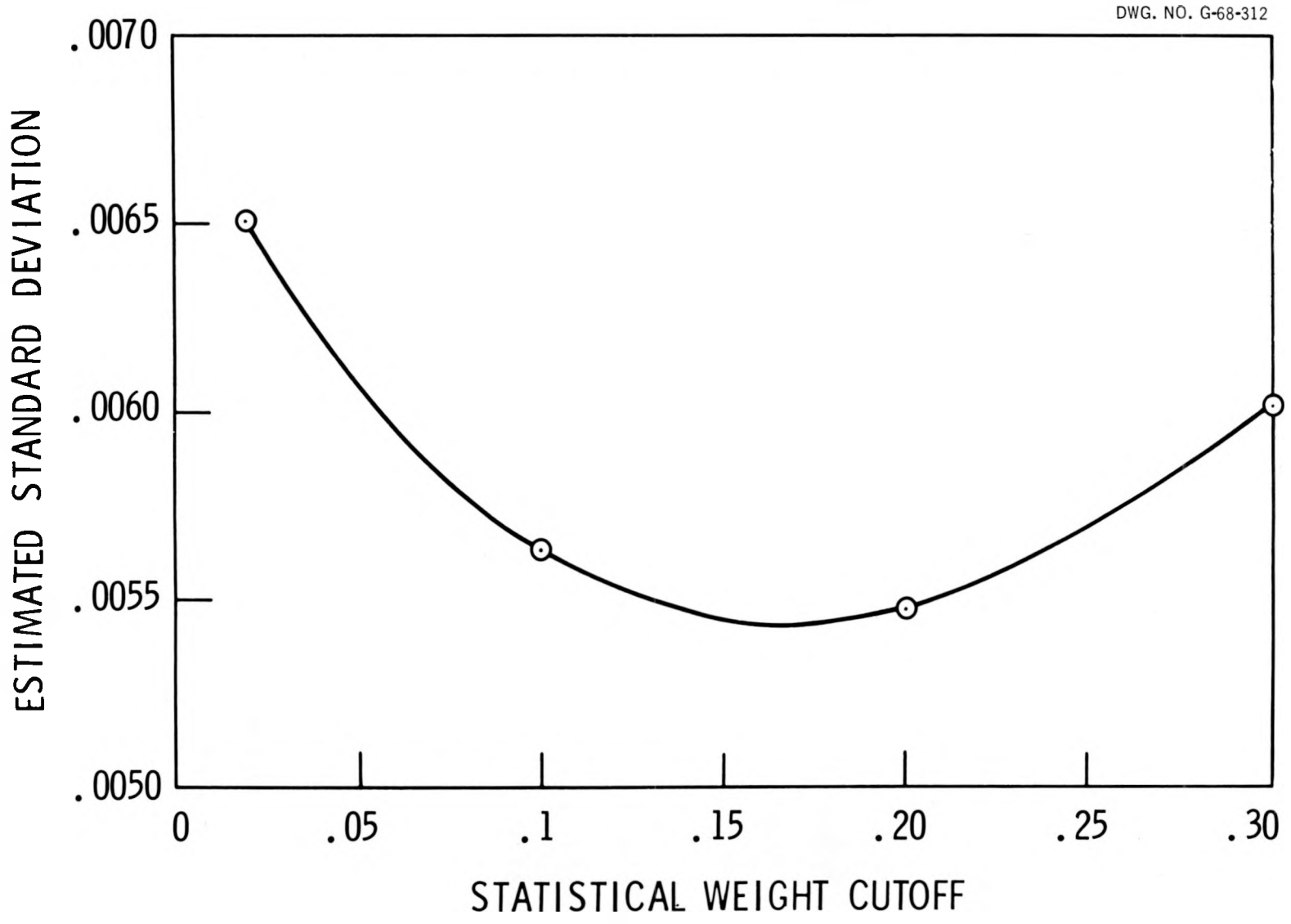
DWG. NO. G-68-312
ESTIMATED STANDARD DEVIATION
.0070
.0065
.0060
.0055
.0050
0
.05
.1
.15
.20
.25
.30
STATISTICAL WEIGHT CUTOFF

Figure 1

GEOMETRY

The geometry portion of KENO is probably its most distinctive feature. The principle which was followed in its development was to make the input to the program as simple as possible in order to minimize input errors. To accomplish this, several restrictions on the geometry description are made: 1) each geometrical surface must completely enclose all geometrical surfaces which are interior to it. (Boundaries of the surfaces may be shared but they must not intersect.) 2) all geometrical surfaces must be describable as spheres, cylinders, cubes, or cuboids. 3) all surfaces in a unit must be described with respect to the same origin. The origin about which a unit is described is governed only by the fact that it must be at the center of all spheres or on the axis of all cylinders. If the unit consists only of cubes and/or cuboids, there is no restriction on the location of the origin. By use of the key words SPHERE, CYLINDER, CUBE, and CUBOID and information about the pertinent dimensions of each shape, the geometry is completely described.

The KENO geometry package allows any applicable shape to be enclosed by any other applicable shape subject only to the complete enclosure restriction. The implication of this type of description is that the entire volume between two sequential geometrical surfaces contains only one mixture. The number of geometrical surfaces which may be used is limited only by the dimension statements assigned to the appropriate variables in the program.

The geometric limitations described above may be removed by using any appropriate geometry package which can be used with the O5R program. A standard feature of KENO is the inclusion of the generalized GEOM routine from the O5R program. While the geometry description for this package is somewhat difficult to prepare, it does enable one to describe all practical problems which the authors have so far encountered.

An O5R type geometry package in KENO is handled through the use of the key word GENERAL. The interior portion of any system can be described using a generalized geometry package and the exterior portion described using the regular KENO geometry package. The only restriction is that the transfer interface between the interior and exterior portions must be a CUBE or CUBOID. When a generalized geometry package is used each material medium (including voids) of that portion of the system described by this package must be identified by the key word GENERAL.

Rectangular arrays of units may be handled in KENO simply by specifying the number of units in the X, Y, and Z directions. In order to use the array feature, each unit must have as its outer surface a CUBE or CUBOID. This is necessary even if a dummy void region must be used as a spacer region.

Reflectors may be placed around the array by using any key word except GENERAL, and may consist of any number of regions in any order (subject to program dimension limitations). The reflector regions may be described about any point of origin; consequently, an initial CUBE or CUBOID must be described which exactly encloses all units in the array. The reflector is then described relative to this boundary.

INITIAL SOURCE

A subroutine called START is used to define the starting positions of the neutrons in the first batch. This routine can be rewritten to satisfy any special need if the present version is inadequate or if a better starting distribution is known. The present version starts neutrons uniformly over the entire array subject to the restriction that all starting points must lie within a mixture having a fission cross section. This technique has been found to be satisfactory for almost all systems which have been examined. A measure of the adequacy of this method is the number of batches which must be discarded due to a poor initial source distribution. A simple but usually adequate method of determining when the source has reached an equilibrium distribution is to observe when the k_{eff}'s of the individual batches no longer increase or decrease monotonically and discard all batches prior to this. More elaborate and rigorous tests could be applied to the problem of determining convergence, but since KENO performs the calculations quite rapidly, it is usually cheaper to discard the first three, five, or possibly even ten batches to ensure source convergence, rather than perform the calculations necessary to prove convergence.

To minimize the time spent using a poor starting source KENO tracks only one-fourth the specified number per batch for the first batch and only one-half the number for the second batch. Therefore, one should always discard the first three batches since their starting source positions are fewer in number than those used for the remaining batches.

ABSORPTION AND LEAKAGE

As indicated earlier, KENO does not allow absorption to occur. However, at each collision point absorption weight is accumulated according to the following equation:

$$\text{Absorption Weight} = \sum_{j=1}^{NPB} \sum_{i=1}^{NCOLL} WT_{ij} \frac{\Sigma_a}{\Sigma_t} .$$

From this an absorption fraction is calculated in the following manner:

$$\text{Absorption Fraction} = \frac{\text{Absorption Weight}}{\sum_{j=1}^{NPB} WT_{oj}} .$$

The total leakage fraction is also calculated as

$$\text{Leakage Fraction} = \frac{\sum_{i=1}^{\text{All neutrons which escape}} WT_i}{\sum_{j=1}^{NPB} WT_{oj}} .$$

The leakage fraction, absorption fraction, and the fission fraction for each energy group is calculated and printed as a portion of the output. The sum of the fission fractions is equal to the k_{eff} of the system. The sum of the absorption and leakage fraction will, in the mean, be equal to 1.0. However, due to efforts to minimize the error in k_{eff} per unit computer time, one often uses biasing techniques which have the effect of increasing the error in the absorption and leakage fraction. This usually results in the sum of the leakage and absorption fractions being slightly different from one. If one desires to know these fractions accurately, they can be obtained by using a low

WTLOW in all regions. A decision about the worth of knowing each quantity to a given precision must be made because it is usually too expensive to obtain all parameters to a high degree of accuracy.

SCATTERING

The energy group to which a neutron is scattered is determined solely from the normalized transfer probabilities. Energy transfers from any energy group to any other energy group are allowed by proper construction of the transfer matrix. Anistropic scattering is accounted for by the use of a P_1 Legendre polynomial expansion of the differential cross section. Since a P_1 representation often is negative over part of the angular range, which makes direct sampling difficult, a so-called $\bar{\mu}$ method is employed. This method involves determining a $\bar{\mu}$ for each mixture, k, and each energy transfer, $E_i \rightarrow E_j$, in the following manner:

$$\bar{\mu}^k_{i\rightarrow j} = \frac{\int_{-1}^{1} \mu \, \Sigma_s^k(E_i \rightarrow E_j, \mu) \, d\mu}{\int_{-1}^{1} \Sigma_s^k(E_i \rightarrow E_j, \mu) \, d\mu} \tag{4}$$

or for a P_1 expansion of the differential cross section,

$$\bar{\mu}^k_{i\rightarrow j} = \frac{C_1}{3C_0}$$

where: $$\Sigma_s^k(\mu) = C_0 P_0 + C_1 P_1$$

and C_0 and C_1 are the coefficients of a Legendre polynomial.

In this treatment an energy transfer from energy group i to group j requires that the neutron scatter through an average angle whose cosine is $\bar{\mu}_{i\rightarrow j}$, except in the case of $\bar{\mu}_{i\rightarrow j} = 0$, when the scattering angle is taken to be isotropic in the lab system. While such a treatment is only an approximation, comparison of calculations with experi-

mental data has shown this to be an adequate treatment for criticality calculations. In order to treat the (n,2n) reaction properly in KENO it is necessary to include the total (n,2n) cross section in the total cross section and to include 2 times the $(n,2n)_{i\rightarrow j}$ in the appropriate transfer cross section position. (n,3n) reactions can be treated similarly.

INPUT

Card 1

FORMAT (F10.5)

Cols. 1 → 10 Maximum execution time (min.), TMAX

Card 2

FORMAT (18A4)

Cols. 1 → 72 Problem title, TITLE

Card 3

FORMAT (14I5)

Cols. 1 → 5 Number of batches or generations, NBA

6 → 10 Number of neutrons per batch, NPB

11 → 15 Number of batches to skip when averaging k's (≥ 2), NSKIP

16 → 20 Number of energy groups, NGP

21 → 25 Maximum number of energy transfer entries for any energy group in the cross section tables (including inscatter), NDS

26 → 30 Number of input nuclides, NMAT

31 → 35 Number of mixtures, MATT

36 → 40 Number of macroscopic mixing table entries (the number of card type 6 cards), NMIX

41 → 45 Number of regions in each unit (the number of geometry cards), KMAX

46 → 50 Number of regions in the array reflector (the number of geometry cards that refer to the regions which surround the array), KREF

51 → 55 Number of units in X direction, NBXMAX

56 → 60 Number of units in Y direction, NBYMAX

61 → 65 Number of units in Z direction, NBZMAX

Card 4

Cross sections for each input material specified in the following form:

FORMAT (17A4,A3,I1)

Cols. 1 → 71 Nuclide identification, XST

72 = 0 if P_0

= 1 if P_1, IORDER

Cross section information follows in the following format:

Card 4-a

FORMAT (6E12.5)

Cols.

GP	1 → 12	13 → 24	25 → 36	37 → 48	49 → 60	61 → 72
1	σ_a^1	$\nu\sigma_f^1$	σ_t^1	$\sigma_{1\to1}$	$\sigma_{1\to2}$	$\sigma_{1\to3}$
	$\sigma_{1\to4}$	$\sigma_{1\to5}$	. . .	$\sigma_{1\to N}$		
2	σ_a^2	$\nu\sigma_f^2$	σ_t^2	$\sigma_{2\to2}$	$\sigma_{2\to3}$	$\sigma_{2\to4}$
	$\sigma_{2\to5}$	$\sigma_{2\to6}$	. . .	$\sigma_{2\to1}$		
⋮						
N-1	σ_a^{N-1}	$\nu\sigma_f^{N-1}$	σ_t^{N-1}	$\sigma_{N-1\to N-1}$	$\sigma_{N-1\to N}$	$\sigma_{N-1\to N-2}$
	$\sigma_{N-1\to N-3}$	$\sigma_{N-1\to N-4}$	. . .	$\sigma_{N-1\to1}$		
N	σ_a^N	$\nu\sigma_f^N$	σ_t^N	$\sigma_{N\to N}$	$\sigma_{N\to N-1}$	$\sigma_{N\to N-2}$
	$\sigma_{N\to N-3}$	$\sigma_{N\to N-4}$	. . .	$\sigma_{N\to1}$		

where σ_a is AXS, $\nu\sigma_f$ is FP, σ_T is SIGT, $\sigma_{i\to j}$ is SP

Card 4-b

If a nuclide has a P_1 scattering component it must be included at this point in the same format as that given above for the P_0 component. The positions occupied by σ_a, $\nu\sigma_f$, and σ_t in the P_0 table should be left blank in the P_1 table. The P_ℓ coefficients given are expected to contain the $2\ell+1$ term. It should be noted that the Hansen-Roach cross section set as published does not contain this term.

Card 5

FORMAT (6E12.5)

Fission spectrum as a function of energy group. (There must be an entry for every energy group.), FIS

Card 6

FORMAT (2I5,E10.0)

Macroscopic mixing table

Cols. 1 → 5 Mixture number (mixtures should be numbered sequentially starting with 1), KK

6 → 10 Input nuclide number (determined by input order), NM

11 → 20 Atomic density (in units of atoms/barn-cm), RHØ

Card 7

FORMAT (2A4,I8,6E8.0)

Geometry description (all dimensions must be consistent with cross section units)

Cols. 1 → 8 Geometry Key word (CUBE, CYLINDER, SPHERE, CUBOID, GENERAL), FGEOM

9 → 16 Mixture Number (0 denotes void), MAT

17 → 24 Radius (SPHERE or CYLINDER), +X (all others)

25 → 32 +Z (CYLINDER), -X (CUBE, CUBOID, GENERAL)

33 → 40 -Z (CYLINDER), +Y (CUBOID, GENERAL)

41 → 48 -Y (CUBOID, GENERAL)

49 → 56 +Z (CUBOID, GENERAL)

57 → 64 -Z (CUBOID, GENERAL)

If a reflector surrounds an array, a CUBOID Card 7 must be located after the unit description cards to define the outer boundary of the array. The material number is unimportant (0 is a good choice). This card defines the origin about which the reflector lies. The geometry cards which describe the reflector follow. Thus, if no reflector is present the number of geometry cards is equal to the "number of regions in the unit", i.e., the number of cards required to describe one unit. If a reflector is present, the number of geometry cards must equal the "number of regions in the unit", plus the "number of regions in the array reflector" plus one. The extra card is the one required to define the reflector origin.

