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EGGNII: A MULTIGROUP CROSS SECTION CODE

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ABSTRACT

The EGGNIT code has been developed to generate multigroup constants for neutron diffusion and transport calculations. This code is a major revision of the GAMTEC-II code. Most of the revisions were made in the resonance theory treatment where the added Nordheim numerical integration method permits treating absorbers and admixed scatterers exactly. An iteration technique is utilized to extend Nordheim's method to multiregion and other complex geometries. Other added features in EGGNIT are: 1) Interference absorption due to a nearby resonance line is permitted, 2) interference scattering is included, 3) resonance absorption integral contributes to the absorption of several GAM-I fine groups, 4) Dancoff shielding correction is computed for either square or hexagonal lattices by Carlvik's DASQUE program.⁽⁶⁾

INTRODUCTION

The EGGNIT code is a major revision of GAMTEC-II* which generates multi-group constants utilized in neutron diffusion and transport calculations. Most of the improvements and strengthening of the code were made in the resonance theory techniques where the Nordheim numerical integration method replaced the method of Adler, Hinman, and Nordheim (AHN).⁽¹⁾⁽²⁾ The (AHN) method assumes either the narrow resonance (NR) or narrow resonance-infinite mass (NRIA) approximations for the absorber and the NR approximation for admixed scatterers. Nordheim's numerical solution to the integral slowing down equation permits treating both absorber and admixed scatterers exactly. Differences in treating the absorbing lump are generally only a few percent; however, the method chosen for the admixed moderators can lead to quite large differences; for some cases, differences of a factor of two have been observed in the effective resonance integral.

The numerical integration technique as developed by Nordheim, as in the AHN method, is limited to a single lump absorber. An iteration technique is presented in this report which extends Nordheim's method to multiregion and other complex geometries. Any geometrical configuration may be treated for which the user has the ingenuity to write a collision probability routine. Other important features in EGGNIT and not available in GAMTEC-II are:

- 1) Resonance overlap capability, i.e., interference absorption due to a nearby resonance spike.

* GAMTEC-II combined the GAM-I and TEMPEST codes into a single program to compute multigroup constants for neutron multiplying media over the energy range $10 \text{ MeV} \geq E \geq 0$.⁽³⁾⁽⁴⁾⁽⁵⁾ TEMPEST is a Fortran II version of SOFOCATE.

- 2) Interference scattering is included in the Nordheim method.
- 3) Resonance absorption integral contributes to the absorption in several GAM fine groups rather than being placed in a single fine group as in GAMTEC II and GAM I.
- 4) Dancoff shielding corrections are computed for square and hexagonal lattices by Carlvik's DASQUE program.⁽⁶⁾

EGGNIT is written in the Fortran IV symbolic language and is operable for a UNIVAC 1108 with an EXEC II monitor system. The library tape of cross sections and other data are contained on a single magnetic tape. For heterogeneous arrays the maximum number of concentric regions is 17 with a maximum of 5 regions being treated by the Nordheim integration scheme.

A general description of EGGNIT is given in this report with a detailed discussion of the resonance absorption and fast fission calculations. Detailed discussions of the P_L and B_L calculation of the slowing down spectra are found in the GAM-I report⁽⁴⁾ and the Wigner-Wilkins and Wilkins thermalization models are described in the TEMPEST document.⁽⁵⁾ Input instructions for EGGNIT are given in APPENDIX A and a description of the library tape and its updating routine are presented in APPENDIX B. A sample problem is given in APPENDIX C. A portion of the information given in this report duplicates that previously found in the GAMTEC-II report⁽³⁾ but is reproduced here for the convenience of the user.

THERMAL GROUP CONSTANTS

Thermal group constants may be averaged over one of three spectrums in a SOFOCATE (TEMPEST)⁽⁵⁾ calculation; 1) a Wigner-Wilkins light moderator spectrum, 2) a Wilkins heavy moderator spectrum, and 3) a Maxwellian distribution. For heterogeneous lattice arrays, the unit

cell is equivalently homogenized by volume and flux weighting atom densities. A one-velocity P_3 approximation to the transport equation is used to compute the neutron fine structure in the unit cell. Although GAMTEC-II has been used very successfully in the analyses and correlation of critical experiments with homogeneous mixtures and solutions of plutonium,⁽⁷⁾⁽⁸⁾ its application to heterogeneous arrays is quite inadequate, because of spectral dependence on lattice position in heterogeneous arrays. For heterogeneous arrays it is recommended that average thermal group constants be obtained separately from THERMOS⁽⁹⁾ which computes the scalar thermal neutron spectrum as a function of lattice position. The user has the option in EGGNIT of omitting the TEMPEST- P_3 calculation.

Provisions are made in EGGNIT input for two temperatures: physical and neutron. The physical temperature is used to compute Doppler effects in resonance absorption calculations and the neutron temperature is used primarily in the thermalization calculation. The average temperature used in the TEMPEST calculation is

$$\bar{T} = \frac{\sum_j V_j T_j \sum_i \xi_{ij} \Sigma_{ij}^S}{\sum_j V_j \sum_i \xi_{ij} \Sigma_{ij}^S}$$

where j and i are summed over all regions and isotopes, respectively, and ξ_{ij} = the average increase in lethargy per collision with i^{th} material in the j^{th} region

Σ_{ij}^S = the corresponding macroscopic scattering cross section

T_j = neutron temperature in the j^{th} region

V_j = volume of the j^{th} region.

FAST GROUP CONSTANTS

To compute a characteristic neutron slowing down spectrum for a means of averaging cross section data to obtain fast group constants, it is necessary to solve the Boltzman transport equation and only approximate solutions are economically feasible. The P_1 and B_1 approximations originally coded into GAM-I have been incorporated into EGGNIT.⁽⁴⁾ Since both methods are discussed in detail in the GAM-I report and in several books,⁽¹⁰⁾⁽¹¹⁾ only a brief description and pertinent remarks concerning the approximations will be herein given.

Both the P_L and B_L are similar in that Legendre expansions are used to reduce the Boltzman equation to a form which may be treated analytically. Their basic differences are as follows: the P_L method approximates the flux, scattering kernel and source by truncating after $(L+1)$ equations, whereas the B_L method only approximates the scattering kernel and the source; the flux is treated exactly. The truncation of source and kernel is a much less severe approximation, since in many cases the kernel is nearly isotropic in the center-of-mass system, and the source, if it is due to fission is always assumed to be isotropic. For the P_L method to be equivalent to a B_L calculation, one would need an infinite number of ϕ_ℓ terms in the flux expansion. However, the B_L method applies only to an infinite medium, whereas the P_L approximation can be applied to any finite system by the addition of the proper boundary conditions. The only way in which the B_L method can be used in a finite media is that the media be homogeneous and the space and energy variables are separable. In this way the Fourier transform variable B may be associated with a finite medium "buckling."

Heterogeneous fine structure of lattice arrays are smeared into a homogeneous media by simple volume weighting atom densities. Resonance self-shielding due to finite dilution or lumping of an absorber is treated by the Nordheim integration technique with the NR and NR1A approximations available.⁽¹⁾ Also, fuel lumping effects on the fast fission in ^{238}U and ^{232}Th as developed for GAMTEC-II has been incorporated into EGGNIT. Detailed discussions of the techniques for treating resonance self-shielding and the fast fission correction in EGGNIT are given below.

A. MULTIGROUP ABSORPTION CONSTANTS

The calculation of group-averaged absorption cross section in the original GAM-I code was divided into two components: 1) a slowly varying cross section and 2) a resonance absorption cross section.⁽⁴⁾ The term $\bar{\sigma}_{an}$, absorption constant for the n^{th} group, thus becomes

$$\bar{\sigma}_{an} = \bar{\sigma}_{an}^{\text{smooth}} + \bar{\sigma}_{an}^{\text{resonance}}$$

A.1 Smooth Absorption Contribution

The contribution of a slowly varying cross section to the microscopic absorption constants is expressed in the usual flux weighted expression

$$\sigma_{an}^s = \frac{\int_{E_i}^{E_{i+1}} \sigma_a(E) \phi(E) dE}{\int_{E_i}^{E_{i+1}} \phi(E) dE} = \frac{\sum_i \overline{\sigma_{ai}^s} \bar{\phi}_i \Delta u_i}{\sum_i \bar{\phi}_i \Delta u_i}$$

where σ_{ai}^s is the smooth absorption cross section and $\bar{\phi}_i$ is the B_1 slowing down flux for the i^{th} fine group comprising the n^{th} broad group.

A.2 Resonance Absorption Contribution

The contribution of a resonance capture line to microscopic absorption constants for multi-group computations is given by

$$\overline{\sigma_a^R} = \frac{\int_{E_i}^{E_{i+1}} \sigma_a(E) \phi(E) dE}{\int_{E_i}^{E_{i+1}} \phi(E) dE} \quad (1)$$

where the integration is carried over the limits of the defined group. For numerical work it is advantageous to express Eq. (1) in terms of lethargy flux, $\phi(u) = E\phi(E)$,

$$\overline{\sigma_a^R} = \frac{\int_{u_i}^{u_{i+1}} \sigma_a(u) \phi(u) du}{\int_{u_i}^{u_{i+1}} \phi(u) du} \quad (2)$$

where

$$u = \ln \frac{E_1}{E}$$

and E_1 is chosen so that for $E > E_1$ the resonance contribution is negligible. Upon introducing the more slowly varying collision density

$$F(u) = \frac{1}{\phi(0)E_1} \sigma_t(u) \phi(u) e^u \quad (3)$$

Eq. (2) becomes

$$\overline{\sigma}_a^R = \frac{\phi(o) E_1 \int_{u_i}^{u_{i+1}} \frac{\sigma_a(u)}{\sigma_t(u)} F(u) e^{-u} du}{\int_{u_i}^{u_{i+1}} \phi(u) du} \quad (4)$$

The collision density, Eq. (3), has been normalized such that the lethargy flux is unity at E_1 .

The effective resonance integral (I) is defined as the lethargy-integrated absorption cross section required to produce the same amount of absorption as actually takes place in the resonance, assuming the flux has the value it would have in absence of the resonance. Thus the contribution to the effective resonance integral by a single k^{th} resonance line is

$$I_k = E_1 \int_0^{\infty} \frac{\sigma_u(u)}{\sigma_t(u)} F(u) e^{-u} du \quad (5)$$

and the multigroup absorption constant becomes

$$\overline{\sigma}_a^R = \frac{\sum_{k=1}^N \phi_k(o) I_k(u_{i+1}, u_i)}{\int_{u_i}^{u_{i+1}} \phi(u) du} \quad (6)$$

for N number of resonances encompassed in the group width $u_{i+1} - u_i$. $I_k(u_{i+1}, u_i)$ denotes that portion of the resonance integral falling within the group width, i.e.,

$$I_k(u_{i+1}, u_i) = E_1 \int_{u_i}^{u_{i+1}} \frac{\sigma_a(u)}{\sigma_t(u)} F(u) e^{-u} du \quad (7)$$

For the problems in which the resonance absorber is located in multiple regions, the cell-averaged resonance integral is defined as

$$I = \frac{\sum_i N_{o_i} V_i I_i}{\sum_i N_{o_i} V_i}$$

where N_{o_i} , V_i , and I_i denote, respectively, the absorber atom density, volume and resonance integral for the i^{th} region.

A2(a) Resonance Cross Sections⁽¹⁾

The resonance cross sections involved in Eq. (7) are given in terms of the Doppler-broadened, Breit-Wigner shape functions, i.e.,

$$\sigma_a = \frac{\Gamma_Y}{\Gamma} \sqrt{\frac{E_0}{E}} \sigma_0 \psi(\zeta, x) \quad ,$$

$$\sigma_s = \frac{\Gamma_n^0}{\Gamma} \sigma_0 \psi(\zeta, x) + \left(\sigma_0 \sigma_{p_0} g \frac{\Gamma_n^0}{\Gamma} \right)^{1/2} \chi(\zeta, x) + \sigma_{p_0}$$

where

$$x = \frac{2(E-E_0)}{\Gamma} ,$$

$$\zeta = \sqrt{\frac{A\Gamma^2}{4EkT}} ,$$

and

$$\psi(\zeta, x) = \frac{\zeta}{\sqrt{4\pi}} \int_{-\infty}^{+\infty} dy \frac{\exp \left\{ -\frac{\xi^2 (x-y)^2}{4} \right\}}{1+y^2}$$

$$\chi(\zeta, x) = \frac{\zeta}{\sqrt{4\pi}} \int_{-\infty}^{+\infty} \frac{2y dy}{1+y^2} \exp \left\{ -\frac{\xi^2 (x-y)^2}{4} \right\}$$

$$= 2x\psi(\zeta, x) + \frac{4}{\zeta^2} \frac{d\psi}{dx} .$$

Γ_n^0 is the neutron width at resonance, σ_{p_0} is the potential scattering cross section,

$$\sigma_0 = g4\pi \lambda_0^2 \frac{\Gamma_n^0}{\Gamma}$$

is the cross section at resonance, and

$$g = \frac{2J+1}{2(2I+1)}$$

the statistical factor due to nuclear spin, I , with J being the channel spin.

A2.b Collision Density for Isolated Resonances

The collision density for the j^{th} region in a unit lattice cell consisting of n regions is⁽¹⁾

$$F_j(u) = \sum_{k=1, n} P_{kj} \left[\frac{1}{\alpha_o} \int_{u-\Delta_o}^u F_k(u') \frac{\Sigma_{s_{ok}}}{\Sigma_{t_{ok}} + \Sigma_{s_k}} du' + \frac{1}{\alpha_{s_k}} \int_{u-\Delta_{s_k}}^u F_k(u') \frac{\Sigma_{s_k}}{\Sigma_{t_{ok}} + \Sigma_{s_k}} du' \right] \quad (8)$$

where the subscripting is illustrated by defining $\Sigma_{s_{ok}}$ and Σ_{s_k} as the macroscopic scattering cross section, respectively, of the absorber and admixture moderator in the k^{th} region. The term Δ_i denotes the maximum lethargy change in an elastic collision with the i^{th} material, i.e.,

$$\Delta_i = \ln \frac{1}{1-\alpha_i}$$

where

$$\alpha = \frac{4A}{(A+1)^2}$$

Nordheim suggested a direct numerical solution of Eq. (8) for a single lumped absorber which eliminated the necessity for distinguishing between narrow and wide resonances, i.e., the NR and WR approximations. An iteration scheme is now described which extends Nordheim's numerical solution to multi-region and other complex geometries.