The last region of the unit must always be a CUBE or CUBOID.

Card 8

FORMAT (16E5.0)

Average neutron weight, WTAVG, as a function of energy group for the region interior to the surface described by the geometry card. A Card 8 must follow each Card 7. Blanks cause the program to use the default weight of 0.5. If it

is desired to change the default options for WTLOW and WTHIGH by region and group, additional input statements may be added to subroutine INPUT. The built-in default options are:

WTLOW = WTAVG/3.0

WTHIGH = WTAVG X 3.0

Any number of sequential cases may be run by stacking each set of data sequentially.

GENERALIZED GEOM INPUT

If generalized geometry is used then a Card 7 with the key word GENERAL must be entered for each material medium described in the generalized data under "MEDIA." Each media in the generalized data should be designated by a unique number, numbered sequentially starting with 1. If a void is present it must be treated as any other material. The purpose of the GENERAL Card 7's is to set up a correspondence between each medium number and a mixture. The first GENERAL card should contain the KENO mixture number corresponding to medium 1 as defined in GEOM, the second should contain the KENO mixture number for medium 2, etc. The dimension specification portion of the GENERAL cards should be left blank except for the last card which should contain the dimensions of a cuboid specified exactly as the outer ZONE boundaries are described in the generalized input.

If a GENERAL card is present in the input above, then generalized GEOM data must be entered after all Card 7 and 8's. The following GEOM input description is essentially the same as that found in ORNL-3622.

The outstanding feature of GEOM is its ability to describe multiple media bounded by essentially arbitrary shapes. As many as 33 distinct media may be included, while the permissible boundaries may be of any shape which can be described by quadric surfaces used singly or in combination.

The initial step in the geometric description of a system for GEOM is to enclose the entire system in a cuboid whose faces are parallel with the xy, yz, and xz coordinate planes. This cuboid is then divided into

several smaller cuboids, called zones, by planes parallel to the coordinate planes and extending entirely across the system.

The zones, in turn, are then divided into smaller cuboids, called blocks, by planes again parallel to the coordinate axes but extending only across individual zones. The planes used as zone and block boundaries need not necessarily be boundaries between media; however, if a boundary between two media is a plane parallel to a coordinate plane it is advantageous to make it a block or zone boundary. The use of the zone-block scheme allows complicated parts of the system under study to be divided into smaller blocks than may be needed for simpler regions. If the whole system is relatively simple or requires a similar description throughout, the system should be composed of one zone divided into many blocks rather than many zones of one block each.

Boundaries between media which are not also block boundaries may be any quadric surface. A quadric surface is defined by the zeros of a quadratic function, and divides all space into two regions. In one region the function defining the surface will be positive; in the other it will be negative. Each block may contain a maximum of 32 such surfaces as medium boundaries. The surfaces will divide the block into sectors. A sector is defined as a volume positive to one set of quadric surfaces but negative to another set. Each sector must contain only one medium which may be the same as the medium in another sector. Spatial volumes containing a single medium which cannot be described by a single sector definition must be divided into two or more sectors. It is not necessary to mention every surface in the block in defining a sector.

It is, in fact, more efficient to include in a sector definition only those surfaces which actually form the boundary of the sector. In addition sectors containing the same medium may overlap without error.

Care must be taken in the use of cones as quadric surfaces, since the quadratic equation describes a surface of two nappes. If, as is usual, the desired surface is but one nappe of the cone, a block boundary through the vertex must be used to cut off the surface.

Input to GEOM. (All alphabetic input must be left-adjusted.)

Card A: Format (I5)[a]

a. An index which is not used in KENO but must be specified as a 2.

Card B: Format [A11,5(E10.5,A1)]

This card lists the zone boundaries in increasing order along the X axis, including the boundaries of the parallelepiped enclosing the entire system. Since the number of boundaries depends upon the problem, commas in the A1 fields separating the boundaries are used to indicate that the list continues, while the absence of a comma following the last boundary indicates that the list has ended. The A11 field is for the programmer's convenience and will be ignored by the code.

Card(s) B': Format [6(E10.5,A1)]

If the number of boundaries exceeds the five allowed by the format of card B, the list is continued on as many cards B' as are required.

Card C: Format [A11,5(E10.5,A1)]

Identical with card B except that the listing is of the zone boundaries in order along the Y axis.

Card C': Format [6(E10.5,A11)]

Identical with card B' but continues the Y axis zone boundaries.

Card D: Format [A11,5(E10.5,A1)]

Identical with card B except that the listing is of the zone boundaries in order along the Z axis.

Card D': Format [6(E10.5,A1)]

Identical with card B' but continues the Z axis zone boundaries.

Cards E through P: Constitute a complete zone description. This set of cards must be included once for each zone.

a ℓ m n
Card E: Format (A6,I5,I5,I5)

a. The word ZONE.

ℓ,m,n: Each zone is located in the system by three integers: ℓ, m, and n. These specify the zone as being the ℓth in the X direction, the mth in the Y direction, and the nth in the Z direction. The integers ℓ, m, and n run from 1 to the maximum number of zones in each direction.

Card F: Format [A11,5(E10.5,A1)]

This card lists the block boundaries in this zone in increasing order along the X axis, including the boundaries of the zone.

Card(s) F': Format [6(E10.5,A1)]

This is a block list continuation card similar to card B' of the zone listing.

Cards G,G':

The same as cards F and F' except that the block boundaries along the Y axis are listed.

Cards H,H':

The same as cards F and F' except that the block boundaries along the Z axis are listed.

Cards J through P: Constitute a complete block description. This set of cards must be included once for each block in the zone.

Card J: Format (A6,I5,I5,I5)
(a, ℓ, m, n)

a. The word BLOCK.

ℓ,m,n: Each block is located in the zone by three integers: ℓ, m, and n. These specify the block as being the ℓth in the X direction, the mth in the Y direction, and the nth in the Z direction, within the given zone. The integers ℓ, m, and n run from 1 to the maximum number of blocks in each direction.

Card K: Format [A12,10(I5,A1)]
(a, b)

a. The word MEDIA.

b. A list of the media, sector by sector, in the block. As with other lists, a comma in the A1 field indicates that the list continues; its termination is indicated by the absence of the comma.

Card(s) K': Format [12(I5,A1)]

The continuation, if required, of the medium list.

Card L: Format [A12,10(I5,A1)]
(a, b)

a. The word SURFACES.

b. A list of the quadric surfaces appearing in the block. Commas in the A1 field indicate that the list continues; a blank indicates the end of the list. The numbers appearing in this list derive from the order in which the surfaces are mathematically described on card R, which will be described later

in the input. The number of surfaces must be one less than the number of media.

Card L': Format [8(I5,A1)]

The continuation, if needed, of the list begun on card L.

Card M: Format (A6,1813) (a, b)

a. The word SECTOR.

b. The designation of each sector with reference to its position relative to the quadric surfaces. For every sector in the block there must be a card M, which will have as many references as there are surfaces in the block. The status of the sector is listed according to the following key:

+1: The sector is on the positive side of the surface.

-1: The sector is on the negative side of the surface.

0: The surface is not needed in the definition of the sector.

The order in which each reference to a quadric surface appears on each card M must correspond to the order in which the quadric surfaces are listed on card L.

If there is only one sector in a block cards L and M should be omitted.

Card Q: Format (I5,11A6) (a)

a. The total number of quadric surfaces in the entire system.

The alphabetic data in the A6 fields is ignored by the code.

Card R: Format [4(E10.5,A5,A1)] (a, b, c)

Each quadric surface is described by writing the quadratic function whose zeros define the surface, in a fixed field format resembling the normal manner of writing functions. Each term in the function is

specified by:

a. The coefficient of the term.

b. May be XSQ, YSQ, ZSQ (used for x^2, y^2, and z^2), XZ, YX, YZ, XY, ZX, YZ, X, Y, Z, or blank.

c. A non-blank character in this field indicates the end of the function. The next function must start on a new card.

OUTPUT

The first part of the output from a KENO calculation consists of a listing of the input data and the computed values of: the absorption probabilities, the non-absorption probabilities, the total cross section, and the energy transfer probabilities for all mixtures. The non-absorption probabilities plus the absorption probabilities will normally add to 1.0. This check will inform the user of any inconsistency in his cross section data. If (n,2n) or (n,3n) cross sections are present the sum of the probabilities will be greater than 1.0 and the user should make some other check for cross section data consistency. As each batch or generation is completed, the value of k_{eff} for that batch is printed. When the number of batches specified has been completed or when the time exceeds the maximum time specified on the input Card 1, a final summary of the average $k_{eff's}$ and its associated deviation for each batch is printed. A list of the overall average $k_{eff's}$ and an estimate of their standard deviations, discarding from the first 3 to the first 10 batches is printed next. This is intended to assist in making a decision about how many batches to discard due to an unconverged initial source distribution.

The next portion of the output consists of the leakage and absorption fractions, and the fissions for each energy group, plus the sum over all groups. These values are computed from all neutron histories except those in the first N batches, where N is the input number for the number of batches to be skipped.

The next item of output is the frequency distribution plot of the $k_{eff's}$ of the batches. This is provided to aid in deciding whether enough neutrons have been followed to produce a near normal distribution of $k_{eff's}$.

The final item of output consists of an estimate of the skewness of the distribution of $k_{eff's}$. This also is intended to aid in determining the degree of confidence one can place in the calculation.

ACKNOWLEDGMENTS

The development of KENO would not have been possible without the encouragement and financial support of the Y-12 Criticality Safety group. A special acknowledgment is due E. C. Crume of the Y-12 Criticality Safety group for his constructive comments and contribution of validity checks.

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APPENDIX I

SAMPLE PROBLEM 1

Sample problem 1 consists of a 64 unit array (4x4x4) of metal cylinders surrounded by a 6 inch paraffin reflector. Each metal unit is 93.2% enriched with a uranium density of 18.76 g/cc. It contains 10.458 kg of uranium, is 11.494 cm. in diameter, and 5.382 cm. tall. The surface to surface separation of the units is 12.360 ± 0.026 cm. The paraffin density is 0.93 g/cc.

SAMPLE PROBLEM 1

NUMBER OF BATCHES	60
NUMBER PER BATCH	300
NUMBER OF BATCHES TO BE SKIPPED	3
NUMBER OF GROUPS	16
MAX. NUMBER OF ENERGY TRANSFERS	6
NUMBER OF INPUT NUCLIDES	4
NUMBER OF MIXTURES	2
NUMBER OF MIXING TABLE ENTRIES	4
NUMBER OF REGIONS	2
NUMBER OF REGIONS IN REFLECTOR	5
UNITS IN X DIRECTION	4
UNITS IN Y DIRECTION	4
UNITS IN Z DIRECTION	4

NUCLIDE 1 U-235 YR

GP.	ABSORPTION	NU-FISSION	TOTAL
1	1.2600E 00	3.5570E 00	4.2500E 00
2	1.3000E 00	3.1960E 00	4.5000E 00
3	1.3300E 00	3.0870E 00	4.6500E 00
4	1.3500E 00	2.9880E 00	5.2000E 00
5	1.6600E 00	3.5180E 00	7.9000E 00
6	3.1500E 00	6.1250E 00	1.2400E 01
7	5.5000E 00	1.0290E 01	1.5100E 01
8	1.1100E 01	1.9360E 01	2.1100E 01
9	2.7200E 01	4.5815E 01	3.7200E 01
10	5.8000E 01	9.3100E 01	6.8000E 01
11	7.9000E 01	1.0690E 02	8.9000E 01
12	7.4000E 01	8.2600E 01	8.4000E 01
13	3.9000E 01	7.3500E 01	4.9000E 01
14	8.9000E 01	1.7150E 02	9.0000E 01
15	2.2400E 02	4.5325E 02	2.3400E 02
16	6.1100E 02	1.2642E 03	6.2100E 02

TRANSFER CROSS SECTIONS

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.2000E 00	2.7000E-01	3.7000E-01	6.5000E-01	4.4000E-01	6.0000E-02
2	1.7700E 00	2.4000E-01	6.7000E-01	4.5000E-01	7.0000E-02	0.0
3	2.3000E 00	5.5000E-01	4.0000E-01	7.0000E-02	0.0	0.0
4	3.4200E 00	3.5000E-01	8.0000E-02	0.0	0.0	0.0
5	6.1600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	9.2000E 00	5.0000E-02	0.0	0.0	0.0	0.0
7	9.5500E 00	5.0000E-02	0.0	0.0	0.0	0.0
8	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
9	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
10	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
11	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
12	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
13	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
14	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
15	9.9600E 00	4.0000E-02	0.0	0.0	0.0	0.0
16	1.0000E 01	0.0	0.0	0.0	0.0	0.0

NUCLIDE 2 U-238-Y

GP.	ABSORPTION	NU-FISSION	TOTAL
1	5.6600E-01	1.7250E 00	4.0000E 00
2	5.3500E-01	1.2130E 00	4.4000E 00
3	1.4400E-01	1.0800E-01	4.5000E 00
4	1.4000E-01	0.0	5.2500E 00
5	1.6000E-01	0.0	8.2000E 00
6	4.5000E-01	0.0	1.2000E 01
7	7.0000E-01	0.0	1.4000E 01
8	2.0000E 00	0.0	1.5000E 01
9	1.1000E 01	0.0	2.2000E 01
10	5.0000E 01	0.0	5.9000E 01
11	5.6000E 01	0.0	6.5000E 01
12	1.1000E 02	0.0	1.1900E 02
13	4.0000E-01	0.0	9.4000E 00
14	5.5000E-01	0.0	9.5500E 00
15	1.0000E 00	0.0	1.0000E 01
16	2.4400E 00	0.0	1.1440E 01

TRANSFER CROSS SECTIONS

FROM I	TO	I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.2540E 00	3.3000E-01	4.6000E-01	7.9000E-01	5.3000E-01	7.0000E-02	
2	1.8250E 00	3.5000E-01	9.6000E-01	6.4000E-01	9.0000E-02	0.0	
3	2.9060E 00	8.0000E-01	5.5000E-01	1.0000E-01	0.0	0.0	
4	4.5300E 00	5.0000E-01	8.0000E-02	0.0	0.0	0.0	
5	7.9600E 00	8.0000E-02	0.0	0.0	0.0	0.0	
6	1.1450E 01	1.0000E-01	0.0	0.0	0.0	0.0	
7	1.3240E 01	6.0000E-02	0.0	0.0	0.0	0.0	
8	1.2940E 01	6.0000E-02	0.0	0.0	0.0	0.0	
9	1.0950E 01	5.0000E-02	0.0	0.0	0.0	0.0	
10	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0	
11	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0	
12	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0	
13	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0	
14	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0	
15	8.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0	
16	9.0000E 00	0.0	0.0	0.0	0.0	0.0	

NUCLIDE 3 HYDROGEN X(E)