Upon application of the NR approximation and the reciprocity theorem to the n^{th} region, Eq. (8) may be expressed in the general form

$$F_j(u) = \sum_{k=1}^{n-1} P_{kj}(u) \left[\int_{u-\Delta o}^u F_k(u') R_{o_k}(u') du' + \int_{u-\Delta s_k}^u F_k(u') R_{s_k}(u') du' \right] + B_n(u) \quad (9)$$

where,

$$B_n(u) = P_{jn}(\Sigma t_{o_j} + \Sigma s_j) \frac{e^u}{E_1}$$

Evaluating the integrals in Equation (9) by Simpson's rule,

$$\int_{u_{i-n\epsilon}}^{u_i} F(u') R(u') du = \frac{\epsilon}{3} \left[F_{i-n} R_{i-n} + 4 \sum_{\ell=0}^{(n-2)/2} F_{i-n+1+2\ell} \right. \\ \left. + 2 \sum_{\ell=0}^{(n-4)/2} F_{i-n+2+2\ell} R_{i-n+2+2\ell} + F_i R_i \right] \quad (10)$$

and inserting into Equation (9) leads to the recurrence formula,

$$F_{ji} \left\{ 1 - \frac{\epsilon}{3} P_{jj}(u) \left[R_{o_{ji}} + R_{s_{ji}} \right] \right\} = \frac{\epsilon}{3} \left\{ \sum_{k=1}^{n-1} P_{kj}(u) \left[F_{k,i-n} R_{o_{k,i-n}} \right. \right. \\ \left. + 4 \sum_{\ell=0}^{(n-2)/2} F_{k,i-n+1+2\ell} R_{o_{k,i-n+1+2\ell}} + 2 \sum_{\ell=0}^{(n-4)/2} F_{k,i-n+2+2\ell} \right. \\ \left. \left. + 2 \sum_{\ell=0}^{(n-4)/2} F_{k,i-n+2+2\ell} \right] \right\}$$

$$\begin{aligned}
& \cdot R_{o_{k,i-n+2+2\ell}} + F_{k,i-m} R_{s_{k,i-m}} + 4 \sum_{\ell=0}^{(m-2)/2} F_{k,i-m+1+2\ell} R_{s_{k,i-m+1+2\ell}} \\
& + 2 \sum_{\ell=0}^{(m-4)/2} F_{k,i-m+2+2\ell} R_{s_{k,i-m+2+2\ell}} \Big] + \sum_{k=1, n-1}^{k \neq j} P_{kj}(u) F_{ki} \left[R_{o_{k,i}} \right. \\
& \left. + R_{s_{k,i}} \right] \Big\} + B_n(u) \tag{11}
\end{aligned}$$

which permits a step-by-step evaluation of F_{ji} .

The collision densities F_{ji} ($j = 1, n-1$) are evaluated by iterating Equation (11) in which the F_{ji} 's from the previous iteration become the F_{ki} 's in the current iteration step. Initial value of F_{ki} 's to begin the iteration procedure are obtained by applying the NR and WR approximation, and making use of the reciprocity theorem to all $k \neq j$ regions. Equation (11) then becomes in the initial iteration cycle

$$\begin{aligned}
F_{ji} \left\{ 1 - \frac{\varepsilon}{3} P_{jj}(u) \left[R_{o_{ji}} + R_{s_{ji}} \right] \right\} &= \frac{\varepsilon}{3} P_{jj}(u) \left[F_{j,i-n} R_{o_{j,in}} \right. \\
&+ 4 \sum_{\ell=0}^{(n-2)/2} F_{j,i-n+1+2\ell} R_{o_{j,i-n+1+2\ell}} \\
&+ 2 \sum_{\ell=0}^{(n-4)/2} F_{j,i-n+2+2\ell} R_{o_{j,i-n+2+2\ell}} + F_{j,i-n} R_{s_{j,i-n}}
\end{aligned}$$

$$\begin{aligned}
 & + \sum_{\ell=0}^{(m-2)/2} F_{j,i-n+1+2\ell} R_{s_{j,i-n+1+2\ell}} \\
 & + 2 \sum_{\ell=0}^{(m-4)/2} F_{j,i-m+2+2\ell} R_{s_{j,i-m+2+2\ell}} \\
 & + \left(\sigma_{t_{o_j}} + \sigma_{s_j} \right) \frac{e^u}{E_1} \sum_{k=1, N}^{k \neq j} P_{jk} \frac{\sigma_{s_{o_k}} + \sigma_{s_k}}{\sigma_{t_{o_k}} + \sigma_{s_k}} \quad (12)
 \end{aligned}$$

A2.c Collision Density for Non-Isolated Resonances

Most computer codes that generate multi-group constants treat resonance self shielding only for the situation in which each resonance line is isolated and unaffected by the presence of a nearby resonance line. However, the problem of interference due to a nearby resonance line is treated in EGGNIT. The interfering resonance line may be either a resonance of the same absorber or of a different absorbing isotope. Also, in our technique, given below, the absorbers may be located in the same or different regions comprising the unit lattice cell except that no absorbers are permitted in the outermost region.

In the presence of an interfering resonance the expression for the collision density becomes.

$$F_j(u) = \sum_{k=1,} P_{kj} \left[\frac{1}{\alpha_o} \int_{u-\Delta_o}^u F_k(u') \frac{\Sigma_{s_{o_k}}}{\Sigma_{t_{o_k}} + \Sigma_{t_{o_k}}' + \Sigma_{s_k}} du' \right]$$

$$\begin{aligned}
& + \frac{1}{\alpha'_0} \int_{u-\Delta'_0}^u F_k(u') \frac{\Sigma'_{s_{0k}}}{\Sigma_{t_{0k}} + \Sigma'_{t_{0k}} + \Sigma_{s_k}} du' \\
& + \frac{1}{\alpha_{s_k}} \int_{u-\Delta_{s_k}}^u F_k(u') \frac{\Sigma_{s_k}}{\Sigma_{t_{0k}} + \Sigma'_{t_{0k}} + \Sigma_{s_k}} du' \Big] \quad (13)
\end{aligned}$$

where the additional primed terms denote those of the interfering resonance line. Evaluating the integral by Simpson's rule, as in the previous section, leads to the following recurrence formula

$$\begin{aligned}
F_{ji} \left\{ 1 - \frac{\varepsilon}{3} P_{jj}(u) \left[R_{0ji} + R'_{0ji} \right] \right\} &= \frac{\varepsilon}{3} \left\{ \sum_{k=1}^{n-1} P_{kj}(u) \left[F_{k,i-n} R_{0k,i-n} \right. \right. \\
&+ 4 \sum_{\ell=0}^{(n-2)/2} F_{k,i-n+1+2\ell} R_{0k,i-n+1+2\ell} + 2 \sum_{\ell=0}^{(n-4)/2} F_{k,i-n+2+2\ell} R_{0k,i-n+2+2\ell} \\
&+ F_{k,i-n'} R'_{0k,i-n'} + 4 \sum_{\ell=0}^{(n'-2)/2} F_{k,i-n'+1+2\ell} R'_{0k,i-n'+1+2\ell} \\
&+ 2 \sum_{\ell=0}^{(n'-4)/2} F_{k,i-n'+2+2\ell} R'_{0k,i-n'+2+2\ell} + F_{k,i-m} R_{s_k,i-m} \Big] \Big\}
\end{aligned}$$

$$\begin{aligned}
 & + 4 \sum_{\ell=0}^{(m-2)/2} F_{k,i-m+1+2\ell} R_{s_{k,i-m+1+2\ell}} + 2 \sum_{\ell=0}^{(m-4)/2} F_{k,i-m+2+2\ell} R_{s_{k,i-m+2+2\ell}} \Bigg] \\
 & + \sum_{k=1, n-1}^{k \neq j} P_{kj}(u) F_{ki} \left[R_{o_{k,i}} + R'_{o_{k,i}} + R_{s_{k,i}} \right] \Bigg\} + B_n(u) . \quad (14)
 \end{aligned}$$

In the usual Nordheim scheme, the numerical integration initiates at a lethargy for which the flux is asymptotic. With the addition of an interfering resonance, care must be taken to ensure that the integration scheme starts in a region of asymptotic flux.

A.3 Broad Group Averaging

If the flux emerging below the resonance recovers to the original asymptotic value and this holds true for all resonances, then

$$\phi(u) = \phi(o) = \text{constant}$$

and Eq. (6) becomes

$$\overline{\sigma}_a^R = \frac{\sum_{k=1}^N I_k(u_{i+1}, u_i)}{u_{i+1} - u_i} \quad (6a)$$

In the GAM code this latter expression is the equation used to obtain the resonance capture contributions to the multi-group constants.

However, as exists in most chain reacting media, the flux emerging below a resonance does not completely recover and utilization of the above expression may lead to serious errors, especially for media having low

moderator-to-absorber ratios. For a simple graphite moderated lattice with uranium metal fuel rods, Eq. (6a) resulted in an error of about 4% in the escape-to-thermal probability.

In EGGNIT, multi-group averages are computed from Eq. (6) directly,

$$\overline{\sigma_a^R} = \frac{\sum_{k=1}^N \phi_k(o) I_k(u_{i+1}, u_i)}{\int_{u_i}^{u_{i+1}} \phi(u) du} \quad (6)$$

The chief difficulty in applying Eq. (6) is that the asymptotic flux $\phi(o)$ is not available in terms of the B_1 -computed slowing down flux. In EGGNIT, as in GAMTEC-II⁽³⁾ the asymptotic flux $\phi(o)$ is taken to be the largest B_1 flux in the sequence

$$\overline{\phi}_{n-2}, \overline{\phi}_{n-1}, \overline{\phi}_n \quad \text{for } E < 101 \text{ eV}$$

$$\overline{\phi}_{n-1}, \overline{\phi}_n \quad \text{for } E \geq 101 \text{ eV}$$

where the subscript n denotes the fine group in which the resonance contribution falls. A breakdown of the GAM-I fine group structure is given in Table I.

TABLE IFINE GROUP STRUCTURE

<u>Group</u>	<u>U(lower)</u>	<u>E(lower)</u>	<u>Group</u>	<u>U(lower)</u>	<u>E(lower)</u>
1	0.25	7.79×10^6	35	8.75	1.59×10^3
2	0.50	6.07×10^6	36	9.00	1.23×10^3
3	0.75	4.72×10^6	37	9.25	961
4	1.00	3.68×10^6	38	9.50	748
5	1.25	2.87×10^6	39	9.75	583
6	1.50	2.23×10^6	40	10.00	454
7	1.75	1.74×10^6	41	10.25	354
8	2.00	1.35×10^6	42	10.50	275
9	2.25	1.05×10^6	43	10.75	215
10	2.50	8.21×10^5	44	11.00	167
11	2.75	6.39×10^5	45	11.25	130
12	3.00	4.98×10^5	46	11.50	101
13	3.25	3.88×10^5	47	11.75	78.9
14	3.50	3.02×10^5	48	12.00	61.4
15	3.75	2.35×10^5	49	12.25	47.9
16	4.00	1.83×10^5	50	12.50	37.3
17	4.25	1.43×10^5	51	12.75	29.0
18	4.50	1.11×10^5	52	13.00	22.6
19	4.75	8.65×10^4	53	13.25	17.6
20	5.00	6.74×10^4	54	13.50	13.7
21	5.25	5.25×10^4	55	13.75	10.68
22	5.50	4.09×10^4	56	14.00	8.32
23	5.75	3.18×10^4	57	14.25	6.48
24	6.00	2.48×10^4	58	14.50	5.04
25	6.25	1.93×10^4	59	14.75	3.93
26	6.50	1.50×10^4	60	15.00	3.06
27	6.75	1.17×10^4	61	15.25	2.38
28	7.00	9.12×10^3	62	15.50	1.86
29	7.25	7.10×10^3	63	15.75	1.44
30	7.50	5.53×10^3	64	16.00	1.125
31	7.75	4.31×10^3	65	16.25	0.876
32	8.00	3.36×10^3	66	16.50	0.683
33	8.25	2.61×10^3	67	16.75	0.532
34	8.50	2.04×10^3	68	17.00	0.414

B. Fast Fission Corrections

Until a fission neutron has undergone at least a few collisions, the homogeneous model is not satisfactory in approximating a lattice array, this being particularly true for fast fissioning ^{238}U . Bonalumi has developed a method for calculating first-flight collision probabilities in concentric geometries.⁽¹²⁾ This method has been used to apply corrections to the atom densities of ^{238}U and ^{232}Th when neutron energies exceed 1.35 MeV, the approximate ^{238}U fission threshold. Bonalumi's method has been extended to include n-flight contributions to the collision probabilities. Interaction effects between neighboring fuel elements are approximated by isotropically reflecting neutrons that escape to the equivalent unit cell boundary with energies exceeding 1.35 MeV.

The following derivation is for neutrons having energies in excess of 1.35 MeV. In a homogeneous mixture, the number of collisions with ^{238}U per original fission neutron is

$$C_1 = \frac{f_1 P_u}{1 - \sum_i P_i \left(\frac{\sigma_{i1} + v_i f_i \sigma_{if}}{\sigma_{it}} \right)} \quad (15)$$

where the cross sections and processes entering the formulation are

P_i = first flight collision probability for a neutron ($E \geq 1.35$ MeV)
with the i^{th} material*

σ_{if} = fission cross section

* The subscript u denotes ^{238}U .

σ_{i1} = scattering cross section for which the neutron energy
remains above 1.35 MeV

σ_{it} = transport cross section

ν_i = mean number of fission neutrons resulting from a fast
fission ($E \geq 1.35$ MeV)

f_1 = the fraction of fission neutrons born with energies
exceeding 1.35 MeV.

The summation in Eq (15) is over all materials making up the unit lattice
cell. For a homogeneous mixture

$$p_i = \frac{N_i \sigma_{it}}{\sum_j N_j \sigma_{jt}} \quad (16)$$

therefore

$$C_1^{\text{Homo}} = \frac{f_1 N_u \sigma_{ut}}{\sum_j N_j \sigma_{jr}} \quad (17)$$

where

$$\sigma_{jr} = \sigma_{jt} - \sigma_{jl} - \nu_j f_1 \sigma_{jf}$$

Equation (17) may be made equivalent to that for a heterogeneous lattice
array by applying correction factors to the atom densities

$$C_1^{\text{Het}} = \frac{\omega_u N_u f_1 \sigma_{tu}}{\omega_u N_f \sigma_{fr} + \omega_o \Sigma_{or}} \quad (18)$$

where $N_{f\text{fr}}^\sigma$ is summed over all fast fissile isotopes in ^{238}U region,* and

$$\Sigma_{\text{or}} = \sum_i N_i^\sigma \sigma_{\text{ir}} - N_{f\text{fr}}^\sigma$$

The correction factor for ^{238}U and all other fast fissile isotopes in ^{238}U region is ω_u ; ω_o is the correction factor for all other isotopes. Setting the mean free paths in the weighted and unweighted mixture equal

$$\omega_u N_{f\text{tf}}^\sigma + \omega_o \Sigma_{\text{ot}} = \sum_i N_i^\sigma \sigma_{\text{it}} \quad (19)$$

results in

$$\omega_u = \frac{C_1^{\text{Het}} \Sigma_{\text{or}} \left(1 + \frac{N_{f\text{ft}}^\sigma}{\Sigma_{\text{ot}}} \right)}{\left[f_1 N_{u\text{ut}}^\sigma - C_1^{\text{Het}} \left(N_{f\text{fr}}^\sigma - \Sigma_{\text{or}} \frac{N_{f\text{ft}}^\sigma}{\Sigma_{\text{ot}}} \right) \right]} \quad (20)$$

and

$$\omega_o = 1 + \frac{(1-\omega_u) N_{f\text{ft}}^\sigma}{\sum_i N_i^\sigma \sigma_{\text{it}} - N_{f\text{ft}}^\sigma} \quad (21)$$

The number of collisions with ^{238}U per original fission neutron in a heterogeneous lattice array is

$$C_1^{\text{Het}} = f_1 \sum_{n=1}^{\infty} P_n^u \quad (22)$$

* An option is provided in the code to either have $N_{f\text{fr}}^\sigma$ summed over just ^{238}U [Loc(527) = 0] or all fast fissile materials located within a ^{238}U [Loc(527) = 1] or ^{232}Th [Loc(527) = 2] region.

where P_n^u is the nth-flight collision probability with ^{238}U . Let $P_n(J)$ be the nth-flight collision probability in the Jth region; therefore, the first flight collision probability is

$$P_1(J) = \sum_{k=1}^N F(k) P(k, J) \quad (23)$$

where N denotes the number of regions in the unit lattice cell and $F(k)$ is the fraction of thermal neutron fission occurring in the kth region;

$$F(k) = \frac{V(k) \bar{\phi}(k) \overline{v\Sigma_f(k)}}{\sum_{J=1}^N V(J) \bar{\phi}(J) \overline{v\Sigma_f(J)}}$$

with $V(k)$, $\bar{\phi}(k)$, and $\overline{v\Sigma_f(k)}$ denoting, respectively, the volume, average thermal flux, and average thermal $v\Sigma_f$ for the kth region. $P(k, J)$ is the probability that a neutron born uniformly in the kth region undergoes its first collision in the Jth region. The expression $P_n(J)$ becomes

$$P_n(J) = \sum_{k=1}^N P_{n-1}(k) \frac{\Sigma_{11}(k)}{\Sigma_t(k)} P(k, J) \quad (24)$$

with

$$\Sigma_{11}(k) = \sum_{i=1}^I N_i (\sigma_{i1} + v_i f_{i1} \sigma_{if}) \quad \text{(I denotes number of isotopes in kth region)}$$

and

$$\Sigma_t(k) = \sum_{i=1}^I N_i \sigma_{it}.$$

The nth-flight collision probability with ^{238}U is

$$P_n^u = \sum_{k=1}^N \frac{\Sigma_t^u(k)}{\Sigma_t(k)} P_n(k) \quad (25)$$

where

$$\Sigma_t^u(k) = N_u \sigma_{ut} \text{ for the } k\text{th region.}$$

The interaction effects between neighboring fuel elements are approximated by isotropically reflecting neutrons that escape to the equivalent cell boundary with energies exceeding 1.35 MeV. The probability of a neutron born in the Jth region escaping to the equivalent cell boundary is

$$1 - P_c(J) = 1 - \sum_{k=1}^N P(J,k).$$

Let G_{ok} be the probability that a neutron isotropically incident on the equivalent cell boundary undergoes its next collision in the kth region. (12)

Now the probability that a neutron uniformly generated in the Jth region and escaping to the equivalent cell boundary undergoes its first flight collision in the kth region is

$$P^*(J,K) = [1 - P_c(J)] \frac{G_{ok}}{1 - (1 - G_{oT})}$$

where

$$G_{oT} = \sum_{k=1}^N G_{ok}.$$

Upon including the interaction effects, Equations (23) and (24) became

$$P_1(J) = \sum_{k=1}^N F(k) [P(k,J) + P'(k,J)] \quad (26)$$

and

$$P_n(J) = \sum_{k=1}^N P_{n-1}(k) \frac{\Sigma_{11}(k)}{\Sigma_t(k)} [P(k,J) + P'(k,J)]. \quad (27)$$

In EGGNIT, the summation in Equation (22) is continued until the contribution to the summation becomes less than 0.01%. The equivalent cell boundary used to calculate the interaction effects is taken to be

$$R_{\text{eff}} = \frac{2(\text{volume of lattice cell})}{\text{Circumference of lattice cell}} .$$

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APPENDIX A

EGGNIT INPUT INSTRUCTIONS

Except for input data required for treating resonance shielding, the input data for EGGNIT is stored in absolute machine locations by the generalized Fortran routine LIST IV.⁽¹³⁾ For the data read in under LIST IV only that data which are nonzero initially or changes from case to case need to be inputted. This minimizes input volume while using only a few simple standard formats. These formats are interpreted as follows:

<u>Column 1</u>	<u>Maximum Number Data Words per Card</u>	<u>Type of Data</u>	<u>Columns Per Word</u>	<u>Words Start in Columns</u>
0	6	Floating Point	10	11, 21, 31...61
1	12	Integer	5	11, 16, 21...66
2	10	Hollerith	6	11, 17, 23...65
9	--	End of Case		

Columns 2, 3

These columns contain the number of words to be read from the data card. If blank, the whole card will be read.

Columns 4, 5

These columns contain a repetition control constant, k. A nonblank k causes this card to be treated as though it were k cards, all identical except the absolute locations will increase sequentially.

Columns 6-10

These columns contain the absolute location of the first data work on the card. Succeeding words will be assigned sequentially higher locations. A blank causes the continuation of sequencing from the last card.

Columns 11-70

The columns contain the input data in the format defined in Column 1.

INPUT DESCRIPTION

<u>Column 1</u> <u>Format Type</u>	<u>Columns 6-10</u> <u>Location</u>	<u>Input Data Description</u>
1	1	Case identification number.
1	2	Number of cylindrical regions.
1	3	Normally zero. Nuclei densities will be inputted in atoms/barn-cm. =2 A special routine to compute nuclei densities for plutonium nitrate solutions experiments at the Battelle-Northwest Critical Mass Laboratory. If LOC(3) = 2 then input data is required in LOC(846)-LOC(850) and may be omitted from LOC(63)-LOC(232) and LOC(676)-LOC(845).
1	4	=1 Average thermal cross sections over Wilkins heavy moderator spectrum. =2 Average thermal cross sections over Wigner- Wilkins light moderator spectrum. =3 Average thermal cross sections over a Maxwellian distribution.
1	5	Indicates the mode of hydrogen bonding in Tempest calculation. This must be an element in the 200 Tempest series.
1	6	=0 $\tau = \text{TAU}(68)$ =1 $\tau = D/\Sigma_{\text{Re}}$
1	8	=0 Use 1/E flux spectrum built into code for neutron slowing down.

<u>Column 1</u> <u>Format Type</u>	<u>Columns 6-10</u> <u>Location</u>	<u>Input Data Description</u>
1	8	=1 Compute slowing down flux by P_1 approximation. =2 Compute slowing down flux by B_1 approximation. =3 Read in fluxes and currents in LOC(884) and LOC(953).
1	9	Fission source; =0 Unit source in one group; LOC(10). =1 ^{233}U fission spectrum. =2 ^{235}U fission spectrum. =3 ^{239}Pu fission spectrum. =4 ^{241}Pu fission spectrum. =5 ^{252}Cf fission spectrum. =6 Po-Be (Whitemore-Baker) =7 Po-Be (Cochrane-Henry) =8 Ra-Be (Hill).
1	10	If LOC(9) = 0, then group number for unit source is inputted here.
1	11	Number (≤ 33) of epithermal broad groups for which cross section averages are requested.
1	12	=0 Do not calculate age. =1 Calculate the age.
1	13	=-N Do not calculate microscopic cross sections =+N Microscopic cross sections printed and punched in DTF format. N = number of groups downscattered. N = 0 No microscopic data. All group down-scattering.

<u>Column 1</u> <u>Format Type</u>	<u>Columns 6-10</u> <u>Location</u>	<u>Input Data Description</u>
1	15	<p>=0 One set of cross section data for the HFN diffusion code will be punched on cards.</p> <p>=N N+1 sets of cross section data for HFN will be punched on cards. $N \leq 5$.</p> <p>=N+6 N sets of cross sections will be punched for HFN and one set in the DTF format.</p> <p>=-1 No HFN cross section data will be punched. If LOC(13) > 0, DTF microscopic will be printed and punched.</p>
1	16	Ignore if LOC(15) is negative. Otherwise, this storage location for the first HFN cross section (13881 for region 1 and group 1).

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<u>Column 1</u> <u>Format Type</u>	<u>Column 6 - 10</u> <u>Location</u>	<u>Input Data Description</u>
1	28	<p>Ignore unless location 8 is equal to one.</p> <p>= 0 Leakage terms for P_1 calculation will be broad energy groups (location 1022). If the leakage terms are carried down from a previous case, this entry must be set to one.</p> <p>= 1 Leakage terms for P_1 calculation will be by fine groups (location 1022).</p>

Column 1 Format Type	Column 6-10 Location	Input Data Description
1	17	Ignore if LOC(15) is negative. Otherwise, this is the type of geometry for the perpendicular buckling*** for the punched HFN cards.
	=1	Slab
	=2	Cylinder
	=3	Constant $B_{\perp}^2$
1	18-27	Ignore if LOC(15) is equal to or less than zero. Otherwise, repeat the instructions for LOC(16) and LOC(17) for each set of HFN cross sections.

$$B_{\perp}^2 = \frac{C_1^2}{(A + 2\lambda)^2} + \frac{C_2^2}{(B + 2\lambda)}$$

where: $\lambda = C_3 \lambda_{tr}$

C_3 = constant input in LOC(609).

Constant $B_{\perp}^2$:

$$C_2 = 0$$

$B_{\perp}^2$ = constant input in LOC(607); for spherical geometry $B_{\perp}^2 = 0$.

Cylinder:

$$C_2 = 0$$

A = length of cylinder (cm) input in LOC(607).

Slab:

A = length of one dimension of slab (cm) input in LOC(607).

B = length of second dimension of slab (cm) input in LOC(608).

Column 1 Format Type	Column 6-10 Location	Input Data Description																																								
1	29	Number of isotopes in inner region. H ₂ O and D ₂ O are considered to be single isotopes.																																								
1	30-45	Number of isotopes in successive regions.																																								
1	46	Number of flux points to be printed out across the inner region from the P ₃ calculation. The calculation does not depend upon number of points chosen.																																								
1	47-62	Number of flux points for successive regions.																																								
1	63-72	Identification numbers of nuclides in region one:																																								
1	73-232	Identification numbers of nuclides in successive regions.*																																								
		<table><tr><th>Region</th><th>Location</th><th>Region</th><th>Location</th></tr><tr><td>1</td><td>63-72</td><td>9</td><td>143-152</td></tr><tr><td>2</td><td>73-82</td><td>10</td><td>153-162</td></tr><tr><td>3</td><td>83-92</td><td>11</td><td>163-172</td></tr><tr><td>4</td><td>93-102</td><td>12</td><td>173-182</td></tr><tr><td>5</td><td>103-112</td><td>13</td><td>183-192</td></tr><tr><td>6</td><td>113-122</td><td>14</td><td>193-202</td></tr><tr><td>7</td><td>123-132</td><td>15</td><td>203-212</td></tr><tr><td>8</td><td>133-142</td><td>16</td><td>213-222</td></tr><tr><td></td><td></td><td>17</td><td>223-232</td></tr></table>	Region	Location	Region	Location	1	63-72	9	143-152	2	73-82	10	153-162	3	83-92	11	163-172	4	93-102	12	173-182	5	103-112	13	183-192	6	113-122	14	193-202	7	123-132	15	203-212	8	133-142	16	213-222			17	223-232
Region	Location	Region	Location																																							
1	63-72	9	143-152																																							
2	73-82	10	153-162																																							
3	83-92	11	163-172																																							
4	93-102	12	173-182																																							
5	103-112	13	183-192																																							
6	113-122	14	193-202																																							
7	123-132	15	203-212																																							
8	133-142	16	213-222																																							
		17	223-232																																							
1	503-522	Identification numbers of the isotopes for which thermal microscopic cross sections are desired that are not present in the lattice cell																																								

* See Table II at the end of Appendix A for nuclide identification numbers,

<u>Column 1</u> <u>Format Type</u>	<u>Column 6-10</u> <u>Location</u>	<u>Input Data Description</u>	
1	525	=n	n neutron flights will be traced in the fast effect collision probability calculation. If zero, the flights will be traced until the contribution from the last flight is less than .01%.
1	527	=0	All isotopes other than ^{238}U or ^{232}Th will have the same weighing factors for the fast effect.
		=1	All fast fissile isotopes admixed with ^{238}U will have the same weight as ^{238}U .
		=2	All fast fissile isotopes admixed with ^{232}Th will have the same weight as ^{232}Th .
1	528	=0	Dancoff shielding correction is inputed in LOC(602).
		=1	Internally computed Dancoff correction for square lattice.
		=2	Internally computed Dancoff correction for hexagonal lattice.
1	529	=0	Tempest and P_3 calculations performed.
		=1	Tempest and P_3 calculations omitted.
0	601		Geometric buckling of the system.
0	602		Dancoff shielding factor.
0	603		Blank.
0	604		$S_{\text{eff}} = \frac{2 \times \text{volume}}{R_{\text{eff}}}$ where R_{eff} is the radius for the outer boundary used in computing the fast neutron interaction effect. R_{eff} is normally the radius of the equivalent unit cell.