GP.	ABSORPTION	NU-FISSION	TOTAL
1	0.0	0.0	1.4340E 00
2	0.0	0.0	2.1400E 00
3	0.0	0.0	3.3740E 00
4	0.0	0.0	4.1030E 00
5	0.0	0.0	6.5810E 00
6	0.0	0.0	1.1700E 01
7	0.0	0.0	1.4250E 01
8	1.0000E-03	0.0	1.5000E 01
9	4.0000E-03	0.0	1.5000E 01
10	8.0000E-03	0.0	1.5000E 01
11	1.4000E-02	0.0	1.5000E 01
12	2.5000E-02	0.0	1.5000E 01
13	4.5000E-02	0.0	1.5000E 01
14	7.0000E-02	0.0	1.8000E 01
15	1.3000E-01	0.0	2.5000E 01
16	2.9000E-01	0.0	4.5000E 01

TRANSFER CROSS SECTIONS

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	4.8000E-02	7.3900E-01	2.3100E-01	2.3100E-01	1.3900E-01	4.6000E-02
2	9.3000E-02	7.3100E-01	7.3100E-01	4.3900E-01	1.2100E-01	2.5000E-02
3	1.9300E-01	1.7670E 00	1.0600E 00	2.9400E-01	4.9000E-02	1.1000E-02
4	4.7900E-01	2.7180E 00	7.5200E-01	1.2700E-01	2.2000E-02	5.0000E-03
5	2.5010E 00	3.3870E 00	5.7100E-01	1.0000E-01	1.8000E-02	4.0000E-03
6	4.4040E 00	6.0220E 00	1.0450E 00	1.8700E-01	2.9600E-02	1.2500E-02
7	5.2290E 00	7.3720E 00	1.3490E 00	2.0900E-01	6.1000E-02	3.0000E-02
8	5.3650E 00	7.8800E 00	1.2200E 00	3.6000E-01	1.2200E-01	5.2000E-02
9	5.3890E 00	6.7190E 00	1.9200E 00	6.8000E-01	1.9200E-01	9.6000E-02
10	3.3480E 00	7.7570E 00	2.7190E 00	7.8000E-01	2.3200E-01	1.5600E-01
11	2.8750E 00	8.4940E 00	2.4180E 00	7.1900E-01	3.6000E-01	1.2000E-01
12	3.1360E 00	7.9060E 00	2.3640E 00	1.1820E 00	3.8700E-01	0.0
13	2.6200E 00	7.4090E 00	3.6840E 00	1.2420E 00	0.0	0.0
14	4.7300E 00	9.9000E 00	3.3000E 00	0.0	0.0	0.0
15	1.9870E 01	5.0000E 00	0.0	0.0	0.0	0.0
16	4.4710E 01	0.0	0.0	0.0	0.0	0.0

NUCLIDE 4 CARBON

GP.	ABSORPTION	NU-FISSION	TOTAL
1	0.0	0.0	1.2300E 00
2	0.0	0.0	1.4200E 00
3	0.0	0.0	2.2600E 00
4	0.0	0.0	2.9300E 00
5	0.0	0.0	3.5900E 00
6	0.0	0.0	4.2500E 00
7	0.0	0.0	4.4400E 00
8	0.0	0.0	4.3400E 00
9	0.0	0.0	4.3400E 00
10	0.0	0.0	4.3400E 00
11	0.0	0.0	4.3400E 00
12	0.0	0.0	4.4400E 00
13	0.0	0.0	4.4400E 00
14	0.0	0.0	4.4400E 00
15	7.0000E-04	0.0	4.4387E 00
16	3.0000E-03	0.0	4.4390E 00

TRANSFER CROSS SECTIONS

FROM I	TO	I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	7.1500E-01	5.1500E-01	0.0	0.0	0.0	0.0	
2	1.1060E 00	3.1400E-01	0.0	0.0	0.0	0.0	
3	1.4040E 00	8.5600E-01	0.0	0.0	0.0	0.0	
4	2.3260E 00	6.0400E-01	0.0	0.0	0.0	0.0	
5	3.1570E 00	4.3300E-01	0.0	0.0	0.0	0.0	
6	3.8490E 00	4.0100E-01	0.0	0.0	0.0	0.0	
7	4.0120E 00	4.2800E-01	0.0	0.0	0.0	0.0	
8	3.9120E 00	4.2800E-01	0.0	0.0	0.0	0.0	
9	3.9120E 00	4.2800E-01	0.0	0.0	0.0	0.0	
10	3.7370E 00	6.0300E-01	0.0	0.0	0.0	0.0	
11	3.6780E 00	6.6200E-01	0.0	0.0	0.0	0.0	
12	3.8240E 00	6.1600E-01	0.0	0.0	0.0	0.0	
13	3.7630E 00	6.7700E-01	0.0	0.0	0.0	0.0	
14	3.6270E 00	8.1300E-01	0.0	0.0	0.0	0.0	
15	3.9020E 00	5.3600E-01	0.0	0.0	0.0	0.0	
16	4.4360E 00	0.0	0.0	0.0	0.0	0.0	

GROUP	FISSION SPECTRUM	CUMULATIVE FISSION SPECTRUM
1	0.20400E 00	0.20400E 00
2	0.34400E 00	0.54800E 00
3	0.16800E 00	0.71600E 00
4	0.18000E 00	0.89600E 00
5	0.90000E-01	0.98600E 00
6	0.14000E-01	0.10000E 01
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
10	0.0	0.0
11	0.0	0.0
12	0.0	0.0
13	0.0	0.0
14	0.0	0.0
15	0.0	0.0
16	0.0	0.0

NGPF = 6

SAMPLE PROBLEM 1

MIXTURE	NUCLIDE	DENSITY
1	1	4.48010E-02
1	2	3.22740E-03
2	3	8.25810E-02
2	4	3.97020E-02

MIXTURE = 1

GP.	ABSORPTION PROBABILITY	NU*FISSION PROBABILITY	NON-ABSORPTION PROBABILITY	TOTAL CROSS-SECTION
1	2.86630E-01	8.11181E-01	7.13369E-01	2.03314E-01
2	2.77880E-01	6.81628E-01	7.22119E-01	2.15805E-01
3	2.69467E-01	6.22170E-01	7.30533E-01	2.22848E-01
4	2.43821E-01	5.35656E-01	7.56178E-01	2.49909E-01
5	1.96865E-01	4.14335E-01	8.03135E-01	3.80392E-01
6	2.39920E-01	4.61760E-01	7.60079E-01	5.94261E-01
7	3.44564E-01	6.38792E-01	6.55436E-01	7.21679E-01
8	5.06934E-01	8.72835E-01	4.93067E-01	9.93712E-01
9	7.21736E-01	1.18126E 00	2.78264E-01	1.73760E 00
10	8.52618E-01	1.28858E 00	1.47381E-01	3.23688E 00
11	8.86336E-01	1.14109E 00	1.13664E-01	4.19707E 00
12	8.84973E-01	8.92273E-01	1.15027E-01	4.14734E 00
13	7.85649E-01	1.47955E 00	2.14351E-01	2.22559E 00
14	8.82583E-01	1.89110E 00	1.17417E-01	4.06291E 00
15	9.54634E-01	1.93102E 00	4.53661E-02	1.05157E 01
16	9.82876E-01	2.03305E 00	1.71244E-02	2.78583E 01

TRANSFER PROBABILITIES

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	3.9857E-01	4.8932E-01	6.1384E-01	8.3220E-01	9.7991E-01	1.0000E 00
2	5.4665E-01	6.2289E-01	8.3539E-01	9.7801E-01	1.0000E 00	1.0000E 00
3	6.9056E-01	8.5777E-01	9.7875E-01	1.0000E 00	1.0000E 00	1.0000E 00
4	8.8815E-01	9.7967E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
5	9.8742E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
6	9.9433E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
7	9.9485E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
8	9.9503E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
9	9.9503E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
10	9.9490E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
11	9.9490E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
12	9.9490E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
13	9.9490E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
14	9.9490E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
15	9.9591E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
16	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00

MUBAR

1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0

MIXTURE = 2

GP.	ABSORPTION PROBABILITY	NU*FISSION PROBABILITY	NON-ABSORPTION PROBABILITY	TOTAL CROSS-SECTION
1	0.0	0.0	1.000000E 00	1.67254E-01
2	0.0	0.0	9.99999E-01	2.33100E-01
3	0.0	0.0	9.99999E-01	3.68355E-01
4	0.0	0.0	1.000000E 00	4.55157E-01
5	0.0	0.0	1.000000E 00	6.85995E-01
6	0.0	0.0	1.000001E 00	1.13493E 00
7	0.0	0.0	9.99999E-01	1.35306E 00
8	5.85257E-05	0.0	9.99941E-01	1.41102E 00
9	2.34103E-04	0.0	9.99764E-01	1.41102E 00
10	4.68205E-04	0.0	9.99531E-01	1.41102E 00
11	8.19360E-04	0.0	9.99179E-01	1.41102E 00
12	1.45904E-03	0.0	9.98541E-01	1.41499E 00
13	2.62627E-03	0.0	9.97373E-01	1.41499E 00
14	3.47661E-03	0.0	9.96523E-01	1.66273E 00
15	4.80345E-03	0.0	9.95197E-01	2.24075E 00
16	6.18326E-03	0.0	9.93817E-01	3.89238E 00

TRANSFER PROBABILITIES

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.9342E-01	6.8055E-01	7.9460E-01	9.0866E-01	9.7729E-01	1.0000E 00
2	2.2132E-01	5.3378E-01	7.9275E-01	9.4828E-01	9.9114E-01	1.0000E 00
3	1.9459E-01	6.8300E-01	9.2064E-01	9.8655E-01	9.9753E-01	1.0000E 00
4	2.8980E-01	8.3562E-01	9.7206E-01	9.9510E-01	9.9909E-01	1.0000E 00
5	4.8378E-01	9.1658E-01	9.8531E-01	9.9735E-01	9.9952E-01	1.0000E 00
6	4.5509E-01	9.0729E-01	9.8333E-01	9.9694E-01	9.9909E-01	1.0000E 00
7	4.3686E-01	8.9936E-01	9.8169E-01	9.9445E-01	9.9817E-01	1.0000E 00
8	4.2409E-01	8.9734E-01	9.6875E-01	9.8982E-01	9.9696E-01	1.0000E 00
9	4.2557E-01	8.3094E-01	9.4334E-01	9.8314E-01	9.9438E-01	1.0000E 00
10	3.0123E-01	7.7241E-01	9.3161E-01	9.7728E-01	9.9087E-01	1.0000E 00
11	2.7197E-01	7.8814E-01	9.2977E-01	9.7189E-01	9.9297E-01	1.0000E 00
12	2.9074E-01	7.7013E-01	9.0830E-01	9.7738E-01	1.0000E 00	1.0000E 00
13	2.5917E-01	7.1175E+01	9.2732E-01	1.0000E 00	1.0000E 00	1.0000E 00
14	3.2264E-01	8.3553E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
15	8.0530E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
16	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00

MUBAR						
1	1.0211E-02	5.6558E-01	5.4978E-01	4.1126E-01	2.5180E-01	1.0870E-01
2	2.4011E-02	6.4515E-01	5.8276E-01	3.5763E-01	1.7355E-01	8.0000E-02
3	1.6129E-01	6.1831E-01	4.6792E-01	2.2449E-01	1.0204E-01	0.0
4	1.7467E-01	5.8304E-01	3.0984E-01	1.2598E-01	4.5455E-02	0.0
5	4.2127E-01	5.0651E-01	2.2242E-01	9.0000E-02	5.5556E-02	0.0
6	4.5727E-01	5.4258E-01	2.3732E-01	1.0160E-01	3.3784E-02	0.0
7	4.7738E-01	5.4765E-01	2.4092E-01	1.1005E-01	6.5574E-02	3.3333E-02
8	4.8539E-01	5.4961E-01	2.5410E-01	1.4167E-01	8.1967E-02	3.8462E-02
9	4.8722E-01	5.7735E-01	3.3177E-01	1.8824E-01	1.0417E-01	6.2500E-02
10	4.2374E-01	6.1688E-01	3.6300E-01	2.0256E-01	1.2069E-01	7.0513E-02
11	3.9067E-01	6.1789E-01	3.5691E-01	2.1140E-01	1.2500E-01	4.1667E-02
12	3.8497E-01	6.1886E-01	3.7902E-01	2.2673E-01	7.2351E-02	0.0
13	3.5989E-01	6.3896E-01	4.0011E-01	1.2882E-01	0.0	0.0
14	6.1788E-01	6.2191E-01	1.8182E-01	0.0	0.0	0.0
15	4.5986E-01	3.8039E-01	0.0	0.0	0.0	0.0
16	2.5618E-01	0.0	0.0	0.0	0.0	0.0

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SAMPLE PROBLEM 1

GEOMETRY DESCRIPTION

     CYLINDER     1  RADIUS = 5.7470E 00    +Z = 2.6910E 00    -Z =-2.6910E 00
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500

     CUBOID       0       +X = 1.1920E 01    -X =-1.1920E 01    +Y = 1.1920E 01    -Y =-1.1920E 01   +Z  = 8.8710E 00    -Z =-8.8710E 00
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500

CORE

     CUBOID       0       +X = 4.7680E 01    -X =-4.7680E 01    +Y = 4.7680E 01    -Y =-4.7680E 01   +Z  = 3.5484E 01    -Z =-3.5484E 01
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
                                                                  WT LOW =   0.167   WT AVG =   0.500    WT HI =    1.500
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                                                                              WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                              WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                              WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                              WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                              WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                              WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                              WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                              WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                              WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500

REFLECTOR

     CUBOID      2      +X = 5.0708E 01   -X =-5.0708E 01   +Y = 5.0708E 01   -Y =-5.0708E 01   +Z = 3.8500E 01   -Z =-3.8500E 01
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000
                                                                              WT LOW =  0.333   WT AVG =  1.000   WT HI =   3.000

     CUBOID      2      +X = 5.3708E 01   -X =-5.3708E 01   +Y = 5.3708E 01   -Y =-5.3708E 01   +Z = 4.1500E 01   -Z =-4.1500E 01
                                                                              WT LOW =  0.380   WT AVG =  1.140   WT HI =   3.420
                                                                              WT LOW =  0.387   WT AVG =  1.160   WT HI =   3.480
                                                                              WT LOW =  0.393   WT AVG =  1.180   WT HI =   3.540
                                                                              WT LOW =  0.400   WT AVG =  1.200   WT HI =   3.600
                                                                              WT LOW =  0.413   WT AVG =  1.240   WT HI =   3.720
                                                                              WT LOW =  0.440   WT AVG =  1.320   WT HI =   3.960
                                                                              WT LOW =  0.460   WT AVG =  1.380   WT HI =   4.140
                                                                              WT LOW =  0.470   WT AVG =  1.410   WT HI =   4.230
                                                                              WT LOW =  0.470   WT AVG =  1.410   WT HI =   4.230
                                                                              WT LOW =  0.470   WT AVG =  1.410   WT HI =   4.230
                                                                              WT LOW =  0.477   WT AVG =  1.430   WT HI =   4.290
                                                                              WT LOW =  0.483   WT AVG =  1.450   WT HI =   4.350
                                                                              WT LOW =  0.517   WT AVG =  1.550   WT HI =   4.650
                                                                              WT LOW =  0.557   WT AVG =  1.670   WT HI =   5.010
                                                                              WT LOW =  0.557   WT AVG =  1.670   WT HI =   5.010
                                                                              WT LOW =  0.577   WT AVG =  1.730   WT HI =   5.190