<u>Column 1</u> <u>Format Type</u>	<u>Columns 6-10</u> <u>Location</u>	<u>Input Data Description</u>
0	605	Minimum energy for the thermal TEMPEST calculation.
0	606	Maximum energy for the thermal TEMPEST calculation.
0	607	Ignore if LOC(15) is negative. Otherwise, this quantity is used for the perpendicular buckling calculation for HFN.
0	608	Ignore if LOC(15) is negative. Otherwise, this quantity is used for the perpendicular buckling calculation for HFN.
0	609	Ignore if LOC(15) is negative. Otherwise, this is the extrapolation constant (normally 0.71).
0	610-624	Ignore if LOC(15) is equal to or less than zero. Otherwise, repeat the instructions for LOC(608) and LOC(609) n times.
0	625	Radius of inner regions in centimeters.
0	626-641	Radii of successive regions.
0	642	Physical temperature of inner region.
0	643-658	Physical temperatures of successive regions.
0	659	Neutron temperature of inner region
0	660-675	Neutron temperatures of successive regions.
0	676-685	Densities of the nuclides in atoms per barn centimeter for region one. These densities must be input in the same order as the identification numbers were. That is, the density in LOC(676) must be for the isotope whose identification number is stored in LOC(63).

<u>Column 1</u> <u>Format Type</u>	<u>Columns 6-10</u> <u>Location</u>	<u>Input Data Description</u>																																								
0	686-845	Densities of nuclides in successive regions <table><tr><td><u>Region</u></td><td><u>Location</u></td><td><u>Region</u></td><td><u>Location</u></td></tr><tr><td>1</td><td>676-685</td><td>9</td><td>756-765</td></tr><tr><td>2</td><td>686-695</td><td>10</td><td>766-775</td></tr><tr><td>3</td><td>696-705</td><td>11</td><td>776-785</td></tr><tr><td>4</td><td>706-715</td><td>12</td><td>786-795</td></tr><tr><td>5</td><td>716-725</td><td>13</td><td>796-805</td></tr><tr><td>6</td><td>726-735</td><td>14</td><td>806-815</td></tr><tr><td>7</td><td>736-745</td><td>15</td><td>816-825</td></tr><tr><td>8</td><td>746-755</td><td>16</td><td>826-835</td></tr><tr><td></td><td></td><td>17</td><td>836-845</td></tr></table>	<u>Region</u>	<u>Location</u>	<u>Region</u>	<u>Location</u>	1	676-685	9	756-765	2	686-695	10	766-775	3	696-705	11	776-785	4	706-715	12	786-795	5	716-725	13	796-805	6	726-735	14	806-815	7	736-745	15	816-825	8	746-755	16	826-835			17	836-845
<u>Region</u>	<u>Location</u>	<u>Region</u>	<u>Location</u>																																							
1	676-685	9	756-765																																							
2	686-695	10	766-775																																							
3	696-705	11	776-785																																							
4	706-715	12	786-795																																							
5	716-725	13	796-805																																							
6	726-735	14	806-815																																							
7	736-745	15	816-825																																							
8	746-755	16	826-835																																							
		17	836-845																																							
0	846	If LOC(3) = 2, density of plutonium in g/liter. If LOC(528) > 0, radius (cm) of shielded surface for Dancoff correction.																																								
0	847	If LOC(3) = 2, density of NO ₃ in g/liter, If LOC(528) > 0, lattice pitch (cm) for Dancoff correction.																																								
0	848	If LOC(3) = 2, density of H ₂ O in g/liter. If LOC(528) > 0, Σ _m (cm ⁻¹) for Dancoff correction.																																								
0	849	If LOC(3) = 2, density of ionized hydrogen in g/liter. If LOC(528) > 0, gap thickness (cm) for Dancoff correction.																																								
0	850	If LOC(3) = 2, percent ²⁴⁰ Pu in plutonium.																																								
0	852	Lower Energy boundary of highest energy group for broad group cross section averaging.																																								

<u>Column 1</u> <u>Format Type</u>	<u>Columns 6-10</u> <u>Location</u>	<u>Input Data Description</u>
0	853-883	Successive energy boundaries of the N groups where N is defined in LOC(11)
0	884-952	If LOC(8) = 3, enter the fluxes for each of the 68 fine energy groups (from high to low).
0	953-1021	If LOC(8) = 3, enter the currents for each fine energy groups.
0	1022-1090	If LOC(8) = 1, enter N leakage term where N depends upon the quantity entered in LOC(28).
2	1091-1106	Descriptive information
9		End of LIST IV data.

RESONANCE DATA

One set of the following data is required for nuclides which have resonance parameters available on the library tape. The input data must be in the same sequential order as the nuclides appear on the library tape.

<u>Card Type</u>	<u>Format</u>	<u>Input Data Description</u>
1	I5	Number of regions involved in Nordheim's integration scheme.
	I5	Number of iterations in integration scheme.
	I5	Number of resonance parameter data inputed (if 0 library data used only).
	I5	Number of interfering resonance lines utilized.
	I5	Number of particle sizes utilized in GRAINS GEOMETRY distribution.
	5X	Blank
	E10.5	Potential scattering cross section for resonance absorber (barns).
	E10.5	σ_m (eff) used in "wing correction." If σ_m (eff) = 0.0, a value will be calculated internally.
2 (One card for each region of integration)		
	I5	Region number (if GRAINS GEOMETRY Region 1 is the particle distribution and Region 2 the fuel cylinder). Maximum of 5 regions permitted.
	5X	Blank
	E10.4	Atomic density of absorber (atoms/barn-cm)
	E10.4	Radius of region (cm). Left blank if region 1 in the GRAINS GEOMETRY.

<u>Card Type</u>	<u>Format</u>	<u>Input Data Description</u>
	E10.4	Mass number of 1st moderator in region (a.m.u.) [†]
	E10.4	Σ_s (cm ⁻¹) of 1st moderator.
	E10.4	Mass number of 2nd moderator in region (a.m.u.) [†]
	E10.4	Σ_s (cm ⁻¹) of 2nd moderator.

If GRAINS GEOMETRY the below data follows the above region 1 card. There will be one card for each particle size.

2(d)	I5	Sequential particle size number (1,2,3,...)
	5X	Blank
	E10.4	Radius of spherical particle (cm.)
	E10.4	Volume fraction of fuel cylinder occupied by the particle.

RESONANCE PARAMETER CARDS

The number of resonance parameter card (NCARD) is indicated on Card 1. If $|INCARD| < 100$ resolved resonance data on library will be completely replaced with input data. If $|INCARD| > 100$ selected data will be replaced and if NCARD = -100 only unresolved data will be inputted.

3(If $|INCARD| < 100$)

E10.4	E_o (eV)
E10.4	Γ_n (eV)
E10.4	Γ_γ (eV)
E10.4	Γ_f (eV)
E10.4	g statistical factor
I5	Calculation Method (=1 denotes Nordheim, = 2 denotes NR approximation).

[†]Mass number must be greater than unity. For example: 1.008 for hydrogen.

<u>Card Type</u>	<u>Format</u>	<u>Input Data Description</u>
3 (If INCARD > 100		One set of cards for each resolved resonance data replaced.)
3(a)	I5	Sequential number of resolved data on library being replaced. First resolved data listed is #1, second #2, etc.
3(b)	E10.5	E_o (eV)
	E10.5	Γ_n (eV)
	E10.5	Γ_γ (eV)
	E10.5	Γ_f (eV)
	E10.5	g statistical factor
	I5	Calculational method (=1 Nordheim, = 2 the NR approximation.
4 (If NCARD < 0 the following input data is required for unresolved data)		
	E10.4	E_c (eV) the upper energy cutoff for resolved data.
	E10.4	$\bar{D}$ (eV) level spacing.
	E10.4	$\overline{\Gamma_n^o}$ (eV)
	E10.4	$\overline{\Gamma_\gamma}$ (eV)
	E10.4	$\overline{\Gamma_f}$ (eV)
	E10.4	E_t (eV) the upper energy limit for unresolved calculation.
	E10.4	g statistical factor
5 (Data for interfering resonance. One set of cards for each interfering resonance)		
5(a)	I5	Sequential number identifying the resonance line which the interfering resonance will perturb.

<u>Card Type</u>	<u>Format</u>	<u>Data Input Description</u>
	5X	Blank
	E10.4	Potential scattering cross section of interfering absorber (cm^2).
	5E 10.5	Atom density of interfering absorber in each sequential region (atoms/barn-cm). Maximum of 5 regions.

The following data pertains to the interfering absorber.

5b	E10.4	Mass number (a.m.u.)
	E10.4	E_o (eV)
	E10.4	Γ_n (eV)
	E10.4	Γ_γ (eV)
	E10.4	Γ_f (eV)
	E10.4	g statistical factor

EXECUTION INSTRUCTIONS

Tape Unit A - GAMTEC II Library

Tape Unit (Optional) - Program tape with absolute program on File 1.

The geometry routine is selected through the execution instruction

XQT	EGGNIT	Solid Cylinder*
XQT	TUBES	Multiannular rings
XQT	GRAINS	GRAINS GEOMETRY in fuel cylinder
XQT	HOMOGR	GRAINS GEOMETRY in homogeneous medium

*For homogeneous mixture use EGGNIT Geometry Routine with the rod radius set to zero.

TABLE IIID NUMBERS*ON THE MASTER GAMTEC II CROSS SECTION TAPE

<u>Nuclide</u>	<u>Number</u>	<u>Nuclide</u>	<u>Number</u>
Aluminum	25	Manganese	28
Beryllium	3	Nickel	31
Boron	4	Nitrogen	22
Cadmium	18	Oxygen	23
Carbon	5	^{239}Pu	14
Chromium	27	^{240}Pu	15
Cobalt	30	^{241}Pu	16
Copper	32	^{242}Pu	17
Deuterium	2	Silicon	26
^{151}Eu	33	^{232}Th	6
Gold	19	^{233}U	8
Hydrogen	1	^{234}U	9
Indium	13	^{235}U	10
Iron	29	^{236}U	11
Lead	20	^{238}U	12
^{175}Lu	34	Water	21
^{176}Lu	35	Zirconium	7

*Maximum of 50 nuclides permitted on library tape.

APPENDIX B

LIBRARY TAPE

The cross section library consists of three general files. The first file contains the thermal cross sections for the P_3 calculation and the fast group cross sections for the n-flight collision probability calculation. The second file contains the cross sections for the TEMPEST (thermal) calculation.

The library tape is updated with the GAMTEC II UPDATE program. The new tape is placed on Tape Unit B and the GAMTEC II library tape used to update the new tape is placed on Tape Unit A. An additional GAMTEC II tape may be used to furnish cross sections for certain isotopes. This tape (if used) is placed on Tape Unit D.

A GAMTEC II library tape may be produced with Battelle Master Library data having access through the BARNS generated HRG library tape.^(14,15,16) Access to the ENDF/B data is obtained by updating with an ETOG produced GAM-I library.⁽¹⁷⁾

The UPDATE program is on file 2 of the EGGNIT program tape and is executed by the control card

▽ XQT,U UPDATE

followed by the input data:

<u>Card Number</u>	<u>Format</u>	<u>Columns</u>	<u>Description</u>
1	815	1-5	P_3 and Collision Probability cross section option.
		=0	Duplicate old tape.
		=N	Cross section changes will be made for N isotopes.

<u>Card Number</u>	<u>Format</u>	<u>Columns</u>	<u>Description</u>
		=-N	N isotopes will be added to the library.
		6-10	Thermal TEMPEST cross section option.
		=0	Duplicate old tape.
		=N	Cross section changes will be made for N isotopes.
		=-N	N isotopes will be added to the library.
		11-15	GAM cross section option
		=0	Duplicate old tape.
		=N	Cross section changes will be made for N isotopes.
		=-N	N isotopes will be added to the library.
		16-20	Number of isotopes on old tape (Tape Unit A.
		21-25	=0 No changes will be made in the fission source spectrum tables.
		=N	The N th source spectrum will be changed.
		=-N	N additional source spectrums will be added to the library.
		26-30	Resonance capture table option. Normally zero.
		=0	No change in the table.
		=1	Changes will be made in the table.
		31-35	Zeta Table option. Normally zero.
		=0	No change in the table.
		=1	Changes will be made.

<u>Card</u> <u>Number</u>	<u>Format</u>	<u>Columns</u>	<u>Description</u>
		36-40	Resonance geometry table option. Normally zero.
		=0	No change will be made in the tables.
		=1	Changes will be made in the table for a slab.
		=2	Changes will be made in the table for a cylinder.
		=3	Changes will be made in the table for a sphere.
		46-50	
		=-1	HRG Tape mounted on Unit D*
		=0	GAMTEC-II tape mounted on Unit D
		=+1	GAM-I Tape mounted on Unit D
2	12A6	1-72	Title card for the P_3 and collision probability cross sections.
3	12A6	1-72	Title card for the TEMPEST cross sections.
4	12A6	1-72	Title card for the GAM cross sections.

If the old tape is being duplicated with no changes or additions (card number one contains all zeros except columns 16-20), then this is all the input required.

Omit cards 5, 6, and 7 if columns 1-5 of card number one are zero or negative.

* Scratch tape on Unit D required if Unit not utilized.

<u>Card Number</u>	<u>Format</u>	<u>Columns</u>	<u>Description</u>
5	14I5	1-70	The identification numbers [*] of the isotopes for which cross section changes are being made in the P_3 are input on this card. These ID numbers must go from low to high.
6	I10, 6E10.3	1-10	Isotope identification number.
		11-20	Atomic weight.
		21-30	Ligarithmic energy decrement.
		31-40	Average (>1.35 MeV) fast transport cross section.
		41-50	Absorption cross section (2200 meter).
		51-60	Thermal scattering cross section (2200 meter).
		61-70	Average (> 1.35 MeV) fast ($\sigma_r - v_{1f}\sigma_{f1}$) ^{**} cross section.
7	6E12.8	1-12	Resonance scattering cross section.
		13-24	v times fission cross section (2200 meters).
		25-72	and the following 21 cards: 42 absorption G factors ⁽²²⁾ 42 fission G factors ⁽²²⁾ 42 corresponding temperatures in °K, low to high.
Repeat cards 6 and 7 for each isotope for which corrections are being made. Omit cards 8 and 9 if columns 1-5 of card number one are zero or positive.			
8	I10 6E10.3	1-70	This card is required for each isotope that is being added to the library. The same data are required as for card number 6.

*All descriptive footnotes for Appendix B begin on Page. 55.

<u>Card Number</u>	<u>Format</u>	<u>Columns</u>	<u>Description</u>
9	6E12.8	1-72	Same data as card number 7.
Repeat cards 8 and 9 for each isotope that is being added to the library.			
If columns 6-10 of card number one are zero or negative, omit cards 10, 11, 12, and 13.			
10	14I5	1-72	The identification numbers ^{***} of the isotopes for which cross section changes are being made in the TEMPEST section are input on this card. These ID numbers must go from low to high.
11	(A6, 3X, I3, 57X I3)	1-6	Element name.
		10-12	Element identification. ^{****}
		70-72	Number of tabulated cross section entries.
12	(5E10.4/5E 10.4)	1-50	Cross section power series. ^{****} { R_j }, resonance parameters { n, r, K, E_o }, and v .
13	7E10.4	1-72	N tabulated cross section where N is the quantity in columns 70-72 of card number 11 ^{*****} . If N is zero, omit this card.

Repeat cards 11, 12, and 13 for the isotopes for which corrections are being made to the TEMPEST section of the library.

Omit cards 14, 15, 16 and 17 if columns 6-10 of card number one are zero or positive.

<u>Card Number</u>	<u>Format</u>	<u>Columns</u>	<u>Description</u>
14	(A6,3X, I3, 57X, I3)	1-72	Same as card number 11 for the isotopes being added to the TEMPEST section of the library.
15	(5E10.4/5E 10.4)		Same as card number 12 for the isotopes being added to the TEMPEST section of the library.
16	7E10.4		Same as card number 13 for the isotopes being added to the TEMPEST section of the library.
Repeat cards 14, 15 and 16 for the isotopes that are being added to the library.			
17	A6	1-6	The word X-LAST.
Omit cards 18 and 19 unless columns 21-25 of card number one are not zero.			
18	12A6	1-72	Description of the source being added or changed.
19	6E12.5	1-72	Source probability spectrum for the 68 groups.

Repeat cards 18 and 19 for each source that is being added to the library.

Omit cards 20, 21, and 22 unless columns 26-30 of card number one are not zero. These cards are used to make corrections to that resonance capture table, FJ(I,J).

<u>Card Number</u>	<u>Format</u>	<u>Columns</u>	<u>Description</u>
20	4I5	1-5	IS-smallest value of I for corrections.
		6-10	IL-largest value of I for corrections.
		11-15	JS-smallest value of J for corrections.
		16-20	JL-largest value of J for corrections.
21	6E12.5	1-72	Resonance capture table corrections. ((FJ(I,), I = IS, IL), J = JS, JL)
Repeat cards 20 and 21 for each set of corrections.			
22			Blank card to indicate there are no more corrections.
Omit cards 23, 24, and 25 unless columns 31-35 of card number one are not zero. These cards are used to make corrections to the Zeta table, CJ(I,J).			
23	4I5	1-5	IS-smallest value of I for corrections.
		6-10	IL-largest value of I for corrections.
		11-15	JS-smallest value of J for corrections.
		16-20	JL-largest value of J for corrections.
24	6E12.5	1-72	Zeta table corrections. ((CJ(I,J), I = IS, IL), J = JS, JL)
Repeat cards 24 and 25 for each set of corrections.			
25			Blank card to indicate there are no more corrections.
Omit cards 26, 27, and 28 unless columns 36-40 of card number one are not zero. These cards are used to make corrections to the resonance geometry table, F(I,J,K).			

<u>Card Number</u>	<u>Format</u>	<u>Columns</u>	<u>Description</u>
26	6I5	1-5	IS-smallest value of I for corrections.
		6-10	IL-largest value of I for corrections.
		11-15	JS-smallest value of J for corrections.
		16-20	JL-largest value of J for corrections.
		21-25	KS-smallest value of K for corrections.
		26-30	KL-largest value of K for corrections.
27	6E12.5	1-72	Resonance geometry table corrections ((F(I,J,K), I = IS, IT), J = JS, JT), K = KS, KT).

Repeat cards 26 and 27 for each set of corrections.

28 Blank card to indicate there are no more
corrections.

Omit cards 29-41 unless columns 11-15 of card number one are not zero.

29 14I5 1-72 These entries identify the isotopes being
corrected or added to the library in the
following manner.

=ID(J) The identification number of the Jth isotope
for which corrections are being made or that
is being added to the library. The new
cross sections will be read from a GAMTEC II
tape on unit D. These identification
numbers must be in sequence.

<u>Card Number</u>	<u>Format</u>	<u>Columns</u>	<u>Description</u>
			-ID(J) The negative of the identification number of the Jth isotope for which corrections are being made or that is being added to the library. The new cross sections will be input by cards.
30	14I5	1-72	The identification number of the isotopes ID(J) on tape unit D. This is set to zero if the entry on card number 29 is negative.
Omit cards 31-41 unless the new cross section corrections or additions are being read in by cards.			
31	4A6	1-24	Description of the nuclide.
32	14I5	1-5	Identification number
		6-10	$LTOT = I_a + I_f + I_v + I_{n,n}$ $+ I_{n,2n} + I_{P(0)} + I_{P(1)}$ <p>where: $I_a = 68$ if tabulated absorption, $= 0$ otherwise.</p> <p>$I_f = 68$ if tabulated fission, $= 0$ otherwise.</p> <p>$I_v = 68$ if tabulated fission, $= 0$ otherwise.</p> <p>$I_{n,n} =$ length of (n,n) matrix. $I_{n,2n} =$ length of (n,2n) matrix. $I_{P(0)} =$ length of P(0) matrix. $I_{P(1)} =$ length of P(1) matrix.</p>

<u>Card Number</u>	<u>Format</u>	<u>Columns</u>	<u>Description</u>
		11-15 =0	No absorption tabulation.
		=1	Absorption tabulation.
		16-20 =0	No fission tabulation.
		=1	Fission tabulation.
		21-25 =0	No resonance parameters.
		=1	Resonance parameters.
		26-30	$I_{n,n}$
		31-35	The number of groups in which inelastic processes occur.
		36-40	The number of groups to which downscatter may occur (not counting ingroup scatter).
		41-55	The data regarding the $n, 2n$ array -- similar to columns 26-40 for the n,n array.
		56-70	The data regarding the $P(0)$ array -- similar to columns 26-40 for the n,n array.
33		1-15	The data regarding the $P(1)$ array similar to columns 26-40 of card number 32 for the n,n array. If there is no $P(1)$ array, this is a blank card.
34	3I5	1-5	IST = starting number of the corrections or additions. See card number 35.
		6-10	IEND = last number of the corrections or additions.

<u>Card Number</u>	<u>Format</u>	<u>Columns</u>	<u>Description</u>
35	E11.4, 5E12.4	1-71	ADUM(I), I=IST, IEND where: ADUM (1 to I_a) = absorption cross sections if they are used. High energy to low. ADUM [$(I_a + 1)$ to $I_a + I_f$] = fission cross sections if they are used. ADUM [$(I_a + I_f + 1)$ to $(I_a + I_f + I_v)$] = v values if they are used. ADUM [$(I_a + I_f + I_v + 1)$ to $(I_a + I_f + I_v$ $+ I_{n,n})$] = inelastic scattering array in the following sequence (1 to 1), (1 to 2), (1 to 3), ..., (1 to J), (2 to 2) (2 to 3), ..., (2 to J), etc. ADUM [$(I_a + I_f + I_v + I_{n,n} + 1)$ to LTOT] = the (n,2n), P(0), and P(1) arrays stored in the same sequence manner as the elastic scattering array.

Cards 34 and 35 are repeated for each set of data. If corrections are being made only the ADUM(I) that are being changed need to be input.

36	I15	10-15	=0	No resonance parameters are being changed.
			=1	Resonance parameters are being input on cards 37, 38, 39, 40 and 41.

Omit cards 37, 38, 39, 40, and 41 if card number 36 contains only zeros.

<u>Card Number</u>	<u>Format</u>	<u>Columns</u>	<u>Description</u>
37	I10, 6E10.5	1-10	Number of resolved resonances
		11-20	Atomic mass
		21-30	Upper energy boundary (eV) for resolved resonances.
		31-40	Upper energy boundary (eV) for unresolved resonances.
		41-50	Unresolved level spacing D in eV.
		51-60	Average unresolved $\left\langle \Gamma_n^o \right\rangle$.
			$\left\langle \Gamma_n^o \right\rangle = \left\langle \Gamma_n \right\rangle / \sqrt{E}.$
		61-70	Average unresolved Γ_γ
38	2E10.5	1-10	Average unresolved Γ_f .
		11-20	Unresolved statistical weight factor.
39	2I5	1-5	IA = first resonance number being corrected. This will be unity when the isotope is being added to the library. Number the resonances from low energies to high.
		6-10	IB = last resonance being corrected in this set. This will be the number of resolved resonances when the isotope is being added to the library.

<u>Card Number</u>	<u>Format</u>	<u>Columns</u>	<u>Description</u>
40	(5E10.4, I5)	1-10	Resonance Energy E_o .
		11-20	Γ_n
		21-30	Γ_γ
		31-40	Γ_f
		41-50	G
		51-55 =1	Use IM approximation.
		=2	Use NR approximation.

Repeat card number 40 $IB - IA + 1$ times where IB and IA are input on card number 39. Then repeat cards 39 and 40 for each set of resonances for the isotope. Only the resonances that are being changed need to be input.

41 Blank card to indicate there are no more resonance parameter corrections.

Repeat cards 31-41 for each nuclide for which the new cross section corrections read in by cards.

* The identification numbers on the cross section tape start with one and increase consecutively to the total number of isotopes. The following isotopes must have the corresponding identification numbers.

1H	1	^{238}U	12
D_2O	2	^{240}Pu	15
^{232}Th	6	H_2O	21
		^{16}O	23

** σ_{r1} = removal cross section

σ_{f1} = fission cross section

f1 = fraction of fissions above 1.35 MeV.

*** Tempest actually has four ID numbers per isotope.

ID numbers 1-100 are absorption ID's

ID numbers 101-200 are fission ID's

ID numbers 201-300 are $(1-\mu)\sigma_s$ ID's

ID numbers 301-400 are $\xi\sigma_s$ ID's.

Example:

The ID numbers for ^{238}U would be:

12 Thermal absorption cross sections.

112 Thermal fission cross sections

212 Thermal $(1-\mu)\sigma_s$ cross sections.

313 Thermal $\xi\sigma_s$ cross sections.

See Reference 8 for additional details.

**** If the cross sections are not tabulated, they are determined from the power series:

$$\sqrt{E}\sigma(E) = \sum_{j=0}^4 R_j (\sqrt{E})^j$$

The entries n , γ , K , and E are required (they may be zero) for the resonance term.

$$\frac{K\gamma}{(\gamma+n\sqrt{E})^2 + 4(E-E_0)}$$

ν is used in the following manner:

ID Number	Value
1-99	Not used
101-199	ν thermal
201-299	$(1 - \mu)$
301-399	ξ

***** The $\sqrt{E}\sigma(E)$ is tabulated at the following mesh intervals in eV:

0.0, 0.001, 0.002, 0.003, ..., 0.050, 0.060, 0.070, ...,

$E_{\max}$

The total tabulated TEMPEST library must be less than 5000 words in length.

APPENDIX C

SAMPLE PROBLEM

* * * * *

* PRINTOUT OF *
* CARD INPUT DATA *

* * * * *

1	1	1	2	0	1	221	1	0	2	2	0	3	1
1 5	13	0	2	713881	3								
1 3	28	0	8	2									
1 2	46	5	5										
1 8	63	5	6	9	10	11	12	22	23				
1 2	73	5	22										
1 4	525	0	0	2	0								
0 1	602	.413											
0 5	603	.158		6.753		0.0		.683		0.0			
0 2	625	.59690		1.07478									
0 2	642	293.0		293.0									
0 2	659	293.0		293.0									
0	676	4.69934-2	1.18607-3	2.41100-7	3.93396-5	1.26500-7	2.59150-6						
0 2	682	2.65486-5	2.37214-3										
0 2	686	8.11648-2	1.40930-5										
0 3	846	.59690	1.905	.38959									
0 3	852	1.35 +6	3.0 +3	.683									
2	1091 HTGR LATTICE CELL CALCULATION - HTLTR MOCKUP T =20 C												
9	END OF CASE												

		INPUT DATA					
CASE	NO. REGIONS	BUCKLING	SHIELDING FACTOR	SQUIGGLY	SURFACE AREA OF U.L.C.		
1	2	.10000-19	.41300	.15800-00	.67530+01		
REGION NUMBER 1							
NO. NUCLIDES	RADIUS OF REGION	PHYSICAL TEMP.	NEUTRON TEMP.	FLUX POINTS			
8	.59690	293.00000	293.00000	5			
NUCLIDE ID NO.	NUCLEI DENSITY						
5	.46993-01						
NUCLIDE ID NO.	NUCLEI DENSITY						
6	.11861-02						
NUCLIDE ID NO.	NUCLEI DENSITY						
9	.24110-06						
NUCLIDE ID NO.	NUCLEI DENSITY						
10	.39340-04						
NUCLIDE ID NO.	NUCLEI DENSITY						
11	.12650-06						
NUCLIDE ID NO.	NUCLEI DENSITY						
12	.25915-05						
NUCLIDE ID NO.	NUCLEI DENSITY						
22	.26549-04						
NUCLIDE ID NO.	NUCLEI DENSITY						
23	.23721-02						

REGION NUMBER	2				
NO. NUCLIDES	2	RADIUS OF REGION	1.07478	PHYSICAL TEMP.	293.00000
				NEUTRON TEMP.	293.00000
					FLUX POINTS
					5
NUCLIDE ID NO.	5	NUCLEI DENSITY	.81165-01		
NUCLIDE ID NO.	22	NUCLEI DENSITY	.14093-04		

P3 OUTPUT FOR CASE 1 HTGR LATTICE CELL CALCULATION - HTLTR MOCKUP T =20 C 0000000000000

REG	RADIUS	AVERAGE FLUX	THERMAL UTIL.	SIGMA-A	SIGMA-S	MASS NUMBER	SOURCE TERM
1	.5969	5.6584	.97886383	.30267-01	.25116-00	17.541	1.219
2	1.0748	5.7987	.02113617	.28442-03	.38973-00	12.011	216.488

TOTAL NEUTRON PRODUCTION .1958 SHOULD EQUAL TOTAL NEUTRON CAPTURE .1958

FLUX TRAVERSE IN REGION 1 CASE 1

RADIUS	FLUX
.1194	5.621
.2388	5.630
.3581	5.647
.4775	5.670
.5969	5.700

FLUX TRAVERSE IN REGION 2 CASE 1

RADIUS	FLUX
.6925	5.733
.7881	5.768
.8836	5.806
.9792	5.847
1.0748	5.891

REGION 1 VOLUME = .11193+01 AND VOLUME FRACTION = .30844-00

REGION 2 VOLUME = .25097+01 AND VOLUME FRACTION = .69156-00

TOTAL VOLUME = .36290+01

HTR LATTICE CELL CALCULATION - HTLTR MOCKUP T =20 C 000000000000
HEAVY MODERATOR

OUTPUT FROM TEMPEST

CASE 1

TEMPERATURE	E MIN	E MAX	H1 SCATTERER	BUCKLING
.2930+03	.0000	.6830-00	NONE	.1000-19

ISOTOPE	NUMBER	DENSITY
C A	5	.7080-01
TH232A	6	.3597-03
U234 A	9	.7311-07
U235 A	10	.1193-04
U236 A	11	.3836-07
U238 A	12	.7858-06
N A	22	.1787-04
O16 A	23	.7193-03

MODERATOR	NUMBER	DENSITY
CARBON	305	.7080-01
N	322	.1787-04
OXYGEN	323	.7193-03

ELEMENT NUMBER 306 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
ELEMENT NUMBER 309 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
ELEMENT NUMBER 310 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
ELEMENT NUMBER 311 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
ELEMENT NUMBER 312 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
ELEMENT NUMBER 105 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
ELEMENT NUMBER 106 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
ELEMENT NUMBER 111 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
ELEMENT NUMBER 112 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
ELEMENT NUMBER 122 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
ELEMENT NUMBER 123 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.