     CUBOID      2      +X = 5.6708E 01   -X =-5.6708E 01   +Y = 5.6708E 01   -Y =-5.6708E 01   +Z = 4.4500E 01   -Z =-4.4500E 01
                                                                              WT LOW =  0.453   WT AVG =  1.360   WT HI =   4.080
```

					WT LOW = 0.470	WT AVG = 1.410	WT HI = 4.230
					WT LOW = 0.517	WT AVG = 1.550	WT HI = 4.650
					WT LOW = 0.537	WT AVG = 1.610	WT HI = 4.830
					WT LOW = 0.587	WT AVG = 1.760	WT HI = 5.280
					WT LOW = 0.667	WT AVG = 2.000	WT HI = 6.000
					WT LOW = 0.713	WT AVG = 2.140	WT HI = 6.420
					WT LOW = 0.747	WT AVG = 2.240	WT HI = 6.720
					WT LOW = 0.753	WT AVG = 2.260	WT HI = 6.780
					WT LOW = 0.783	WT AVG = 2.350	WT HI = 7.050
					WT LOW = 0.797	WT AVG = 2.390	WT HI = 7.170
					WT LOW = 0.817	WT AVG = 2.450	WT HI = 7.350
					WT LOW = 0.920	WT AVG = 2.760	WT HI = 8.280
					WT LOW = 0.983	WT AVG = 2.950	WT HI = 8.850
					WT LOW = 0.990	WT AVG = 2.970	WT HI = 8.910
					WT LOW = 1.033	WT AVG = 3.100	WT HI = 9.300
CUBOID	2	+X = 5.9708E 01	-X =-5.9708E 01	+Y = 5.9708E 01	-Y =-5.9708E 01	+Z = 4.7500E 01	-Z =-4.7500E 01
					WT LOW = 0.547	WT AVG = 1.640	WT HI = 4.920
					WT LOW = 0.607	WT AVG = 1.820	WT HI = 5.460
					WT LOW = 0.707	WT AVG = 2.120	WT HI = 6.360
					WT LOW = 0.783	WT AVG = 2.350	WT HI = 7.050
					WT LOW = 0.930	WT AVG = 2.790	WT HI = 8.370
					WT LOW = 1.107	WT AVG = 3.320	WT HI = 9.960
					WT LOW = 1.203	WT AVG = 3.610	WT HI = 10.830
					WT LOW = 1.290	WT AVG = 3.870	WT HI = 11.610
					WT LOW = 1.333	WT AVG = 4.000	WT HI = 12.000
					WT LOW = 1.373	WT AVG = 4.120	WT HI = 12.360
					WT LOW = 1.453	WT AVG = 4.360	WT HI = 13.080
					WT LOW = 1.490	WT AVG = 4.470	WT HI = 13.410
					WT LOW = 1.667	WT AVG = 5.000	WT HI = 15.000
					WT LOW = 1.763	WT AVG = 5.290	WT HI = 15.870
					WT LOW = 1.797	WT AVG = 5.390	WT HI = 16.170
					WT LOW = 1.887	WT AVG = 5.660	WT HI = 16.980
CUBOID	2	+X = 6.2880E 01	-X =-6.2880E 01	+Y = 6.2880E 01	-Y =-6.2880E 01	+Z = 5.0684E 01	-Z =-5.0684E 01
					WT LOW = 0.700	WT AVG = 2.100	WT HI = 6.300
					WT LOW = 0.817	WT AVG = 2.450	WT HI = 7.350
					WT LOW = 1.053	WT AVG = 3.160	WT HI = 9.480
					WT LOW = 1.270	WT AVG = 3.810	WT HI = 11.430
					WT LOW = 1.563	WT AVG = 4.690	WT HI = 14.070
					WT LOW = 2.000	WT AVG = 6.000	WT HI = 18.000
					WT LOW = 2.160	WT AVG = 6.480	WT HI = 19.440
					WT LOW = 2.357	WT AVG = 7.070	WT HI = 21.210
					WT LOW = 2.540	WT AVG = 7.620	WT HI = 22.860
					WT LOW = 2.603	WT AVG = 7.810	WT HI = 23.430
					WT LOW = 2.750	WT AVG = 8.250	WT HI = 24.750
					WT LOW = 2.907	WT AVG = 8.720	WT HI = 26.160
					WT LOW = 3.250	WT AVG = 9.750	WT HI = 29.250
					WT LOW = 3.400	WT AVG = 10.200	WT HI = 30.600
					WT LOW = 3.500	WT AVG = 10.500	WT HI = 31.500

NPBX = 75

WT LOW = 3.733 WT AVG = 11.200 WT HI = 33.600

K-EFFECTIVE

1.13747E 00
1.01958E 00
9.94661E-01
9.36860E-01
1.04982E 00
1.00281E 00
9.68470E-01
1.07983E 00
1.01845E 00
9.68129E-01
9.41386E-01
1.04142E 00
9.68510E-01
9.48280E-01
1.02349E 00
1.02515E 00
1.03509E 00
9.51036E-01
1.01630E 00
9.72397E-01
9.61658E-01
9.84389E-01
9.53381E-01
1.00595E 00
1.01363E 00
1.00420E 00
9.90385E-01
1.00459E 00
1.00041E 00
1.08349E 00
9.96430E-01
9.84159E-01
1.01844E 00
9.60977E-01
1.01650E 00
1.02070E 00
9.67916E-01
9.31442E-01
1.04404E 00
9.85473E-01
1.00882E 00
1.04279E 00
9.08362E-01
9.53171E-01
1.00505E 00
9.51900E-01
9.40990E-01
9.63071E-01
9.93963E-01

9.92526E-01
9.49148E-01
9.39483E-01
1.05562E 00
9.41868E-01
9.30147E-01
9.35588E-01
1.01739E 00
9.90207E-01
1.02413E 00
1.03252E 00

SAMPLE PROBLEM 1

BATCH	K-EFFECTIVE	DEVIATION
1	1.13747E 00	1.47088E-01
2	1.01958E 00	2.91892E-02
3	9.94661E-01	4.27473E-03
4	9.36860E-01	-5.35256E-02
5	1.04982E 00	5.94350E-02
6	1.00281E 00	1.24227E-02
7	9.68470E-01	-2.19159E-02
8	1.07983E 00	8.94462E-02
9	1.01845E 00	2.80648E-02
10	9.68129E-01	-2.22569E-02
11	9.41386E-01	-4.90000E-02
12	1.04142E 00	5.10303E-02
13	9.68510E-01	-2.18760E-02
14	9.48280E-01	-4.21063E-02
15	1.02349E 00	3.31079E-02
16	1.02515E 00	3.47615E-02
17	1.03509E 00	4.47036E-02
18	9.51036E-01	-3.93500E-02
19	1.01630E 00	2.59153E-02
20	9.72397E-01	-1.79893E-02
21	9.61658E-01	-2.87274E-02
22	9.84389E-01	-5.99706E-03
23	9.53381E-01	-3.70054E-02
24	1.00595E 00	1.55660E-02
25	1.01363E 00	2.32469E-02
26	1.00420E 00	1.38189E-02
27	9.90385E-01	-1.01328E-06
28	1.00459E 00	1.42041E-02
29	1.00041E 00	1.00223E-02
30	1.08349E 00	9.31026E-02
31	9.96430E-01	6.04391E-03
32	9.84159E-01	-6.22737E-03
33	1.01844E 00	2.80496E-02
34	9.60977E-01	-2.94093E-02
35	1.01650E 00	2.61136E-02
36	1.02070E 00	3.03184E-02
37	9.67916E-01	-2.24701E-02
38	9.31442E-01	-5.89439E-02
39	1.04404E 00	5.36538E-02
40	9.85473E-01	-4.91309E-03
41	1.00882E 00	1.84318E-02
42	1.04279E 00	5.24045E-02
43	9.08362E-01	-8.20241E-02
44	9.53171E-01	-3.72154E-02
45	1.00505E 00	1.46686E-02
46	9.51900E-01	-3.84857E-02
47	9.40990E-01	-4.93955E-02

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   48       9.63071E-01      -2.73146E-02
   49       9.93963E-01       3.57729E-03
   50       9.92526E-01       2.14010E-03
   51       9.49148E-01      -4.12380E-02
   52       9.39483E-01      -5.09027E-02
   53       1.05562E 00       6.52305E-02
   54       9.41868E-01      -4.85174E-02
   55       9.30147E-01      -6.02386E-02
   56       9.35588E-01      -5.47975E-02
   57       1.01739E 00       2.70082E-02
   58       9.90207E-01      -1.78397E-04
   59       1.02413E 00       3.37459E-02
   60       1.03252E 00       4.21373E-02

SKIP   3  BATCHES

AVERAGE K-EFFECTIVE =       9.90386E-01    + OR -      5.31223E-03

SKIP   4  BATCHES

AVERAGE K-EFFECTIVE =       9.91342E-01    + OR -      5.31968E-03

SKIP   5  BATCHES

AVERAGE K-EFFECTIVE =       9.90279E-01    + OR -      5.30801E-03

SKIP   6  BATCHES

AVERAGE K-EFFECTIVE =       9.90047E-01    + OR -      5.40207E-03

SKIP   7  BATCHES

AVERAGE K-EFFECTIVE =       9.90454E-01    + OR -      5.48932E-03

SKIP   8  BATCHES

AVERAGE K-EFFECTIVE =       9.88735E-01    + OR -      5.31456E-03

SKIP   9  BATCHES

AVERAGE K-EFFECTIVE =       9.88153E-01    + OR -      5.38715E-03

SKIP  10  BATCHES

AVERAGE K-EFFECTIVE =       9.88553E-01    + OR -      5.48077E-03

GROUP,      LEAKAGE        ABSORPTIONS       FISSIONS       WITH    3 BATCHES SKIPPED
  1      0.50425D-02      0.34567D-01      0.97827D-01
  2      0.51338D-02      0.66129D-01      0.16221D 00
  3      0.21934D-02      0.38739D-01      0.89444D-01
```

4	0.46756D-02	0.60958D-01	0.13392D 00
5	0.32823D-02	0.56897D-01	0.11975D 00
6	0.18877D-02	0.20791D-01	0.40014D-01
7	0.11193D-02	0.10038D-01	0.18609D-01
8	0.10871D-02	0.87415D-02	0.14955D-01
9	0.11383D-02	0.10799D-01	0.17312D-01
10	0.12646D-02	0.74503D-02	0.10787D-01
11	0.96451D-03	0.72152D-02	0.86687D-02
12	0.43284D-03	0.71672D-02	0.63082D-02
13	0.45761D-03	0.69616D-02	0.10241D-01
14	0.83174D-03	0.73662D-02	0.11489D-01
15	0.71602D-03	0.24002D-01	0.25524D-01
16	0.11979D-01	0.56705D 00	0.22336D 00
TOTAL =	0.42206D-01	0.93487D 00	0.99042D 00

ELAPSED TIME 5.07817MINUTES

SAMPLE PROBLEM 2

Sample problem 2 consists of a composite array of four 20.96-kg U(93.2) metal units and four 2.07 kg U(92.6) units of $UO_2(NO_3)_2$ solution shown in figure 2. The metal units had a surface to surface spacing of 2.248 cm., a diameter of 11.506 cm. and a height of 10.765 cm. The uranium density was 18.76 g/cc.

Each solution unit consists of a right circular cylinder of aqueous uranyl nitrate solution contained in a 0.64 cm.-thick plexiglas vessel 20.32 cm. in outside diameter and 19.05 cm. in outside height. Each unit contains 2.07 kg of uranium enriched to 92.6%. $H:U^{235}=58.76$. The spacing between the metal units and the solution units was 1.689 cm.

Since more than one type of unit is involved, the system is described using generalized geometry.

PHOTO NO. ORNL 70801

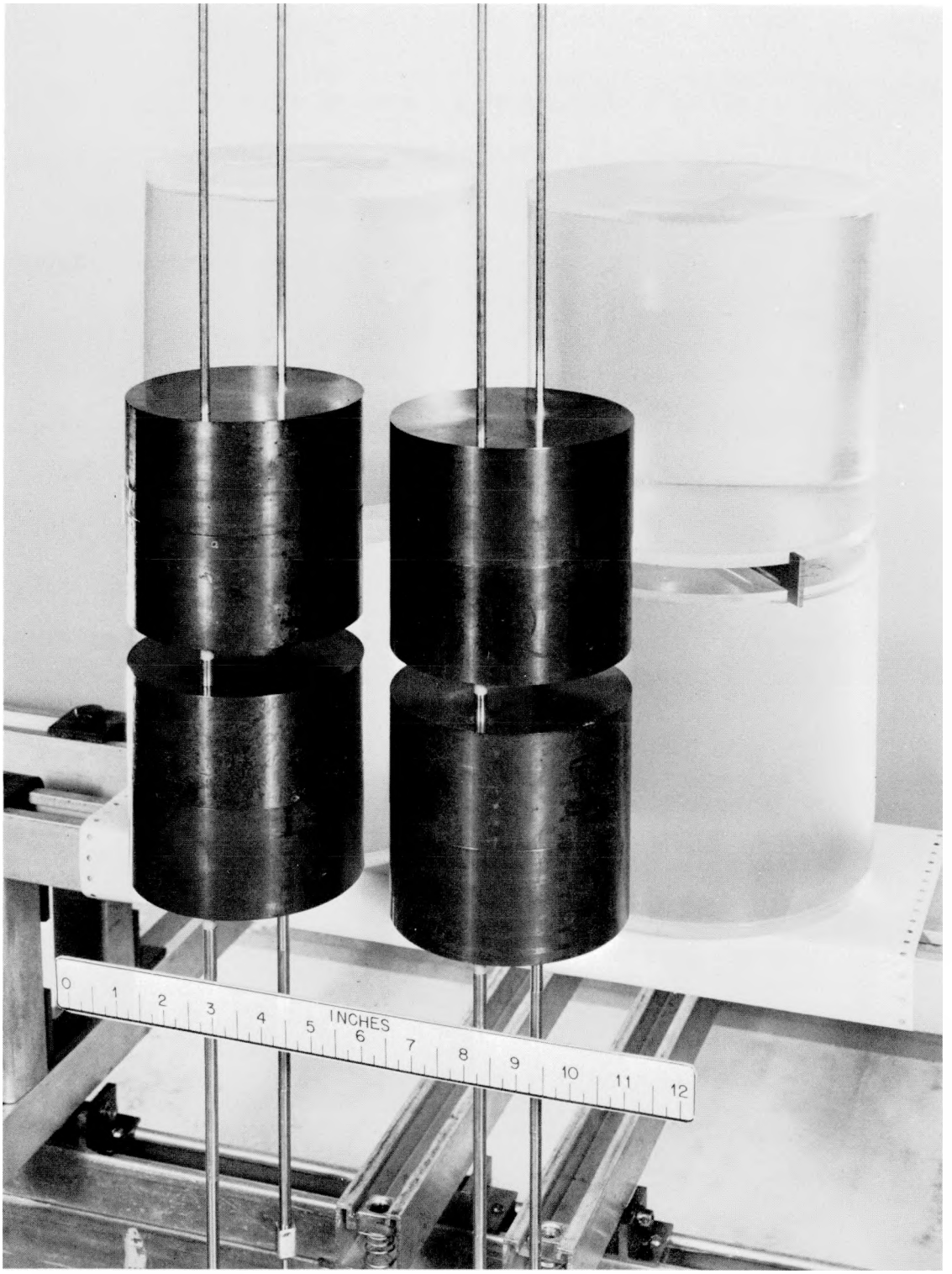

Figure 2. Composite array consisting of four solution units and four metal units.

SAMPLE PROBLEM 2

NUMBER OF BATCHES	60
NUMBER PER BATCH	300
NUMBER OF BATCHES TO BE SKIPPED	3
NUMBER OF GROUPS	16
MAX. NUMBER OF ENERGY TRANSFERS	6
NUMBER OF INPUT NUCLIDES	6
NUMBER OF MIXTURES	3
NUMBER OF MIXING TABLE ENTRIES	10
NUMBER OF REGIONS	5
NUMBER OF REGIONS IN REFLECTOR	0
UNITS IN X DIRECTION	1
UNITS IN Y DIRECTION	1
UNITS IN Z DIRECTION	1

NUCLIDE 1 CARBON

GP.	ABSORPTION	NU-FISSION	TOTAL
1	0.0	0.0	1.2300E 00
2	0.0	0.0	1.4200E 00
3	0.0	0.0	2.2600E 00
4	0.0	0.0	2.9300E 00
5	0.0	0.0	3.5900E 00
6	0.0	0.0	4.2500E 00
7	0.0	0.0	4.4400E 00
8	0.0	0.0	4.3400E 00
9	0.0	0.0	4.3400E 00
10	0.0	0.0	4.3400E 00
11	0.0	0.0	4.3400E 00
12	0.0	0.0	4.4400E 00
13	0.0	0.0	4.4400E 00
14	0.0	0.0	4.4400E 00
15	7.0000E-04	0.0	4.4387E 00
16	3.0000E-03	0.0	4.4390E 00

TRANSFER CROSS SECTIONS

FROM I	TO	I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	7.1500E-01	5.1500E-01	0.0	0.0	0.0	0.0	
2	1.1060E 00	3.1400E-01	0.0	0.0	0.0	0.0	
3	1.4040E 00	8.5600E-01	0.0	0.0	0.0	0.0	
4	2.3260E 00	6.0400E-01	0.0	0.0	0.0	0.0	
5	3.1570E 00	4.3300E-01	0.0	0.0	0.0	0.0	
6	3.8490E 00	4.0100E-01	0.0	0.0	0.0	0.0	
7	4.0120E 00	4.2800E-01	0.0	0.0	0.0	0.0	
8	3.9120E 00	4.2800E-01	0.0	0.0	0.0	0.0	
9	3.9120E 00	4.2800E-01	0.0	0.0	0.0	0.0	
10	3.7370E 00	6.0300E-01	0.0	0.0	0.0	0.0	
11	3.6780E 00	6.6200E-01	0.0	0.0	0.0	0.0	
12	3.8240E 00	6.1600E-01	0.0	0.0	0.0	0.0	
13	3.7630E 00	6.7700E-01	0.0	0.0	0.0	0.0	
14	3.6270E 00	8.1300E-01	0.0	0.0	0.0	0.0	
15	3.9020E 00	5.3600E-01	0.0	0.0	0.0	0.0	
16	4.4360E 00	0.0	0.0	0.0	0.0	0.0	

NUCLIDE 2 HYDROGEN DE/E

GP.	ABSORPTION	NU-FISSION	TOTAL
1	0.0	0.0	1.4500E 00
2	0.0	0.0	2.1750E 00
3	0.0	0.0	3.3000E 00
4	0.0	0.0	4.1250E 00
5	0.0	0.0	6.7500E 00
6	0.0	0.0	1.1700E 01
7	0.0	0.0	1.4250E 01
8	1.0000E-03	0.0	1.5000E 01
9	4.0000E-03	0.0	1.5000E 01
10	8.0000E-03	0.0	1.5000E 01
11	1.4000E-02	0.0	1.5000E 01
12	2.5000E-02	0.0	1.5000E 01
13	4.5000E-02	0.0	1.5000E 01
14	7.0000E-02	0.0	1.8000E 01
15	1.3000E-01	0.0	2.5000E 01
16	2.9000E-01	0.0	4.5000E 01

TRANSFER CROSS SECTIONS

FROM I	TO	I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1		1.0000E-02	7.6900E-01	2.3900E-01	2.3900E-01	1.4400E-01	4.9000E-02
2		2.4400E-01	6.9000E-01	6.9000E-01	4.1500E-01	1.1600E-01	2.0000E-02
3		6.4000E-02	1.7960E 00	1.0760E 00	3.0000E-01	5.2000E-02	1.2000E-02
4		3.5700E-01	2.8270E 00	7.8100E-01	1.3200E-01	2.2000E-02	6.0000E-03
5		1.8810E 00	4.0410E 00	6.8400E-01	1.1700E-01	2.2000E-02	5.0000E-03
6		4.4040E 00	6.0220E 00	1.0450E 00	1.8700E-01	3.0000E-02	1.2000E-02
7		5.2290E 00	7.3720E 00	1.3490E 00	2.0900E-01	6.1000E-02	3.0000E-02
8		5.3650E 00	7.8800E 00	1.2200E 00	3.6000E-01	1.2200E-01	5.2000E-02
9		5.3890E 00	6.7190E 00	1.9200E 00	6.8000E-01	1.9200E-01	9.6000E-02
10		3.3480E 00	7.7570E 00	2.7190E 00	7.8000E-01	2.3200E-01	1.5600E-01
11		2.8750E 00	8.4940E 00	2.4180E 00	7.1900E-01	3.6000E-01	1.2000E-01
12		3.1360E 00	7.9060E 00	2.3640E 00	1.1820E 00	3.8700E-01	0.0
13		2.6200E 00	7.4090E 00	3.6840E 00	1.2420E 00	0.0	0.0
14		4.7300E 00	9.9000E 00	3.3000E 00	0.0	0.0	0.0
15		1.9870E 01	5.0000E 00	0.0	0.0	0.0	0.0
16		4.4710E 01	0.0	0.0	0.0	0.0	0.0

NUCLIDE 3 NITROGEN

GP.	ABSORPTION	NU-FISSION	TOTAL
1	2.5000E-01	0.0	9.7000E-01
2	1.1000E-01	0.0	1.4800E 00
3	4.0000E-02	0.0	1.6900E 00
4	4.0000E-02	0.0	2.1700E 00
5	2.0000E-03	0.0	3.2940E 00
6	2.0000E-03	0.0	5.4360E 00
7	4.0001E-03	0.0	7.3590E 00
8	8.0000E-03	0.0	8.0920E 00
9	1.9000E-02	0.0	8.4930E 00
10	4.0000E-02	0.0	9.3300E 00
11	7.0000E-02	0.0	9.5900E 00
12	1.2000E-01	0.0	9.6400E 00
13	2.2000E-01	0.0	9.7400E 00
14	3.6000E-01	0.0	9.8800E 00
15	6.4000E-01	0.0	1.0160E 01
16	1.6700E 00	0.0	1.1190E 01

TRANSFER CROSS SECTIONS

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	3.9000E-01	3.3000E-01	0.0	0.0	0.0	0.0
2	1.0100E 00	3.6000E-01	0.0	0.0	0.0	0.0
3	1.2000E 00	4.5000E-01	0.0	0.0	0.0	0.0
4	1.7800E 00	3.5000E-01	0.0	0.0	0.0	0.0
5	3.1220E 00	1.7000E-01	0.0	0.0	0.0	0.0
6	4.9940E 00	4.4000E-01	0.0	0.0	0.0	0.0
7	6.7450E 00	6.1000E-01	0.0	0.0	0.0	0.0
8	7.4040E 00	6.8000E-01	0.0	0.0	0.0	0.0
9	7.7640E 00	7.1000E-01	0.0	0.0	0.0	0.0
10	8.1800E 00	1.1100E 00	0.0	0.0	0.0	0.0
11	8.2800E 00	1.2400E 00	0.0	0.0	0.0	0.0
12	8.3800E 00	1.1400E 00	0.0	0.0	0.0	0.0
13	8.2800E 00	1.2400E 00	0.0	0.0	0.0	0.0
14	8.0300E 00	1.4900E 00	0.0	0.0	0.0	0.0
15	8.5300E 00	9.9000E-01	0.0	0.0	0.0	0.0
16	9.5200E 00	0.0	0.0	0.0	0.0	0.0

NUCLIDE 4 OXYGEN

GP.	ABSORPTION	NU-FISSION	TOTAL
1	4.0000E-02	0.0	1.3300E 00
2	0.0	0.0	1.1800E 00
3	0.0	0.0	3.2300E 00
4	0.0	0.0	3.6300E 00
5	0.0	0.0	3.7100E 00
6	0.0	0.0	3.2600E 00
7	0.0	0.0	3.5500E 00
8	0.0	0.0	3.6400E 00
9	0.0	0.0	3.6400E 00
10	0.0	0.0	3.6400E 00
11	0.0	0.0	3.6400E 00
12	0.0	0.0	3.6400E 00
13	0.0	0.0	3.6400E 00
14	0.0	0.0	3.6400E 00
15	0.0	0.0	3.6400E 00
16	2.0000E-04	0.0	3.6412E 00

TRANSFER CROSS SECTIONS

FROM I	TO	I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	8.6600E-01	4.2400E-01	0.0	0.0	0.0	0.0	
2	9.8900E-01	1.9100E-01	0.0	0.0	0.0	0.0	
3	2.3280E 00	9.0200E-01	0.0	0.0	0.0	0.0	
4	3.0740E 00	5.5600E-01	0.0	0.0	0.0	0.0	
5	3.3730E 00	3.3700E-01	0.0	0.0	0.0	0.0	
6	3.0290E 00	2.3100E-01	0.0	0.0	0.0	0.0	
7	3.2950E 00	2.5500E-01	0.0	0.0	0.0	0.0	
8	3.3700E 00	2.7000E-01	0.0	0.0	0.0	0.0	
9	3.3700E 00	2.7000E-01	0.0	0.0	0.0	0.0	
10	3.2600E 00	3.8000E-01	0.0	0.0	0.0	0.0	
11	3.2260E 00	4.1400E-01	0.0	0.0	0.0	0.0	
12	3.2600E 00	3.8000E-01	0.0	0.0	0.0	0.0	
13	3.2260E 00	4.1400E-01	0.0	0.0	0.0	0.0	
14	3.1420E 00	4.9800E-01	0.0	0.0	0.0	0.0	
15	3.3090E 00	3.3100E-01	0.0	0.0	0.0	0.0	
16	3.6410E 00	0.0	0.0	0.0	0.0	0.0	

NUCLIDE 5 U-235 YR

GP.	ABSORPTION	NU-FISSION	TOTAL
1	1.2600E 00	3.5570E 00	4.2500E 00
2	1.3000E 00	3.1960E 00	4.5000E 00
3	1.3300E 00	3.0870E 00	4.6500E 00
4	1.3500E 00	2.9880E 00	5.2000E 00
5	1.6600E 00	3.5180E 00	7.9000E 00
6	3.1500E 00	6.1250E 00	1.2400E 01
7	5.5000E 00	1.0290E 01	1.5100E 01
8	1.1100E 01	1.9360E 01	2.1100E 01
9	2.7200E 01	4.5815E 01	3.7200E 01
10	5.8000E 01	9.3100E 01	6.8000E 01
11	7.9000E 01	1.0690E 02	8.9000E 01
12	7.4000E 01	8.2600E 01	8.4000E 01
13	3.9000E 01	7.3500E 01	4.9000E 01
14	8.0000E 01	1.7150E 02	9.0000E 01
15	2.2400E 02	4.5325E 02	2.3400E 02
16	6.1100E 02	1.2642E 03	6.2100E 02

TRANSFER CROSS SECTIONS

FROM I	TO	I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.2000E 00	2.7000E-01	3.7000E-01	6.5000E-01	4.4000E-01	6.0000E-02	
2	1.7700E 00	2.4000E-01	6.7000E-01	4.5000E-01	7.0000E-02	0.0	
3	2.3000E 00	5.5000E-01	4.0000E-01	7.0000E-02	0.0	0.0	
4	3.4200E 00	3.5000E-01	8.0000E-02	0.0	0.0	0.0	
5	6.1600E 00	8.0000E-02	0.0	0.0	0.0	0.0	
6	9.2000E 00	5.0000E-02	0.0	0.0	0.0	0.0	
7	9.5500E 00	5.0000E-02	0.0	0.0	0.0	0.0	
8	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0	
9	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0	
10	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0	
11	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0	
12	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0	
13	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0	
14	9.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0	
15	9.9600E 00	4.0000E-02	0.0	0.0	0.0	0.0	
16	1.0000E 01	0.0	0.0	0.0	0.0	0.0	

NUCLIDE 6 U-238-Y

GP.	ABSORPTION	NU-FISSION	TOTAL
1	5.6600E-01	1.7250E 00	4.0000E 00
2	5.3500E-01	1.2130E 00	4.4000E 00
3	1.4400E-01	1.0800E-01	4.5000E 00
4	1.4000E-01	0.0	5.2500E 00
5	1.6000E-01	0.0	8.2000E 00
6	4.5000E-01	0.0	1.2000E 01
7	7.0000E-01	0.0	1.4000E 01
8	2.0000E 00	0.0	1.5000E 01
9	1.1000E 01	0.0	2.2000E 01
10	5.0000E 01	0.0	5.9000E 01
11	5.6000E 01	0.0	6.5000E 01
12	1.1000E 02	0.0	1.1900E 02
13	4.0000E-01	0.0	9.4000E 00
14	5.5000E-01	0.0	9.5500E 00
15	1.0000E 00	0.0	1.0000E 01
16	2.4400E 00	0.0	1.1440E 01

TRANSFER CROSS SECTIONS

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.2540E 00	3.3000E-01	4.6000E-01	7.9000E-01	5.3000E-01	7.0000E-02
2	1.8250E 00	3.5000E-01	9.6000E-01	6.4000E-01	9.0000E-02	0.0
3	2.9060E 00	8.0000E-01	5.5000E-01	1.0000E-01	0.0	0.0
4	4.5300E 00	5.0000E-01	8.0000E-02	0.0	0.0	0.0
5	7.9600E 00	8.0000E-02	0.0	0.0	0.0	0.0
6	1.1450E 01	1.0000E-01	0.0	0.0	0.0	0.0
7	1.3240E 01	6.0000E-02	0.0	0.0	0.0	0.0
8	1.2940E 01	6.0000E-02	0.0	0.0	0.0	0.0
9	1.0950E 01	5.0000E-02	0.0	0.0	0.0	0.0
10	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0
11	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0
12	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0
13	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0
14	8.9400E 00	6.0000E-02	0.0	0.0	0.0	0.0
15	8.9500E 00	5.0000E-02	0.0	0.0	0.0	0.0
16	9.0000E 00	0.0	0.0	0.0	0.0	0.0