AVERAGE TRANSPORT
CROSS SECTION
.3359-00
TOTAL FLUX
.2208+01

DIFFUSION CONSTANT
D AVERAGED
.9924-00
XI SIGMA S
.5398-01

MACRO ABSORPTION
CROSS SECTION
.7238-02
NU SIGMA F
.1077-01

	ELEMENT	ID NUMBER	MICRO CROSS SECTION
	C A	5	.2505-02
ELEMENT NUMBER 105	IS NOT IN THE LIBRARY.		ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
	C X	205	.4534+01
	CARBON	305	.7574-00
	TH232A	6	.5080+01
ELEMENT NUMBER 106	IS NOT IN THE LIBRARY.		ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
	TH232X	206	.1256+02
ELEMENT NUMBER 306	IS NOT IN THE LIBRARY.		ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
	U234 A	9	.7051+02
	U234 F	109	.4366-00
	U234 X	209	.9971+01
ELEMENT NUMBER 309	IS NOT IN THE LIBRARY.		ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
	U235 A	10	.4363+03
	U235 F	110	.3717+03
	U235 X	210	.9972+01
ELEMENT NUMBER 310	IS NOT IN THE LIBRARY.		ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
	U236 A	11	.4141+01
ELEMENT NUMBER 111	IS NOT IN THE LIBRARY.		ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
	U236 X	211	.9972+01
ELEMENT NUMBER 311	IS NOT IN THE LIBRARY.		ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
	U238 A	12	.1854+01
ELEMENT NUMBER 112	IS NOT IN THE LIBRARY.		ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
	U238 X	212	.8067+01
ELEMENT NUMBER 312	IS NOT IN THE LIBRARY.		ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
	N A	22	.1262+01
ELEMENT NUMBER 122	IS NOT IN THE LIBRARY.		ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
	N X	222	.9524+01
	N	322	.1360+01
	O16 A	23	.1351-03
ELEMENT NUMBER 123	IS NOT IN THE LIBRARY.		ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
	O16 X	223	.4025+01
	OXYGEN	323	.4560-00

AVERAGE NEUTRON VELOCITY = .33151+04

ENERGY	N(E)	PHI(E)	E PHI(E)
--.0000	.000000	.000000	.000000
.0001	.281458+01	.156977-00	.156977-04
.0002	.397243+01	.313324-00	.626649-04
.0003	.485326+01	.468831-00	.140649-03
.0004	.558897+01	.623426-00	.249371-03
.0005	.623092+01	.777070-00	.388535-03
.0006	.680552+01	.929737-00	.557842-03
.0007	.732857+01	.108141+01	.756988-03
.0008	.781037+01	.123208+01	.985666-03
.0009	.825814+01	.138174+01	.124357-02
.0010	.867738+01	.153042+01	.153042-02
.0011	.907426+01	.167854+01	.184639-02
.0012	.945171+01	.182610+01	.219132-02
.0013	.981185+01	.197308+01	.256501-02
.0014	.101564+02	.211948+01	.296727-02
.0015	.104869+02	.226526+01	.339769-02
.0016	.108046+02	.241041+01	.385666-02
.0017	.111105+02	.255494+01	.434339-02
.0018	.114055+02	.269881+01	.485786-02
.0019	.116904+02	.284204+01	.539987-02
.0020	.119660+02	.298460+01	.596920-02
.0021	.122328+02	.312649+01	.656563-02
.0022	.124914+02	.326771+01	.718897-02
.0023	.127422+02	.340825+01	.783898-02
.0024	.129858+02	.354811+01	.851547-02
.0025	.132225+02	.368728+01	.921819-02
.0026	.134526+02	.382575+01	.994695-02
.0027	.136766+02	.396352+01	.107015-01
.0028	.138946+02	.410060+01	.114817-01
.0029	.141069+02	.423697+01	.122872-01
.0030	.143139+02	.437263+01	.131179-01
.0031	.145157+02	.450758+01	.139735-01
.0032	.147126+02	.464181+01	.148538-01
.0033	.149047+02	.477533+01	.157586-01
.0034	.150923+02	.490814+01	.166877-01
.0035	.152754+02	.504021+01	.176407-01
.0036	.154542+02	.517157+01	.186176-01
.0037	.156290+02	.530219+01	.196181-01
.0038	.157998+02	.543208+01	.206419-01
.0039	.159667+02	.556124+01	.216888-01
.0040	.161300+02	.568966+01	.227566-01
.0041	.162896+02	.581734+01	.238511-01
.0042	.164457+02	.594428+01	.249660-01
.0043	.165984+02	.607047+01	.261030-01
.0044	.167477+02	.619592+01	.272620-01
.0045	.168939+02	.632062+01	.284428-01
.0046	.170369+02	.644456+01	.296450-01

•0047	•171769+02	•656775+01	•308684-01
•0048	•173139+02	•669019+01	•321129-01
•0049	•174430+02	•681187+01	•333781-01
•0050	•175792+02	•693278+01	•346639-01
•0060	•187435+02	•810008+01	•486005-01
•0070	•197013+02	•919321+01	•643525-01
•0080	•204758+02	•102143+02	•817144-01
•0090	•211026+02	•111655+02	•100490+00
•0100	•216040+02	•120492+02	•120492+00
•0110	•219977+02	•128676+02	•141543-00
•0120	•222986+02	•136236+02	•163483-00
•0130	•225189+02	•143199+02	•186159-00
•0140	•226689+02	•149595+02	•209433-00
•0150	•227571+02	•155448+02	•233173-00
•0160	•227911+02	•160786+02	•257257-00
•0170	•227770+02	•165632+02	•281575-00
•0180	•227205+02	•170011+02	•306020-00
•0190	•226264+02	•173946+02	•330498-00
•0200	•224989+02	•177459+02	•354919-00
•0210	•223418+02	•180572+02	•379202-00
•0220	•221587+02	•183307+02	•403275-00
•0230	•219527+02	•185684+02	•427073-00
•0240	•217265+02	•187724+02	•450537-00
•0250	•214827+02	•189445+02	•473612-00
•0260	•212236+02	•190866+02	•496252-00
•0270	•209511+02	•192005+02	•518413-00
•0280	•206672+02	•192878+02	•540059-00
•0290	•203735+02	•193503+02	•561157-00
•0300	•200714+02	•193893+02	•581679-00
•0310	•197625+02	•194064+02	•601599-00
•0320	•194479+02	•194030+02	•620898-00
•0330	•191287+02	•193805+02	•639558-00
•0340	•188060+02	•193402+02	•657565-00
•0350	•184808+02	•192831+02	•674910-00
•0360	•181538+02	•192106+02	•691583-00
•0370	•178258+02	•191238+02	•707579-00
•0380	•174975+02	•190235+02	•722894-00
•0390	•171695+02	•189110+02	•737527-00
•0400	•168424+02	•187870+02	•751479-00
•0410	•165166+02	•186525+02	•764752-00
•0420	•161927+02	•185063+02	•777349-00
•0430	•158710+02	•183553+02	•789278-00
•0440	•155519+02	•181942+02	•800544-00
•0450	•152357+02	•180257+02	•811157-00
•0460	•149228+02	•178505+02	•821124-00
•0470	•146133+02	•176693+02	•830458-00
•0480	•143075+02	•174827+02	•839168-00
•0490	•140056+02	•172912+02	•847267-00
•0500	•137079+02	•170953+02	•854766-00

.0600	.109782+02	.149978+02	.899869-00
.0700	.872395+01	.128732+02	.901121-00
.0800	.691733+01	.109120+02	.872964-00
.0900	.549507+01	.919428+01	.827485-00
.1000	.438730+01	.773785+01	.773785-00
.1100	.352941+01	.652862+01	.718149-00
.1200	.286651+01	.553818+01	.664581-00
.1300	.235396+01	.473363+01	.615372-00
.1400	.195650+01	.408288+01	.571604-00
.1500	.164676+01	.355712+01	.533567-00
.1600	.140376+01	.313168+01	.501068-00
.1700	.121158+01	.278613+01	.473642-00
.1800	.105817+01	.250389+01	.450699-00
.1900	.934431-00	.227168+01	.431619-00
.2000	.833534-00	.207903+01	.415806-00
.2100	.750339-00	.191774+01	.402726-00
.2200	.680963-00	.178139+01	.391905-00
.2300	.622465-00	.166495+01	.382939-00
.2400	.572612-00	.156455+01	.375492-00
.2500	.529697-00	.147714+01	.369284-00
.2600	.492407-00	.140034+01	.364089-00
.2700	.459722-00	.133229+01	.359719-00
.2800	.430842-00	.127151+01	.356023-00
.2900	.405135-00	.121681+01	.352874-00
.3000	.382098-00	.116723+01	.350170-00
.3100	.361327-00	.112203+01	.347829-00
.3200	.342491-00	.108055+01	.345778-00
.3300	.325323-00	.104230+01	.343960-00
.3400	.309604-00	.100686+01	.342332-00
.3500	.295154-00	.973881-00	.340858-00
.3600	.281824-00	.943087-00	.339511-00
.3700	.269489-00	.914250-00	.338273-00
.3800	.258044-00	.887174-00	.337126-00
.3900	.247398-00	.861690-00	.336059-00
.4000	.237471-00	.837653-00	.335061-00
.4100	.228196-00	.814936-00	.334124-00
.4200	.219514-00	.793432-00	.333241-00
.4300	.211372-00	.773044-00	.332409-00
.4400	.203723-00	.753685-00	.331621-00
.4500	.196527-00	.735278-00	.330875-00
.4600	.189746-00	.717752-00	.330166-00
.4700	.183348-00	.701048-00	.329492-00
.4800	.177303-00	.685108-00	.328852-00
.4900	.171584-00	.669880-00	.328241-00
.5000	.166167-00	.655319-00	.327660-00
.5100	.161030-00	.641381-00	.327104-00
.5200	.156154-00	.628027-00	.326574-00
.5300	.151520-00	.615221-00	.326067-00
.5400	.147112-00	.602930-00	.325582-00

.5500
.5600
.5700
.5800
.5900
.6000
.6100
.6200
.6300
.6400
.6500
.6600
.6700
.6800
.6900

.142914-00
.138912-00
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.131450-00
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.112655+00
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.324673-00
.324246-00
.323837-00
.323444-00
.323066-00
.322703-00
.322353-00
.322017-00
.321694-00
.321382-00
.321081-00
.320791-00
.320512-00
.320242-00

FIRST COLLISION PROBABILITIES /

P(1,J) J=1 TO 2
 .60778-01 .79783-01
 P(2,J) J=1 TO 2
 .23061-01 .10827+00

URANIUM COLLISION PROBABILITY =	.35496-04	FOR 1-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.00000
THORIUM COLLISION PROBABILITY =	.14485-01	FOR 1-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.00000
URANIUM COLLISION PROBABILITY =	.62121-04	FOR 2-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.42860-00
THORIUM COLLISION PROBABILITY =	.25349-01	FOR 2-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.42860-00
URANIUM COLLISION PROBABILITY =	.84409-04	FOR 3-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.26404-00
THORIUM COLLISION PROBABILITY =	.34444-01	FOR 3-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.26404-00
URANIUM COLLISION PROBABILITY =	.10314-03	FOR 4-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.18162-00
THORIUM COLLISION PROBABILITY =	.42088-01	FOR 4-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.18162-00
URANIUM COLLISION PROBABILITY =	.11889-03	FOR 5-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.13246-00
THORIUM COLLISION PROBABILITY =	.48514-01	FOR 5-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.13246-00
URANIUM COLLISION PROBABILITY =	.13213-03	FOR 6-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.10019+00
THORIUM COLLISION PROBABILITY =	.53916-01	FOR 6-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.10019+00
URANIUM COLLISION PROBABILITY =	.14326-03	FOR 7-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.77683-01
THORIUM COLLISION PROBABILITY =	.58457-01	FOR 7-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.77683-01
URANIUM COLLISION PROBABILITY =	.15261-03	FOR 8-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.61300-01
THORIUM COLLISION PROBABILITY =	.62275-01	FOR 8-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.61300-01
URANIUM COLLISION PROBABILITY =	.16048-03	FOR 9-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.49006-01
THORIUM COLLISION PROBABILITY =	.65484-01	FOR 9-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.49006-01
URANIUM COLLISION PROBABILITY =	.16709-03	FOR 10-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.39567-01
THORIUM COLLISION PROBABILITY =	.68182-01	FOR 10-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.39567-01
URANIUM COLLISION PROBABILITY =	.17264-03	FOR 11-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.32191-01