GROUP	FISSION SPECTRUM	CUMULATIVE FISSION SPECTRUM
1	0.20400E 00	0.20400E 00
2	0.34400E 00	0.54800E 00
3	0.16800E 00	0.71600E 00
4	0.18000E 00	0.89600E 00
5	0.90000E-01	0.98600E 00
6	0.14000E-01	0.10000E 01
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
10	0.0	0.0
11	0.0	0.0
12	0.0	0.0
13	0.0	0.0
14	0.0	0.0
15	0.0	0.0
16	0.0	0.0

NGPF = 6

SAMPLE PROBLEM 2

MIXTURE	NUCLIDE	DENSITY
1	5	4.48020E-02
1	6	3.22750E-03
2	2	5.78597E-02
2	3	2.13112E-03
2	4	3.74479E-02
2	5	9.84680E-04
2	6	7.76900E-05
3	1	3.55520E-02
3	2	5.68840E-02
3	4	1.42210E-02

MIXTURE = 1

GP.	ABSORPTION PROBABILITY	NU*FISSION PROBABILITY	NON-ABSORPTION PROBABILITY	TOTAL CROSS-SECTION
1	2.86630E-01	8.11181E-01	7.13369E-01	2.03318E-01
2	2.77880E-01	6.81628E-01	7.22119E-01	2.15810E-01
3	2.69466E-01	6.22169E-01	7.30533E-01	2.22853E-01
4	2.43821E-01	5.35656E-01	7.56178E-01	2.49915E-01
5	1.96865E-01	4.14335E-01	8.03135E-01	3.80401E-01
6	2.39920E-01	4.61760E-01	7.60079E-01	5.94275E-01
7	3.44564E-01	6.38791E-01	6.55436E-01	7.21695E-01
8	5.06933E-01	8.72835E-01	4.93067E-01	9.93734E-01
9	7.21736E-01	1.18126E 00	2.78264E-01	1.73764E 00
10	8.52618E-01	1.28858E 00	1.47381E-01	3.23696E 00
11	8.86336E-01	1.14109E 00	1.13664E-01	4.19716E 00
12	8.84973E-01	8.92272E-01	1.15027E-01	4.14744E 00
13	7.85649E-01	1.47955E 00	2.14351E-01	2.22564E 00
14	8.82583E-01	1.89110E 00	1.17417E-01	4.06300E 00
15	9.54634E-01	1.93102E 00	4.53661E-02	1.05159E 01
16	9.82876E-01	2.03305E 00	1.71244E-02	2.78589E 01

TRANSFER PROBABILITIES

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	3.9857E-01	4.8932E-01	6.1384E-01	8.3220E-01	9.7991E-01	1.0000E 00
2	5.4665E-01	6.2289E-01	8.3539E-01	9.7801E-01	1.0000E 00	1.0000E 00
3	6.9056E-01	8.5777E-01	9.7875E-01	1.0000E 00	1.0000E 00	1.0000E 00
4	8.8815E-01	9.7967E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
5	9.8742E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
6	9.9433E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
7	9.9485E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
8	9.9503E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
9	9.9503E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
10	9.9490E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
11	9.9490E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
12	9.9490E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
13	9.9490E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
14	9.9490E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
15	9.9591E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
16	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00

MUBAR						
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0

MIXTURE = 2

GP.	ABSORPTION PROBABILITY	NU*FISSION PROBABILITY	NON-ABSORPTION PROBABILITY	TOTAL CROSS-SECTION
1	2.36365E-02	2.59261E-02	9.76363E-01	1.40265E-01
2	8.74393E-03	1.82135E-02	9.91256E-01	1.77960E-01
3	4.38812E-03	9.51272E-03	9.95611E-01	3.20423E-01
4	3.70475E-03	7.64691E-03	9.96295E-01	3.84760E-01
5	3.03028E-03	6.35708E-03	9.96969E-01	5.44920E-01
6	3.81294E-03	7.32146E-03	9.96186E-01	8.23765E-01
7	5.53913E-03	1.02442E-02	9.94461E-01	9.89079E-01
8	1.06961E-02	1.82706E-02	9.89303E-01	1.04339E 00
9	2.63140E-02	4.25337E-02	9.73686E-01	1.06064E 00
10	5.61724E-02	8.36722E-02	9.43827E-01	1.09563E 00
11	7.43734E-02	9.42089E-02	9.25627E-01	1.11733E 00
12	7.44281E-02	7.28343E-02	9.25572E-01	1.11671E 00
13	3.86484E-02	6.73910E-02	9.61353E-01	1.07394E 00
14	6.49235E-02	1.31092E-01	9.35077E-01	1.28820E 00
15	1.25041E-01	2.43133E-01	8.74959E-01	1.83564E 00
16	1.84279E-01	3.68702E-01	8.15721E-01	3.37626E 00

TRANSFER PROBABILITIES

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	2.5644E-01	7.0453E-01	8.0843E-01	9.1453E-01	9.7883E-01	1.0000E 00
2	3.1287E-01	5.8557E-01	8.1605E-01	9.5496E-01	9.9344E-01	1.0000E 00
3	3.0070E-01	7.3722E-01	9.3374E-01	9.8839E-01	9.9782E-01	1.0000E 00
4	3.7378E-01	8.5775E-01	9.7585E-01	9.9577E-01	9.9909E-01	1.0000E 00
5	4.5739E-01	9.1182E-01	9.8466E-01	9.9712E-01	9.9947E-01	1.0000E 00
6	4.7383E-01	9.1017E-01	9.8385E-01	9.9704E-01	9.9915E-01	1.0000E 00
7	4.5826E-01	9.0300E-01	9.8235E-01	9.9465E-01	9.9824E-01	1.0000E 00
8	4.4874E-01	9.0169E-01	9.7007E-01	9.9025E-01	9.9709E-01	1.0000E 00
9	4.5045E-01	8.3820E-01	9.4577E-01	9.8387E-01	9.9462E-01	1.0000E 00
10	3.3239E-01	7.8251E-01	9.3465E-01	9.7829E-01	9.9127E-01	1.0000E 00
11	3.0486E-01	7.9765E-01	9.3292E-01	9.7315E-01	9.9329E-01	1.0000E 00
12	3.2109E-01	7.7983E-01	9.1217E-01	9.7834E-01	1.0000E 00	1.0000E 00
13	2.9110E-01	7.2394E-01	9.3040E-01	1.0000E 00	1.0000E 00	1.0000E 00
14	3.4780E-01	8.4149E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
15	8.1082E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
16	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00

MUBAR						
1	2.4713E-02	5.3648E-01	5.2051E-01	3.8228E-01	2.3653E-01	1.1972E-01
2	1.3419E-01	6.1460E-01	5.6497E-01	3.4945E-01	1.7049E-01	5.0000E-02
3	1.5079E-02	5.6714E-01	4.6791E-01	2.2567E-01	9.6154E-02	0.0
4	7.3090E-02	5.7666E-01	3.1695E-01	1.2121E-01	4.5455E-02	0.0
5	2.8571E-01	5.5216E-01	2.2661E-01	1.0256E-01	4.5455E-02	0.0
6	4.2558E-01	5.4486E-01	2.3732E-01	1.0160E-01	3.3333E-02	0.0
7	4.3862E-01	5.4891E-01	2.4092E-01	1.1005E-01	6.5574E-02	3.3333E-02
8	4.3932E-01	5.4995E-01	2.5410E-01	1.4167E-01	8.1967E-02	3.8462E-02
9	4.4054E-01	5.7768E-01	3.3177E-01	1.8824E-01	1.0417E-01	6.2500E-02
10	3.6697E-01	6.1705E-01	3.6300E-01	2.0256E-01	1.2069E-01	7.0513E-02
11	3.3289E-01	6.1815E-01	3.5691E-01	2.1140E-01	1.2500E-01	4.1667E-02
12	3.3386E-01	6.1941E-01	3.7902E-01	2.2673E-01	7.2351E-02	0.0
13	3.0688E-01	6.3986E-01	4.0011E-01	1.2882E-01	0.0	0.0
14	5.5244E-01	6.2268E-01	1.8182E-01	0.0	0.0	0.0
15	4.4430E-01	3.8085E-01	0.0	0.0	0.0	0.0
16	2.5210E-01	0.0	0.0	0.0	0.0	0.0

MIXTURE = 3

GP.	ABSORPTION PROBABILITY	NU*FISSION PROBABILITY	NON-ABSORPTION PROBABILITY	TOTAL CROSS-SECTION
1	3.91966E-03	0.0	9.96080E-01	1.45125E-01
2	0.0	0.0	1.00000E 00	1.90987E-01
3	0.0	0.0	9.99999E-01	3.13998E-01
4	0.0	0.0	9.99999E-01	3.90436E-01
5	0.0	0.0	9.99999E-01	5.64358E-01
6	0.0	0.0	1.00000E 00	8.62999E-01
7	0.0	0.0	9.99999E-01	1.01893E 00
8	5.36987E-05	0.0	9.99945E-01	1.05932E 00
9	2.14795E-04	0.0	9.99786E-01	1.05932E 00
10	4.29589E-04	0.0	9.99571E-01	1.05932E 00
11	7.51781E-04	0.0	9.99247E-01	1.05932E 00
12	1.33798E-03	0.0	9.98662E-01	1.06287E 00
13	2.40836E-03	0.0	9.97593E-01	1.06287E 00
14	3.22805E-03	0.0	9.96772E-01	1.23353E 00
15	4.54737E-03	0.0	9.95453E-01	1.63167E 00
16	5.99625E-03	0.0	9.94004E-01	2.76937E 00

TRANSFER PROBABILITIES

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	2.6498E-01	7.3596E-01	8.3001E-01	9.2405E-01	9.8072E-01	1.0000E 00
2	3.5220E-01	6.3038E-01	8.3589E-01	9.5949E-01	9.9404E-01	1.0000E 00
3	2.7600E-01	7.3913E-01	9.3406E-01	9.8841E-01	9.9783E-01	1.0000E 00
4	3.7578E-01	8.6290E-01	9.7669E-01	9.9592E-01	9.9913E-01	1.0000E 00
5	4.7346E-01	9.1654E-01	9.8549E-01	9.9728E-01	9.9950E-01	1.0000E 00
6	4.9876E-01	9.1603E-01	9.8491E-01	9.9723E-01	9.9921E-01	1.0000E 00
7	4.7789E-01	9.0794E-01	9.8325E-01	9.9492E-01	9.9833E-01	1.0000E 00
8	4.6465E-01	9.0581E-01	9.7133E-01	9.9066E-01	9.9721E-01	1.0000E 00
9	4.6601E-01	8.4489E-01	9.4801E-01	9.8453E-01	9.9484E-01	1.0000E 00
10	3.4912E-01	7.9118E-01	9.3725E-01	9.7916E-01	9.9162E-01	1.0000E 00
11	3.2137E-01	8.0563E-01	9.3557E-01	9.7421E-01	9.9355E-01	1.0000E 00
12	3.3982E-01	7.8923E-01	9.1592E-01	9.7926E-01	1.0000E 00	1.0000E 00
13	3.1000E-01	7.3573E-01	9.3337E-01	1.0000E 00	1.0000E 00	1.0000E 00
14	3.6004E-01	8.4733E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
15	8.1026E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
16	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00

MUBAR

1	2.2276E-02	4.7541E-01	5.3556E-01	4.0167E-01	2.5000E-01	1.2245E-01
2	1.0825E-01	5.4711E-01	5.7536E-01	3.5663E-01	1.7241E-01	5.0000E-02
3	1.6410E-02	5.3393E-01	4.7119E-01	2.2667E-01	9.6154E-02	0.0
4	7.0176E-02	5.5301E-01	3.1754E-01	1.2121E-01	4.5455E-02	0.0
5	2.6121E-01	5.3596E-01	2.2661E-01	1.0256E-01	4.5455E-02	0.0
6	3.7796E-01	5.3267E-01	2.3732E-01	1.0160E-01	3.3333E-02	0.0
7	3.9917E-01	5.3873E-01	2.4092E-01	1.1005E-01	6.5574E-02	3.3333E-02
8	4.0647E-01	5.4096E-01	2.5410E-01	1.4167E-01	8.1967E-02	3.8462E-02
9	4.0823E-01	5.6677E-01	3.3177E-01	1.8824E-01	1.0417E-01	6.2500E-02
10	3.3546E-01	6.0324E-01	3.6300E-01	2.0256E-01	1.2069E-01	7.0513E-02
11	3.0333E-01	6.0424E-01	3.5691E-01	2.1140E-01	1.2500E-01	4.1667E-02
12	3.0200E-01	6.0530E-01	3.7902E-01	2.2673E-01	7.2351E-02	0.0
13	2.7586E-01	6.2276E-01	4.0011E-01	1.2882E-01	0.0	0.0
14	5.1398E-01	6.0764E-01	1.8182E-01	0.0	0.0	0.0
15	4.3223E-01	3.6916E-01	0.0	0.0	0.0	0.0
16	2.4797E-01	0.0	0.0	0.0	0.0	0.0

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SAMPLE PROBLEM 2

GEOMETRY DESCRIPTION

     GENERAL     1        +X = 0.0           -X = 0.0           +Y = 0.0           -Y = 0.0              +Z = 0.0              -Z = 0.0
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
     GENERAL     2        +X = 0.0           -X = 0.0           +Y = 0.0           -Y = 0.0              +Z = 0.0              -Z = 0.0
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
     GENERAL     3        +X = 0.0           -X = 0.0           +Y = 0.0           -Y = 0.0              +Z = 0.0              -Z = 0.0
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
                                                                                   WT LOW =   0.167      WT AVG =   0.500      WT HI =    1.500
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                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500

GENERAL     0      +X = 2.1035E 01   -X =-1.2350E 01   +Y = 2.1035E 01   -Y =-2.1035E 01   +Z = 1.9765E 01   -Z =-1.9765E 01
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500

CUBOID      0      +X = 2.1035E 01   -X =-1.2350E 01   +Y = 2.1035E 01   -Y =-2.1035E 01   +Z = 1.9765E 01   -Z =-1.9765E 01
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                         WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
```

```
    2      MALE
X ZONE       -0.12350E 02,  0.0         ,  0.21035E 02
Y ZONE       -0.21035E 02,  0.21035E 02
Z ZONE       -0.19765E 02,  0.19765E 02

ZONE      1     1    1
X BLOCK      -0.12350E 02,  0.0
Y BLOCK      -0.21035E 02,  0.0         ,  0.21035E 02
Z BLOCK      -0.19765E 02, -0.11609E 02, -0.84450E 00,  0.84450E 00,  0.11609E 02,
  0.19765E 02

BLOCK     1     1    1
MEDIA            4

BLOCK     1     1    2
MEDIA            1,    4
SURFACES         6
SECTOR -1
SECTOR  1

BLOCK     1     1    3
MEDIA            4

BLOCK     1     1    4
MEDIA            1,    4
SURFACES         6
SECTOR -1
SECTOR  1

BLOCK     1     1    5
MEDIA            4

BLOCK     1     2    1
MEDIA            4

BLOCK     1     2    2
MEDIA            1,    4
SURFACES         5
SECTOR -1
SECTOR  1

BLOCK     1     2    3
MEDIA            4

BLOCK     1     2    4
MEDIA            1,    4
SURFACES         5
SECTOR -1
SECTOR  1
```

```
BLOCK      1     2     5
MEDIA                4

ZONE       2     1     1
X BLOCK          0.0           ,  0.21035E 02
Y BLOCK       -0.21035E 02,  0.0           ,  0.21035E 02
Z BLOCK       -0.19765E 02, -0.19125E 02, -0.15650E 01, -0.13550E 01, -0.71500E 00,
  0.71500E 00,  0.13550E 01,  0.18915E 02,  0.19125E 02,  0.19765E 02