THORIUM COLLISION PROBABILITY =	.70450-01 FOR 11-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.32191-01
URANIUM COLLISION PROBABILITY =	.17732-03 FOR 12-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.26348-01
THORIUM COLLISION PROBABILITY =	.72356-01 FOR 12-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.26348-01
URANIUM COLLISION PROBABILITY =	.18124-03 FOR 13-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.21669-01
THORIUM COLLISION PROBABILITY =	.73959-01 FOR 13-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.21669-01
URANIUM COLLISION PROBABILITY =	.18455-03 FOR 14-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.17890-01
THORIUM COLLISION PROBABILITY =	.75306-01 FOR 14-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.17890-01
URANIUM COLLISION PROBABILITY =	.18732-03 FOR 15-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.14816-01
THORIUM COLLISION PROBABILITY =	.76438-01 FOR 15-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.14816-01
URANIUM COLLISION PROBABILITY =	.18965-03 FOR 16-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.12302-01
THORIUM COLLISION PROBABILITY =	.77391-01 FOR 16-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.12302-01
URANIUM COLLISION PROBABILITY =	.19162-03 FOR 17-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.10236-01
THORIUM COLLISION PROBABILITY =	.78191-01 FOR 17-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.10236-01
URANIUM COLLISION PROBABILITY =	.19326-03 FOR 18-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.85312-02
THORIUM COLLISION PROBABILITY =	.78664-01 FOR 18-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.85312-02
URANIUM COLLISION PROBABILITY =	.19465-03 FOR 19-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.71206-02
THORIUM COLLISION PROBABILITY =	.79429-01 FOR 19-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.71206-02
URANIUM COLLISION PROBABILITY =	.19582-03 FOR 20-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.59503-02
THORIUM COLLISION PROBABILITY =	.79905-01 FOR 20-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.59503-02
URANIUM COLLISION PROBABILITY =	.19679-03 FOR 21-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.49771-02
THORIUM COLLISION PROBABILITY =	.80304-01 FOR 21-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.49771-02
URANIUM COLLISION PROBABILITY =	.19762-03 FOR 22-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.41666-02
THORIUM COLLISION PROBABILITY =	.80640-01 FOR 22-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.41666-02
URANIUM COLLISION PROBABILITY =	.19831-03 FOR 23-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.34904-02

THORIUM COLLISION PROBABILITY =	.80923-01 FOR 23-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.34904-02
URANIUM COLLISION PROBABILITY =	.19889-03 FOR 24-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.29256-02
THORIUM COLLISION PROBABILITY =	.81160-01 FOR 24-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.29256-02
URANIUM COLLISION PROBABILITY =	.19938-03 FOR 25-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.24533-02
THORIUM COLLISION PROBABILITY =	.81360-01 FOR 25-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.24533-02
URANIUM COLLISION PROBABILITY =	.19979-03 FOR 26-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.20581-02
THORIUM COLLISION PROBABILITY =	.81528-01 FOR 26-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.20581-02
URANIUM COLLISION PROBABILITY =	.20014-03 FOR 27-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.17271-02
THORIUM COLLISION PROBABILITY =	.81669-01 FOR 27-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.17271-02
URANIUM COLLISION PROBABILITY =	.20043-03 FOR 28-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.14498-02
THORIUM COLLISION PROBABILITY =	.81787-01 FOR 28-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.14498-02
URANIUM COLLISION PROBABILITY =	.20067-03 FOR 29-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.12173-02
THORIUM COLLISION PROBABILITY =	.81887-01 FOR 29-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.12173-02
URANIUM COLLISION PROBABILITY =	.20088-03 FOR 30-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.10223-02
THORIUM COLLISION PROBABILITY =	.81971-01 FOR 30-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.10223-02
URANIUM COLLISION PROBABILITY =	.20105-03 FOR 31-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.85861-03
THORIUM COLLISION PROBABILITY =	.82041-01 FOR 31-FLIGHT COLLISIONS.	CONTRIBUTION OF LAST FLIGHT =	.85861-03

FAST FISSION RATIO FOR U-238. REGION 1 TO 2
.33301-04 .00000

FAST FISSION RATIO FOR TH-232. REGION 1 TO 2
.38238-02 .00000

THE NUMBER OF NUCLIDES FROM CHAIN 2 IS 8

NUMBER OF NUCLIDES PRESENT IS 8

NUMBER OF BROAD GROUPS IS 3

IF YES(R=1),IF NO(R=0)

SHOULD AGE BE CALCULATED - R=1

SHOULD MICROSCOPIC CROSS-SECTIONS BE AVERAGED - R=0

REVISED 13ROAD GROUP BOUNDARIES BY ENERGY AND LETHARGY

DESIRED ENERGY	ACTUAL ENERGY USED	DESIRED LETHARGY	ACTUAL LETHARGY USED
.100000000+08	.100000000+08	.000000000	.000000000
.135000000+07	.13533528+07	.20024805+01	.200000000+01
.300000000+04	.33546262+04	.81117281+01	.800000000+01
.683000000-00	.68256032-00	.16499355+02	.165000000+02

GROUP	DELTA-U
1	.20000000+01
2	.60000000+01
3	.85000000+01

THE SOURCE SPECTRUM USED FOR THIS PROBLEM IS

THE U235 SPECTRUM

(CFRANBERG)

OUTPUT FROM GAM CASE 1 HTGR LATTICE CELL CALCULATION - HTLTR MOCKUP T =20 C 00000000000000 PAGE 4

RESONANCE GEOMETRY

(G=1) FOR SLAB

(G=2) FOR CYLINDER

(G=3) FOR SPHERE

G=2

SELF SHIELDING FACTORS ARE SET TO UNITY BELOW 1.35 MEV AND ARE SET TO .1002R+01 ABOVE 1.35 MEV.

TAPE I.D. NUMBER IS 5

CARBON

NUCLEI DENSITY= .70625135-01 ATOMS*10E24/C.C.

SELF SHIELDING FACTORS ARE SET TO UNITY BELOW 1.35 MEV AND ARE SET TO .10146+01 ABOVE 1.35 MEV.

TAPE I.D. NUMBER IS 6

THORIUM-232

NUCLEI DENSITY= .36582579-03 ATOMS*10E24/C.C.

PARTICLE RADII ARE .11000-02 .29500-02 .44750-02 .63500-02 .89750-02

DISTRIBUTION FRACTIONS .26050-01 .86500-02 .10230-01 .58500-02 .19500-02

LUMPED NUCLEI DENSITY FOR REGION 1 = .22492-01

LUMPED NUCLEI DENSITY FOR REGION 2 = .00000

TEMPERATURE = .29300+03

DANCOFF CORR. = .413000-00

NUMBER OF P WIDTHS= 5.000000+00

MASS OF ABSORBER = 232.00

POTENTIAL SIGMA = 1.025000+01

NUMBER OF RESOLVED= 96

GEOMETRY = 2

REGIONS	1	2	3	4	5
ATOMIC DENSITY =	.22492-01	.00000	.00000	.00000	.00000
MASS OF MODER.-1 =	.16000+02	.12000+02	.00000	.00000	.00000
SIGMA SCAT.-1 =	.17094-00	.23812-00	.00000	.00000	.00000
MASS OF MODER.-2 =	.00000	.23500+03	.00000	.00000	.00000
SIGMA SCAT.-2 =	.00000	.43110-03	.00000	.00000	.00000
RADIUS =	.00000	.59690-00	.00000	.00000	.00000

NUMBER	ENERGY	GAMMA-N	GAMMA-G	GAMMA-F	R-MESH	SPIN FACTOR
1	.2178000+02	.2000000-02	.2500000-01	.0000000	.5899609+01	.1000000+01
2	.2345000+02	.3740000-02	.2700000-01	.0000000	.5819891+01	.1000000+01
3	.5946000+02	.4000000-02	.2700000-01	.0000000	.6294612+01	.1000000+01
4	.6913000+02	.4200000-01	.2400000-01	.0000000	.5655659+01	.1000000+01
5	.1128700+03	.1240000-01	.2000000-01	.0000000	.6706605+01	.1000000+01
6	.1207500+03	.2050000-01	.2200000-01	.0000000	.6345685+01	.1000000+01
7	.1291000+03	.3500000-02	.2200000-01	.0000000	.7319059+01	.1000000+01
8	.1702000+03	.6000000-01	.2400000-01	.0000000	.5808331+01	.1000000+01
9	.1926000+03	.1500000-01	.2590000-01	.0000000	.6766012+01	.1000000+01
10	.1993000+03	.1100000-01	.2590000-01	.0000000	.6991205+01	.1000000+01
11	.2211000+03	.2950000-01	.2300000-01	.0000000	.6474089+01	.1000000+01
12	.2514000+03	.3100000-01	.2600000-01	.0000000	.6447760+01	.1000000+01
13	.2631000+03	.2070000-01	.2500000-01	.0000000	.6847281+01	.1000000+01
14	.2857000+03	.2920000-01	.2800000-01	.0000000	.6537970+01	.1000000+01
15	.3054000+03	.2700000-01	.2200000-01	.0000000	.6856210+01	.1000000+01
16	.3289000+03	.7200000-01	.2600000-01	.0000000	.5963152+01	.1000000+01
17	.3418000+03	.3750000-01	.2300000-01	.0000000	.6590448+01	.1000000+01
18	.3651000+03	.2600000-01	.2300000-01	.0000000	.7029545+01	.1000000+01
19	.3693000+03	.2600000-01	.2700000-01	.0000000	.6887133+01	.1000000+01
20	.4009000+03	.1030000-01	.4000000-01	.0000000	.7051366+01	.1000000+01
21	.4625000+03	.6200000-01	.2400000-01	.0000000	.6301506+01	.1000000+01
22	.4887000+03	.5800000-01	.2200000-01	.0000000	.6438202+01	.1000000+01
23	.5285000+03	.1450000-01	.2590000-01	.0000000	.7961624+01	.1000000+01
24	.5698000+03	.2600000-01	.2500000-01	.0000000	.7436014+01	.1000000+01
25	.5982000+03	.9500000-02	.2590000-01	.0000000	.8595909+01	.1000000+01
26	.6179000+03	.4300000-02	.2590000-01	.0000000	.9283916+01	.1000000+01
27	.6567000+03	.4500000-01	.2900000-01	.0000000	.6A02356+01	.1000000+01
28	.6652000+03	.2100000-01	.2590000-01	.0000000	.7862148+01	.1000000+01
29	.6752000+03	.2020000-00	.3500000-01	.0000000	.5570633+01	.1000000+01
30	.6873000+03	.5900000-01	.2590000-01	.0000000	.6607142+01	.1000000+01
31	.7011000+03	.1300000-01	.2590000-01	.0000000	.8542657+01	.1000000+01
32	.7129000+03	.5800000-01	.2800000-01	.0000000	.6615863+01	.1000000+01
33	.7409000+03	.2000000-00	.2590000-01	.0000000	.5627122+01	.1000000+01
34	.7787000+03	.1130000-01	.2590000-01	.0000000	.8904190+01	.1000000+01
35	.8043000+03	.1850000-00	.2590000-01	.0000000	.5699876+01	.1000000+01
36	.8213000+03	.1000000-02	.2590000-01	.0000000	.1054482+02	.1000000+01
37	.8425000+03	.2700000-01	.2590000-01	.0000000	.7855736+01	.1000000+01
38	.8665000+03	.1350000-01	.2590000-01	.0000000	.8688453+01	.1000000+01
39	.8902000+03	.3400000-01	.2590000-01	.0000000	.7592422+01	.1000000+01
40	.9434000+03	.4200000-01	.2400000-01	.0000000	.7422104+01	.1000000+01
41	.9829000+03	.3100000-01	.2590000-01	.0000000	.7867683+01	.1000000+01
42	.9905000+03	.8000000-01	.2590000-01	.0000000	.6546750+01	.1000000+01
43	.1010500+04	.1200000+00	.2590000-01	.0000000	.6133970+01	.1000000+01
44	.1039300+04	.1100000-01	.2590000-01	.0000000	.9547083+01	.1000000+01
45	.1077200+04	.9000000-02	.2590000-01	.0000000	.9894536+01	.1000000+01

46	.1110000+04	.2300000-01	.2500000-01	.0000000	.8546022+01	.1000000+01
47	.1139000+04	.1400000-01	.2590000-01	.0000000	.9402281+01	.1000000+01
48	.1150600+04	.2000000-01	.2590000-01	.0000000	.8846257+01	.1000000+01
49	.1227000+04	.2500000-01	.2590000-01	.0000000	.8582901+01	.1000000+01
50	.1243100+04	.1500000-01	.2590000-01	.0000000	.9432426+01	.1000000+01
51	.1248700+04	.9000000-01	.2590000-01	.0000000	.6586845+01	.1000000+01
52	.1269500+04	.1900000-01	.2590000-01	.0000000	.9130083+01	.1000000+01
53	.1292100+04	.6500000-01	.2590000-01	.0000000	.7058131+01	.1000000+01
54	.1301600+04	.3800000-01	.2590000-01	.0000000	.7938507+01	.1000000+01
55	.1354800+04	.6624000-01	.2590000-01	.0000000	.7079113+01	.1000000+01
56	.1377900+04	.3896000-01	.2590000-01	.0000000	.7978658+01	.1000000+01
57	.1397700+04	.9350000-01	.2590000-01	.0000000	.6629639+01	.1000000+01
58	.1426600+04	.7500000-01	.2590000-01	.0000000	.6936751+01	.1000000+01
59	.1518400+04	.1325000-00	.2590000-01	.0000000	.6280344+01	.1000000+01
60	.1524100+04	.1327000-00	.2590000-01	.0000000	.6281127+01	.1000000+01
61	.1589100+04	.2594000-00	.2590000-01	.0000000	.5727215+01	.1000000+01
62	.1602700+04	.4403000-01	.2590000-01	.0000000	.7979555+01	.1000000+01
63	.1630600+04	.3636000-00	.2590000-01	.0000000	.5539579+01	.1000000+01
64	.1661000+04	.9300000-01	.2590000-01	.0000000	.6772064+01	.1000000+01
65	.1762700+04	.7976000-01	.2590000-01	.0000000	.7068080+01	.1000000+01
66	.1803200+04	.6800000-01	.2590000-01	.0000000	.7353668+01	.1000000+01
67	.1824400+04	.6800000-01	.2590000-01	.0000000	.7359923+01	.1000000+01
68	.1900800+04	.8720000-01	.2590000-01	.0000000	.7006293+01	.1000000+01
69	.1951200+04	.7960000-01	.2590000-01	.0000000	.7179150+01	.1000000+01
70	.1971200+04	.1643000-00	.2590000-01	.0000000	.6214909+01	.1000000+01
71	.2005200+04	.8900000-01	.2590000-01	.0000000	.7017835+01	.1000000+01
72	.2061700+04	.4540000-01	.2590000-01	.0000000	.8314454+01	.1000000+01
73	.2116700+04	.7300000-01	.2590000-01	.0000000	.7406553+01	.1000000+01
74	.2147400+04	.6480000-01	.2590000-01	.0000000	.7659120+01	.1000000+01
75	.2162400+04	.8370000-01	.2590000-01	.0000000	.7208240+01	.1000000+01
76	.2178300+04	.5140000-01	.2590000-01	.0000000	.8142448+01	.1000000+01
77	.2197000+04	.4690000-01	.2590000-01	.0000000	.8350985+01	.1000000+01
78	.2222200+04	.5650000-01	.2590000-01	.0000000	.7977509+01	.1000000+01
79	.2286700+04	.2199000-00	.2590000-01	.0000000	.6012538+01	.1000000+01
80	.2336100+04	.8690000-01	.2590000-01	.0000000	.7230105+01	.1000000+01
81	.2374600+04	.7790000-01	.2590000-01	.0000000	.7443458+01	.1000000+01
82	.2418400+04	.6890000-01	.2590000-01	.0000000	.7699880+01	.1000000+01
83	.2456100+04	.1438000-00	.2590000-01	.0000000	.6519952+01	.1000000+01
84	.2508700+04	.2505000-00	.2590000-01	.0000000	.5943138+01	.1000000+01
85	.2526500+04	.4527000-01	.2590000-01	.0000000	.8675797+01	.1000000+01
86	.2563000+04	.2024000-00	.2590000-01	.0000000	.6154137+01	.1000000+01
87	.2611700+04	.1278000-00	.2590000-01	.0000000	.6730520+01	.1000000+01
88	.2634200+04	.2565000-00	.2590000-01	.0000000	.5945907+01	.1000000+01
89	.2664200+04	.3096000-00	.2590000-01	.0000000	.5800718+01	.1000000+01
90	.2688100+04	.7770000-01	.2590000-01	.0000000	.7604664+01	.1000000+01
91	.2712600+04	.1302000-00	.2590000-01	.0000000	.6736516+01	.1000000+01
92	.2733200+04	.2615000-00	.2590000-01	.0000000	.5946755+01	.1000000+01
93	.2773000+04	.5270000-01	.2590000-01	.0000000	.8486913+01	.1000000+01
94	.2792500+04	.1162000+00	.2590000-01	.0000000	.6935492+01	.1000000+01
95	.2852700+04	.1495000-00	.2590000-01	.0000000	.6584847+01	.1000000+01
96	.2947200+04	.7600000-01	.2590000-01	.0000000	.7772805+01	.1000000+01