BLOCK      1     1     1
MEDIA                3,    4
SURFACES             3
SECTOR -1
SECTOR  1

BLOCK      1     1     2
MEDIA                2,    3,    4
SURFACES             3,    4
SECTOR  0 -1
SECTOR -1  1
SECTOR  1  0

BLOCK      1     1     3
MEDIA                3,    4,    4
SURFACES             3,    4
SECTOR -1  1
SECTOR  0 -1
SECTOR  1  0

BLOCK      1     1     4
MEDIA                3,    4
SURFACES             3
SECTOR -1
SECTOR  1

BLOCK      1     1     5
MEDIA                4

BLOCK      1     1     6
MEDIA                3,    4
SURFACES             3
SECTOR -1
SECTOR  1

BLOCK      1     1     7
MEDIA                2,    3,    4
SURFACES             3,    4
SECTOR  0 -1
SECTOR -1  1
SECTOR  1  0
```

```
BLOCK     1    1    8
MEDIA          3,    4,    4
SURFACES       3,    4
SECTOR -1  1
SECTOR  0 -1
SECTOR  1  0

BLOCK     1    1    9
MEDIA          3,    4
SURFACES       3
SECTOR -1
SECTOR  1

BLOCK     1    2    1
MEDIA          3,    4
SURFACES       1
SECTOR -1
SECTOR  1

BLOCK     1    2    2
MEDIA          2,    3,    4
SURFACES       1,    2
SECTOR  0 -1
SECTOR -1  1
SECTOR  1  0

BLOCK     1    2    3
MEDIA          3,    4,    4
SURFACES       1,    2
SECTOR -1  1
SECTOR  0 -1
SECTOR  1  0

BLOCK     1    2    4
MEDIA          3,    4
SURFACES       1
SECTOR -1
SECTOR  1

BLOCK     1    2    5
MEDIA          4

BLOCK     1    2    6
MEDIA          3,    4
SURFACES       1
SECTOR -1
SECTOR  1

BLOCK     1    2    7
MEDIA          2,    3,    4
```

```
SURFACES        1,    2
SECTOR  0 -1
SECTOR -1  1
SECTOR  1  0

BLOCK     1    2    8
MEDIA           3,    4,    4
SURFACES        1,    2
SECTOR -1  1
SECTOR  0 -1
SECTOR  1  0

BLOCK     1    2    9
MEDIA           3,    4
SURFACES        1
SECTOR -1
SECTOR  1

   68 UNIT METAL-SOLUTION ARRAY - CODE CHECK-III
 0.10000E 01XSQ    -0.21750E 02X       0.10000E 01YSQ    -0.21750E 02Y
 0.13331E 03     $
 0.10000E 01XSQ    -0.21750E 02X       0.10000E 01YSQ    -0.21750E 02Y
 0.14590E 03     $
 0.10000E 01XSQ    -0.21750E 02X       0.10000E 01YSQ     0.21750E 02Y
 0.13331E 03     $
 0.10000E 01XSQ    -0.21750E 02X       0.10000E 01YSQ     0.21750E 02Y
 0.14590E 03     $
 0.10000E 01XSQ     0.13195E 02X       0.10000E 01YSQ    -0.13195E 02Y
 0.53957E 02     $
 0.10000E 01XSQ     0.13195E 02X       0.10000E 01YSQ     0.13195E 02Y
 0.53957E 02     $
                                                        NPBX =   75
```

K-EFFECTIVE

7.42162E-01
8.39813E-01
8.54985E-01
9.56883E-01
9.16939E-01
9.49045E-01
1.01622E 00
1.00906E 00
9.94093E-01
9.74147E-01
9.14112E-01
1.08953E 00
9.55192E-01
9.52559E-01
1.04608E 00
9.63986E-01
9.38175E-01
1.02217E 00
1.08615E 00
9.90745E-01
1.00019E 00
9.23897E-01
9.84893E-01
8.98096E-01
9.51947E-01
9.30343E-01
8.74055E-01
9.79343E-01
1.05381E 00
9.09435E-01
9.42684E-01
9.45363E-01
9.61548E-01
9.55792E-01
9.41439E-01
1.05839E 00
1.02037E 00
1.01434E 00
1.00383E 00
9.42751E-01
9.58530E-01
9.41462E-01
9.56152E-01
9.48591E-01
9.47645E-01
9.14042E-01
9.42327E-01
9.67132E-01
9.74607E-01

1.05561E 00
9.01027E-01
9.72199E-01
1.09434E 00
9.10212E-01
9.07019E-01
8.94393E-01
1.03553E 00
1.06403E 00
9.93743E-01
9.67608E-01

SAMPLE PROBLEM 2

BATCH	K-EFFECTIVE	DEVIATION
1	7.42162E-01	-2.30004E-01
2	8.39813E-01	-1.32353E-01
3	8.54985E-01	-1.17182E-01
4	9.56883E-01	-1.52829E-02
5	9.16939E-01	-5.52268E-02
6	9.49045E-01	-2.31207E-02
7	1.01622E 00	4.40559E-02
8	1.00906E 00	3.68919E-02
9	9.94093E-01	2.19265E-02
10	9.74147E-01	1.98102E-03
11	9.14112E-01	-5.80540E-02
12	1.08953E 00	1.17364E-01
13	9.55192E-01	-1.69740E-02
14	9.52559E-01	-1.96067E-02
15	1.04608E 00	7.39183E-02
16	9.63986E-01	-8.18008E-03
17	9.38175E-01	-3.39915E-02
18	1.02217E 00	5.00059E-02
19	1.08615E 00	1.13986E-01
20	9.90745E-01	1.85794E-02
21	1.00019E 00	2.80209E-02
22	9.23897E-01	-4.82688E-02
23	9.84893E-01	1.27265E-02
24	8.98096E-01	-7.40704E-02
25	9.51947E-01	-2.02195E-02
26	9.30343E-01	-4.18235E-02
27	8.74055E-01	-9.81109E-02
28	9.79343E-01	7.17717E-03
29	1.05381E 00	8.16469E-02
30	9.09435E-01	-6.27308E-02
31	9.42684E-01	-2.94822E-02
32	9.45363E-01	-2.68031E-02
33	9.61548E-01	-1.06182E-02
34	9.55792E-01	-1.63743E-02
35	9.41439E-01	-3.07273E-02
36	1.05839E 00	8.62246E-02
37	1.02037E 00	4.82063E-02
38	1.01434E 00	4.21724E-02
39	1.00383E 00	3.16629E-02
40	9.42751E-01	-2.94154E-02
41	9.58530E-01	-1.36358E-02
42	9.41462E-01	-3.07045E-02
43	9.56152E-01	-1.60137E-02
44	9.48591E-01	-2.35748E-02
45	9.47645E-01	-2.45212E-02
46	9.14042E-01	-5.81239E-02
47	9.42327E-01	-2.98386E-02

```
   48       9.67132E-01      -5.03391E-03
   49       9.74607E-01       2.44087E-03
   50       1.05561E 00       8.34408E-02
   51       9.01027E-01      -7.11391E-02
   52       9.72199E-01       3.27826E-05
   53       1.09434E 00       1.22172E-01
   54       9.10212E-01      -6.19537E-02
   55       9.07019E-01      -6.51470E-02
   56       8.94393E-01      -7.77732E-02
   57       1.03553E 00       6.33640E-02
   58       1.06403E 00       9.18646E-02
   59       9.93743E-01       2.15774E-02
   60       9.67608E-01      -4.55785E-03

SKIP   3  BATCHES

AVERAGE K-EFFECTIVE =       9.72166E-01   + OR -      6.99817E-03

SKIP   4  BATCHES

AVERAGE K-EFFECTIVE =       9.72439E-01   + OR -      7.11885E-03

SKIP   5  BATCHES

AVERAGE K-EFFECTIVE =       9.73448E-01   + OR -      7.17626E-03

SKIP   6  BATCHES

AVERAGE K-EFFECTIVE =       9.73900E-01   + OR -      7.29590E-03

SKIP   7  BATCHES

AVERAGE K-EFFECTIVE =       9.73102E-01   + OR -      7.39022E-03

SKIP   8  BATCHES

AVERAGE K-EFFECTIVE =       9.72411E-01   + OR -      7.50070E-03

SKIP   9  BATCHES

AVERAGE K-EFFECTIVE =       9.71986E-01   + OR -      7.63695E-03

SKIP  10  BATCHES

AVERAGE K-EFFECTIVE =       9.71943E-01   + OR -      7.79113E-03

GROUP,      LEAKAGE        ABSORPTIONS       FISSIONS       WITH    3 BATCHES SKIPPED
  1      0.66090D-01      0.28209D-01      0.76007D-01
  2      0.11831D 00      0.49783D-01      0.12142D 00
  3      0.61205D-01      0.31294D-01      0.72142D-01
```

4	0.95568D-01	0.51564D-01	0.11313D 00
5	0.72127D-01	0.46260D-01	0.97352D-01
6	0.25634D-01	0.15655D-01	0.30121D-01
7	0.15329D-01	0.45934D-02	0.85053D-02
8	0.12294D-01	0.69958D-02	0.11983D-01
9	0.11322D-01	0.12290D-01	0.19898D-01
10	0.62554D-02	0.15430D-01	0.23014D-01
11	0.61744D-02	0.16703D-01	0.21162D-01
12	0.51049D-02	0.16507D-01	0.16166D-01
13	0.57614D-02	0.76321D-02	0.13382D-01
14	0.42315D-02	0.11046D-01	0.22280D-01
15	0.66489D-02	0.52018D-01	0.10076D 00
16	0.65748D-02	0.11312D 00	0.22487D 00
TOTAL =	0.51863D 00	0.47910D 00	0.97219D 00

ELAPSED TIME 2.896000MINUTES

SAMPLE PROBLEM 3

Sample problem 3 is a fictitious problem containing two interior regions of fissionable material, a thick region having a very low absorption probability and a blanket with a higher absorption probability surrounding the entire system. The intent of this problem is to show a single unit with upscatter cross sections.

SAMPLE PROBLEM 3

NUMBER OF BATCHES	60
NUMBER PER BATCH	200
NUMBER OF BATCHES TO BE SKIPPED	3
NUMBER OF GROUPS	9
MAX. NUMBER OF ENERGY TRANSFERS	6
NUMBER OF INPUT NUCLIDES	4
NUMBER OF MIXTURES	4
NUMBER OF MIXING TABLE ENTRIES	4
NUMBER OF REGIONS	5
NUMBER OF REGIONS IN REFLECTOR	0
UNITS IN X DIRECTION	1
UNITS IN Y DIRECTION	1
UNITS IN Z DIRECTION	1

NUCLIDE 1 MAT 1

GP.	ABSORPTION	NU-FISSION	TOTAL
1	3.3265E-04	3.3767E-04	2.0367E-01
2	2.0033E-04	6.3266E-04	3.8659E-01
3	6.1228E-04	1.6061E-04	4.1842E-01
4	2.7934E-03	5.2214E-04	4.3321E-01
5	3.4745E-03	2.6561E-03	4.2589E-01
6	3.5239E-03	6.5387E-03	4.2807E-01
7	3.1070E-03	4.1990E-03	4.3047E-01
8	5.0528E-03	6.2125E-03	4.4020E-01
9	9.4033E-03	1.1761E-02	4.4699E-01

TRANSFER CROSS SECTIONS

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.7027E-01	3.3042E-02	1.4845E-05	4.1283E-08	1.2426E-10	0.0
2	3.6595E-01	2.0429E-02	7.6440E-06	8.3548E-08	0.0	0.0
3	3.9830E-01	1.9506E-02	0.0	0.0	0.0	0.0
4	4.1189E-01	1.8524E-02	0.0	0.0	0.0	0.0
5	4.0383E-01	1.8585E-02	0.0	0.0	0.0	0.0
6	3.5696E-01	6.7546E-02	3.7674E-05	1.1000E-06	0.0	0.0
7	3.7360E-01	4.9249E-02	2.7038E-03	1.8151E-03	0.0	0.0
8	3.6878E-01	2.4625E-02	4.1742E-02	1.3646E-07	0.0	0.0
9	3.6066E-01	7.0736E-02	6.1870E-03	1.0817E-08	0.0	0.0

NUCLIDE 2 MAT 2

GP.	ABSORPTION	NU-FISSION	TOTAL
1	2.1110E-03	2.1415E-03	2.0904E-01
2	1.3968E-03	4.4082E-04	4.1572E-01
3	3.9832E-03	1.1472E-03	2.5295E-01
4	1.2430E-02	3.7295E-03	3.2934E-01
5	1.7278E-02	1.8972E-02	2.7616E-01
6	2.5484E-02	4.7975E-02	3.1250E-01
7	2.1834E-02	3.0449E-02	3.1058E-01
8	3.5815E-02	4.5470E-02	3.2849E-01
9	6.7962E-02	8.7764E-02	3.7648E-01

TRANSFER CROSS SECTIONS

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.5429E-01	5.2542E-02	7.7246E-05	1.2706E-07	1.0086E-11	0.0
2	4.0109E-01	1.3162E-02	5.5143E-05	6.0313E-07	0.0	0.0
3	2.4428E-01	4.6876E-03	0.0	0.0	0.0	0.0
4	3.0870E-01	8.2098E-03	0.0	0.0	0.0	0.0
5	2.5062E-01	8.2640E-03	0.0	0.0	0.0	0.0
6	2.4929E-01	3.7714E-02	8.6683E-06	3.2619E-08	0.0	0.0
7	2.4970E-01	3.7151E-02	7.2924E-04	1.1643E-03	0.0	0.0
8	2.3190E-01	2.8252E-02	3.2521E-02	3.0302E-08	0.0	0.0
9	2.2450E-01	8.2297E-02	1.7192E-03	3.3103E-10	0.0	0.0

NUCLIDE 3 MAT 3

GP.	ABSORPTION	NU-FISSION	TOTAL
1	5.0121E-08	0.0	2.2001E-01
2	1.6423E-07	0.0	3.9190E-01
3	8.3083E-07	0.0	4.4528E-01
4	4.1178E-06	0.0	4.4889E-01
5	2.0843E-05	0.0	4.4905E-01
6	5.4965E-05	0.0	4.3769E-01
7	1.0955E-04	0.0	4.4313E-01
8	1.7895E-04	0.0	4.4709E-01
9	3.2263E-04	0.0	4.3973E-01

TRANSFER CROSS SECTIONS

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	1.8875E-01	3.1256E-02	4.1323E-06	2.9326E-08	1.6369E-10	0.0
2	3.7031E-01	2.1588E-02	0.0	0.0	0.0	0.0
3	4.2336E-01	2.1918E-02	0.0	0.0	0.0	0.0
4	4.2868E-01	2.0203E-02	0.0	0.0	0.0	0.0
5	4.2876E-01	2.0265E-02	0.0	0.0	0.0	0.0
6	3.6630E-01	7.1286E-02	4.1700E-05	1.2524E-06	0.0	0.0
7	3.8782E-01	5.0328E-02	2.9682E-03	1.9018E-03	0.0	0.0
8	3.8119E-01	2.3436E-02	4.2279E-02	1.5010E-07	0.0	0.0
9	3.6645E-01	6.6335E-03	6.6149E-02	1.1978E-08	0.0	0.0

NUCLIDE 4 MAT 4

GP.	ABSORPTION	NU-FISSION	TOTAL
1	4.3251E-03	2.5712E-05	2.9935E-01
2	1.4584E-03	0.0	5.0776E-01
3	7.6172E-03	0.0	1.5848E 00
4	2.7703E-02	0.0	1.2498E 00
5	6.8707E-02	0.0	1.3498E 00
6	5.1988E-02	0.0	1.2990E 00
7	1.0322E-01	0.0	1.3524E 00
8	1.7017E-01	0.0	1.4241E 00
9	3.1276E-01	0.0	1.5862E 00

TRANSFER CROSS SECTIONS

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	2.6664E-01	2.8271E-02	1.0322E-04	4.2925E-07	2.3389E-09	0.0
2	4.9675E-01	9.5476E-03	2.3793E-08	0.0	0.0	0.0
3	1.5661E 00	1.1062E-02	0.0	0.0	0.0	0.0
4	1.2102E 00	1.1860E-02	0.0	0.0	0.0	0.0
5	1.2692E 00	1.1916E-02	0.0	0.0	0.0	0.0
6	1.1928E 00	5.4187E-02	0.0	0.0	0.0	0.0
7	1.1599E 00	8.61C9E-02	1.6089E-06	3.1718E-03	0.0	0.0
8	1.1057E 00	6.8172E-02	8.0102E-02	0.0	0.0	0.0
9	1.0677E 00	2.0573E-01	4.0839E-06	0.0	0.0	0.0

GROUP	FISSION SPECTRUM	CUMULATIVE FISSION SPECTRUM
1	0.74911E 00	0.74911E 00
2	0.24913E 00	0.99823E 00
3	0.17680E-02	0.10000E 01
4	0.0	0.0
5	0.0	0.0
6	0.0	0.0
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0

NGPF = 3

SAMPLE PROBLEM 3

MIXTURE	NUCLIDE	DENSITY
1	1	1.00000E 00
2	2	1.00000E 00
3	3	1.00000E 00
4	4	1.00000E 00

MIXTURE = 1

GP.	ABSORPTION PROBABILITY	NU*FISSION PROBABILITY	NON-ABSORPTION PROBABILITY	TOTAL CROSS-SECTION
1	1.63330E-03	1.65798E-03	9.98354E-01	2.03666E-01
2	5.18182E-04	1.63650E-03	9.99478E-01	3.86594E-01
3	1.46332E-03	3.83848E-04	9.98533E-01	4.18418E-01
4	6.44810E-03	1.20529E-03	9.93546E-01	4.33208E-01
5	8.15824E-03	6.23665E-03	9.91840E-01	4.25892E-01
6	8.23200E-03	1.52747E-02	9.91767E-01	4.28071E-01
7	7.21760E-03	9.75424E-03	9.92780E-01	4.30475E-01
8	1.14783E-02	1.41129E-02	9.88517E-01	4.40204E-01
9	2.10370E-02	2.63109E-02	9.78961E-01	4.46989E-01

TRANSFER PROBABILITIES

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	8.3742E-01	9.9993E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
2	9.4711E-01	9.9998E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
3	9.5331E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
4	9.5696E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
5	9.5600E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
6	8.4081E-01	9.9991E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
7	8.7419E-01	9.8943E-01	9.9575E-01	1.0000E 00	1.0000E 00	1.0000E 00
8	8.4748E-01	9.0407E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
9	8.2421E-01	9.8586E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00

MUBAR						
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0

MIXTURE = 2

GP.	ABSORPTION PROBABILITY	NU*FISSION PROBABILITY	NON-ABSORPTION PROBABILITY	TOTAL CROSS-SECTION
1	1.00987E-02	1.02447E-02	9.89822E-01	2.09037E-01
2	3.36007E-03	1.06039E-03	9.96610E-01	4.15718E-01
3	1.57469E-02	4.53523E-03	9.84248E-01	2.52953E-01
4	3.77415E-02	1.13243E-02	9.62254E-01	3.29340E-01
5	6.25664E-02	6.87001E-02	9.37431E-01	2.76161E-01
6	8.15493E-02	1.53522E-01	9.18445E-01	3.12498E-01
7	7.03002E-02	9.80385E-02	9.29691E-01	3.10581E-01
8	1.09030E-01	1.38422E-01	8.90962E-01	3.28488E-01
9	1.80521E-01	2.33119E-01	8.19473E-01	3.76476E-01

TRANSFER PROBABILITIES

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	7.4569E-01	9.9963E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
2	9.6810E-01	9.9987E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
3	9.8117E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
4	9.7409E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
5	9.6808E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
6	8.6857E-01	9.9997E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
7	8.6478E-01	9.9344E-01	9.9597E-01	1.0000E 00	1.0000E 00	1.0000E 00
8	7.9235E-01	8.8888E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
9	7.2767E-01	9.9443E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00

MUBAR

1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0

MIXTURE = 3

GP.	ABSORPTION PROBABILITY	NU*FISSION PROBABILITY	NON-ABSORPTION PROBABILITY	TOTAL CROSS-SECTION
1	2.27814E-07	0.0	9.99985E-01	2.20010E-01
2	4.19063E-07	0.0	9.99992E-01	3.91903E-01
3	1.86586E-06	0.0	9.99993E-01	4.45282E-01
4	9.17342E-06	0.0	9.99987E-01	4.48886E-01
5	4.64150E-05	0.0	9.99948E-01	4.49051E-01
6	1.25579E-04	0.0	9.99868E-01	4.37692E-01
7	2.47210E-04	0.0	9.99748E-01	4.43134E-01
8	4.00261E-04	0.0	9.99597E-01	4.47090E-01
9	7.33713E-04	0.0	9.98881E-01	4.39729E-01

TRANSFER PROBABILITIES

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	8.5791E-01	9.9998E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
2	9.4491E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
3	9.5078E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
4	9.5499E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
5	9.5487E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
6	8.3701E-01	9.9990E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
7	8.7541E-01	9.8901E-01	9.9571E-01	1.0000E 00	1.0000E 00	1.0000E 00
8	8.5296E-01	9.0540E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
9	8.3430E-01	8.4940E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00

MUBAR

1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0

MIXTURE = 4

GP.	ABSORPTION PROBABILITY	NU*FISSION PROBABILITY	NON-ABSORPTION PROBABILITY	TOTAL CROSS-SECTION
1	1.44482E-02	8.58944E-05	9.85516E-01	2.99350E-01
2	2.87223E-03	0.0	9.97112E-01	5.07762E-01
3	4.80637E-03	0.0	9.95187E-01	1.58481E 00
4	2.21658E-02	0.0	9.77829E-01	1.24982E 00
5	5.09019E-02	0.0	9.49100E-01	1.34979E 00
6	4.00200E-02	0.0	9.59967E-01	1.29904E 00
7	7.63230E-02	0.0	9.23675E-01	1.35237E 00
8	1.19496E-01	0.0	8.80503E-01	1.42411E 00
9	1.97179E-01	0.0	8.02810E-01	1.58620E 00

TRANSFER PROBABILITIES

FROM I	TO I+ 0	I+ 1	I+ 2	I+ 3	I+ 4	I+ 5
1	9.0382E-01	9.9965E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
2	9.8114E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
3	9.9299E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
4	9.9030E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
5	9.9070E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
6	9.5655E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
7	9.2853E-01	9.9746E-01	9.9746E-01	1.0000E 00	1.0000E 00	1.0000E 00
8	8.8175E-01	9.3612E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00
9	8.3844E-01	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00	1.0000E 00

MUBAR

1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0

```
SAMPLE PROBLEM 3

GEOMETRY DESCRIPTION

     CYLINDER     1  RADIUS = 1.6764E 02   +Z = 1.0000E 20   -Z =-1.0000E 20
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
     CYLINDER     2  RADIUS = 1.9820E 02   +Z = 1.0000E 20   -Z =-1.0000E 20
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
     CYLINDER     3  RADIUS = 2.5908E 02   +Z = 1.0000E 20   -Z =-1.0000E 20
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
     CYLINDER     4  RADIUS = 2.6416E 02   +Z = 1.0000E 20   -Z =-1.0000E 20
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
     CUBOID       0      +X = 2.6500E 02   -X =-2.6500E 02   +Y = 2.6500E 02   -Y =-2.6500E 02   +Z = 1.0000E 20   -Z =-1.0000E 20
                                                                      WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
```

```
                                     WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                     WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                     WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                     WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                     WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                     WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                     WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
                                     WT LOW =  0.167   WT AVG =  0.500   WT HI =   1.500
NPBX =    50
```

K-EFFECTIVE

8.87652E-01
1.02622E 00
9.69237E-01
9.56239E-01
1.01715E 00
1.05609E 00
9.99759E-01
9.95886E-01
1.00299E 00
9.97400E-01
1.02713E 00
1.02854E 00
1.03678E 00
1.05046E 00
9.75875E-01
1.00431E 00
9.39318E-01
1.01275E 00
9.72966E-01
1.08269E 00
1.02631E 00
1.05831E 00
1.03475E 00
1.03533E 00
1.01518E 00
1.01119E 00
9.98625E-01
1.02793E 00
9.99084E-01
1.00190E 00
1.05281E 00
1.02237E 00
1.02245E 00
1.04394E 00
1.09072E 00
1.02835E 00
1.04664E 00
9.88980E-01
9.86214E-01
1.02787E 00
9.90229E-01
1.03708E 00
1.01224E 00
1.04184E 00
9.70901E-01
1.01347E 00
9.77477E-01
9.76803E-01
9.58770E-01

1.08100E 00
9.87561E-01
1.00015E 00
1.03300E 00
1.01525E 00
1.07969E 00
1.00961E 00
1.07197E 00
9.89469E-01
1.07476E 00
9.82408E-01

SAMPLE PROBLEM 3

BATCH	K-EFFECTIVE	DEVIATION
1	8.87652E-01	-1.29516E-01
2	1.02622E 00	9.04751E-03
3	9.69237E-01	-4.79315E-02
4	9.56239E-01	-6.09288E-02
5	1.01715E 00	-2.00272E-05
6	1.05609E 00	3.89252E-02
7	9.99759E-01	-1.74094E-02
8	9.95886E-01	-2.12822E-02
9	1.00299E 00	-1.41802E-02
10	9.97400E-01	-1.97681E-02
11	1.02713E 00	9.96399E-03
12	1.02854E 00	1.13754E-02
13	1.03678E 00	1.96104E-02
14	1.05046E 00	3.32966E-02
15	9.75875E-01	-4.12933E-02
16	1.00431E 00	-1.28622E-02
17	9.39318E-01	-7.78499E-02
18	1.01275E 00	-4.42219E-03
19	9.72966E-01	-4.42016E-02
20	1.08269E 00	6.55241E-02
21	1.02631E 00	9.14097E-03
22	1.05831E 00	4.11453E-02
23	1.03475E 00	1.75838E-02
24	1.03533E 00	1.81637E-02
25	1.01518E 00	-1.98460E-03
26	1.01119E 00	-5.97668E-03
27	9.98625E-01	-1.85431E-02
28	1.02793E 00	1.07622E-02
29	9.99084E-01	-1.80838E-02
30	1.00190E 00	-1.52645E-02
31	1.05281E 00	3.56379E-02
32	1.02237E 00	5.20229E-03
33	1.02245E 00	5.28526E-03
34	1.04394E 00	2.67744E-02
35	1.09072E 00	7.35512E-02
36	1.02835E 00	1.11799E-02
37	1.04664E 00	2.94762E-02
38	9.88980E-01	-2.81880E-02
39	9.86214E-01	-3.09542E-02
40	1.02787E 00	1.07040E-02
41	9.90229E-01	-2.69392E-02
42	1.03708E 00	1.99080E-02
43	1.01224E 00	-4.93145E-03
44	1.04184E 00	2.46735E-02
45	9.70901E-01	-4.62671E-02
46	1.01347E 00	-3.69930E-03
47	9.77477E-01	-3.96912E-02

48	9.76803E-01	-4.03646E-02
49	9.58770E-01	-5.83982E-02
50	1.08100E 00	6.38342E-02
51	9.87561E-01	-2.96066E-02
52	1.00015E 00	-1.70183E-02
53	1.03300E 00	1.58358E-02
54	1.01525E 00	-1.91689E-03
55	1.07969E 00	6.25238E-02
56	1.00961E 00	-7.56168E-03
57	1.07197E 00	5.48000E-02
58	9.89469E-01	-2.76990E-02
59	1.07476E 00	5.75886E-02
60	9.82408E-01	-3.47598E-02

SKIP 3 BATCHES

AVERAGE K-EFFECTIVE = 1.01717E 00 + OR - 4.49742E-03

SKIP 4 BATCHES

AVERAGE K-EFFECTIVE = 1.01826E 00 + OR - 4.44244E-03

SKIP 5 BATCHES

AVERAGE K-EFFECTIVE = 1.01828E 00 + OR - 4.52391E-03

SKIP 6 BATCHES

AVERAGE K-EFFECTIVE = 1.01758E 00 + OR - 4.55295E-03

SKIP 7 BATCHES

AVERAGE K-EFFECTIVE = 1.01791E 00 + OR - 4.62700E-03

SKIP 8 BATCHES

AVERAGE K-EFFECTIVE = 1.01834E 00 + OR - 4.69704E-03

SKIP 9 BATCHES

AVERAGE K-EFFECTIVE = 1.01864E 00 + OR - 4.78021E-03

SKIP 10 BATCHES

AVERAGE K-EFFECTIVE = 1.01906E 00 + OR - 4.85748E-03

GROUP,	LEAKAGE	ABSORPTIONS	FISSIONS	WITH 3 BATCHES SKIPPED
1	0.0	0.98674D-02	0.10015D-01	
2	0.0	0.17840D-01	0.29923D-01	
3	0.0	0.57962D-01	0.16012D-01	

```
  4      0.0              0.13900D 00      0.29393D-01
  5      0.0              0.13113D 00      0.10704D 00
  6      0.0              0.40534D-01      0.75146D-01
  7      0.11869D-03      0.17172D 00      0.22879D 00
  8      0.0              0.26960D 00      0.32803D 00
  9      0.0              0.15527D 00      0.19284D 00

TOTAL = 0.11869D-03      0.99292D 00      0.10172D 01

ELAPSED TIME   5.99850MINUTES

IHC900I EXECUTION TERMINATING DUE TO ERROR COUNT FOR ERROR NUMBER  217

IHC217I FIOCS - END OF DATA SET ON UNIT    9

TRACEBACK FOLLOWS-   ROUTINE    ISN   REG.  14   REG.  15   REG.   0   REG.   1

                     IBCOM            0001DA8C   0001DAE0   FD000006   0004BFF8

                        MAIN          0000B342   0101D7E0   FD000006   0004BFF8

ENTRY POINT=  0101D7E0

SUMMARY OF ERRORS FOR THIS JOB   ERROR NUMBER   NUMBER OF ERRORS

                                     217              1
```