RESONANCE REGION	ENERGY	WING CORRECTION	RESONANCE INTEGRAL
1	.2178000+02	.6859030-01	.6606982+01
2	.2345000+02	.8124754-01	.7901394+01
3	.5946000+02	.2213524-01	.2341090+01
4	.6913000+02	.3275518-01	.3327084+01
5	.1128700+03	.1054352-01	.1342846+01
6	.1207500+03	.1182640-01	.1401880+01
7	.1291000+03	.2556365-02	.6033844-00
8	.1702000+03	.9400187-02	.9502406-00
9	.1926000+03	.4685548-02	.7059169-00
10	.1993000+03	.3165770-02	.5876482-00
11	.2211000+03	.5408943-02	.6330464-00
12	.2514000+03	.4949243-02	.5630937-00
13	.2631000+03	.2856533-02	.4703804-00
14	.2857000+03	.3684591-02	.4761099-00
15	.3054000+03	.2246138-02	.3702217-00
16	.3289000+03	.3882791-02	.3917229-00
17	.3418000+03	.2490647-02	.3340810-00
18	.3651000+03	.1482332-02	.2809950-00
19	.3693000+03	.1681415-02	.2994850-00
20	.4009000+03	.8425422-03	.1915322-00
21	.4625000+03	.1993061-02	.2203423-00
22	.4887000+03	.1498678-02	.1837946-00
23	.5285000+03	.3649360-03	.1212162+00
24	.5698000+03	.5162551-03	.1347533-00
25	.5982000+03	.1733360-03	.7432531-01
26	.6179000+03	.7267354-04	.3832068-01
27	.6567000+03	.7345346-03	.1330316-00
28	.6652000+03	.2995487-03	.9522240-01
29	.6752000+03	.1917315-02	.1483690-00
30	.6873000+03	.7723061-03	.1191136+00
31	.7011000+03	.1607294-03	.6705978-01
32	.7129000+03	.7354996-03	.1179908+00
33	.7409000+03	.1254285-02	.9916577-01
34	.7787000+03	.1076935-03	.5026406-01
35	.8043000+03	.1098016-02	.8866040-01
36	.8213000+03	.8355765-05	.5803222-02
37	.8425000+03	.2116076-03	.6839820-01
38	.8665000+03	.9866445-04	.4574856-01
39	.8902000+03	.2316783-03	.6712728-01
40	.9434000+03	.2286760-03	.6123033-01
41	.9829000+03	.1657574-03	.5411724-01
42	.9905000+03	.4160646-03	.6562862-01

43	1	.1010500+04	.6006311-03	.6403197-01
44	1	.1039300+04	.5051819-04	.2821715-01
45	1	.1077200+04	.3804841-04	.2289090-01
46	1	.1110000+04	.9106178-04	.3793834-01
47	1	.1139000+04	.5135389-04	.2755418-01
48	1	.1150600+04	.7134783-04	.3304953-01
49	1	.1227800+04	.7673325-04	.3250473-01
50	1	.1243100+04	.4566446-04	.2471102-01
51	1	.1248700+04	.2601677-03	.4413919-01
52	1	.1269500+04	.5324857-04	.2660276-01
53	1	.1292100+04	.1765225-03	.3982045-01
54	1	.1301600+04	.1001368-03	.3429731-01
55	1	.1354800+04	.1589425-03	.3663252-01
56	1	.1377900+04	.8937560-04	.3104865-01
57	1	.1397700+04	.2084673-03	.3621411-01
58	1	.1426600+04	.1581917-03	.3404024-01
59	1	.1518400+04	.2401933-03	.3182544-01
60	1	.1524100+04	.2378671-03	.3161645-01
61	1	.1589100+04	.4038140-03	.2864956-01
62	1	.1602700+04	.6928085-04	.2422664-01
63	1	.1630600+04	.3946051-03	.2649716-01
64	1	.1661000+04	.1347587-03	.2648637-01
65	1	.1762700+04	.9953471-04	.2322460-01
66	1	.1803200+04	.7867360-04	.2163160-01
67	1	.1824400+04	.7745377-04	.2117974-01
68	1	.1900800+04	.8953740-04	.2044928-01
69	1	.1951200+04	.7578272-04	.1919746-01
70	1	.1971200+04	.1544544-03	.2006318-01
71	1	.2005200+04	.8077823-04	.1857766-01
72	1	.2061700+04	.3764424-04	.1508899-01
73	1	.2116700+04	.5822779-04	.1622966-01
74	1	.2147400+04	.4856072-04	.1537241-01
75	1	.2162400+04	.6203895-04	.1595190-01
76	1	.2178300+04	.3745786-04	.1409087-01
77	1	.2197000+04	.3334192-04	.1348365-01
78	1	.2222200+04	.3923751-04	.1391724-01
79	1	.2286700+04	.1413199-03	.1535830-01
80	1	.2336100+04	.5324342-04	.1386569-01
81	1	.2374800+04	.4603161-04	.1318174-01
82	1	.2418400+04	.3852606-04	.1241366-01
83	1	.2456100+04	.7692505-04	.1335246-01
84	1	.2508700+04	.1301096-03	.1296870-01
85	1	.2526500+04	.2265799-04	.1016318-01
86	1	.2563000+04	.9683130-04	.1249569-01
87	1	.2611700+04	.5843845-04	.1179650-01
88	1	.2634200+04	.1149020-03	.1167003-01
89	1	.2664200+04	.1363841-03	.1155795-01
90	1	.2688100+04	.3365068-04	.1039135-01
91	1	.2712600+04	.5459211-04	.1100310-01

92	1	.2733200+04	.1064819-03	.1109948-01
93	1	.2773000+04	.2084155-04	.A890153-02
94	1	.2792500+04	.4515505-04	.1029312-01
95	1	.2852700+04	.5547991-04	.1012275-01
96	1	.2947200+04	.2608932-04	.A662836-02

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ABSORPTION RESONANCE INTEGRAL = .33019745+02

FISSION RESONANCE INTEGRAL = .00000000 REGION 1

RESOLVANCE ABSORPTION AND FISSION ALLOCATION TO FINE GROUPS

GROUP	ABSORPTION	FISSION	GROUP	ABSORPTION	FISSION
1	0.0000000	0.0000000	35	2.4973966-01	0.0000000
2	0.0000000	0.0000000	36	3.7143274-01	0.0000000
3	0.0000000	0.0000000	37	3.6588954-01	0.0000000
4	0.0000000	0.0000000	38	3.8799924-01	0.0000000
5	0.0000000	0.0000000	39	8.9182980-01	0.0000000
6	0.0000000	0.0000000	40	6.6010591-01	0.0000000
7	0.0000000	0.0000000	41	7.7201183-01	0.0000000
8	0.0000000	0.0000000	42	1.5721345+00	0.0000000
9	0.0000000	0.0000000	43	1.6665199+00	0.0000000
10	0.0000000	0.0000000	44	2.2329134+00	0.0000000
11	0.0000000	0.0000000	45	1.3685600-02	0.0000000
12	0.0000000	0.0000000	46	3.3453350+00	0.0000000
13	0.0000000	0.0000000	47	0.0000000	0.0000000
14	0.0000000	0.0000000	48	3.3098570+00	0.0000000
15	0.0000000	0.0000000	49	2.3583167+00	0.0000000
16	0.0000000	0.0000000	50	0.0000000	0.0000000
17	0.0000000	0.0000000	51	0.0000000	0.0000000
18	0.0000000	0.0000000	52	7.8191836+00	0.0000000
19	0.0000000	0.0000000	53	6.6891913+00	0.0000000
20	0.0000000	0.0000000	54	0.0000000	0.0000000
21	0.0000000	0.0000000	55	0.0000000	0.0000000
22	0.0000000	0.0000000	56	0.0000000	0.0000000
23	0.0000000	0.0000000	57	0.0000000	0.0000000
24	0.0000000	0.0000000	58	0.0000000	0.0000000
25	0.0000000	0.0000000	59	0.0000000	0.0000000
26	0.0000000	0.0000000	60	0.0000000	0.0000000
27	0.0000000	0.0000000	61	0.0000000	0.0000000
28	0.0000000	0.0000000	62	0.0000000	0.0000000
29	0.0000000	0.0000000	63	0.0000000	0.0000000
30	0.0000000	0.0000000	64	0.0000000	0.0000000
31	0.0000000	0.0000000	65	0.0000000	0.0000000
32	0.0000000	0.0000000	66	0.0000000	0.0000000
33	9.4874978-02	0.0000000	67	0.0000000	0.0000000
34	2.1874559-01	0.0000000	68	0.0000000	0.0000000

UNRESOLVED RES. ABS. INT. = .13930+01 UNRESOLVED RES. FIS. INT. = .0000000

SELF SHIELDING FACTORS ARE SET TO UNITY BELOW 1.35 MEV AND ARE SFT TO .10146+01 ABOVE 1.35 MEV.

TAPE I.O. NUMBER IS 9

U234 A 092766

NUCLEI DENSITY= .74363736-07 ATOMS*10E24/C.C.

SELF SHIELDING FACTORS ARE SET TO UNITY BELOW 1.35 MEV AND ARE SET TO .10146+01 ABOVE 1.35 MEV.

TAPE I.D. NUMBER IS 10

U235*

NUCLEI DENSITY= .12133719-04 ATOMS*10E24/C.C.

PARTICLE RADII ARE .25000-01 .13500-01 .14500-01 .16000-01 .17000-01 .18500-01 .19500-01

DISTRIBUTION FRACTIONS .31300-03 .44700-03 .35100-03 .29900-03 .17500-03 .61000-04

LUMPED NUCLEI DENSITY FOR REGION 1 = .22713-01

LUMPED NUCLEI DENSITY FOR REGION 2 = .00000

TEMPERATURE = .29300+03

DANCOFF CORR. = .413000-00

NUMBER OF P WIDTHS= 5.000000+00

MASS OF ABSORBER = 235.12

POTENTIAL SIGMA = 1.038000+01

NUMBER OF RESOLVED= 28

GEOMETRY = 0

REGIONS	1	2	3	4	5
ATOMIC DENSITY =	.22713-01	.00000	.00000	.00000	.00000
MASS OF MODER.-1 =	.12000+02	.16000+02	.00000	.00000	.00000
SIGMA SCAT.-1 =	.23445-00	.90300-02	.00000	.00000	.00000
MASS OF MODER.-2 =	.23600+03	.12000+02	.00000	.00000	.00000
SIGMA SCAT.-2 =	.18281-01	.22555-00	.00000	.00000	.00000
RADIUS =	.00000	.59690-00	.00000	.00000	.00000

NUMBER	ENERGY	GAMMA-N	GAMMA-G	GAMMA-F	R-MESH	SPIN FACTOR
1	.1140000+01	.1720000-04	.4400000-01	.1250000-00	.5125410+01	.5000000-00
2	.2035000+01	.7700000-05	.2500000-01	.1200000-01	.5294925+01	.5000000-00
3	.2820000+01	.3000000-05	.3300000-01	.5100000-01	.5263071+01	.5000000-00
4	.3160000+01	.3230000-04	.3100000-01	.1550000-00	.5296164+01	.5000000-00
5	.3600000+01	.4600000-04	.3300000-01	.6500000-01	.5296849+01	.5000000-00
6	.4840000+01	.5200000-04	.1600000-01	.7000000-02	.5708592+01	.5000000-00
7	.5450000+01	.2200000-04	.3300000-01	.5100000-01	.5365508+01	.5000000-00
8	.5800000+01	.1600000-04	.3300000-01	.5100000-01	.5377131+01	.5000000-00
9	.6170000+01	.2700000-04	.3300000-01	.5100000-01	.5388845+01	.5000000-00
10	.6380000+01	.2800000-03	.3500000-01	.1900000-01	.5370156+01	.5000000-00
11	.7090000+01	.1000000-03	.1700000-01	.3200000-01	.5805063+01	.5000000-00
12	.8790000+01	.1000000-02	.2900000-01	.5700000-01	.5510947+01	.5000000-00
13	.9270000+01	.1200000-03	.3300000-01	.5100000-01	.5475283+01	.5000000-00
14	.9700000+01	.5000000-04	.3300000-01	.5100000-01	.5487211+01	.5000000-00
15	.1016000+02	.6400000-04	.3300000-01	.5100000-01	.5498418+01	.5000000-00
16	.1060000+02	.3300000-04	.3300000-01	.5100000-01	.5509574+01	.5000000-00
17	.1165000+02	.7000000-03	.3300000-01	.9000000-02	.5523643+01	.5000000-00
18	.1240000+02	.1400000-02	.2800000-01	.2300000-01	.5619250+01	.5000000-00
19	.1335000+02	.9900000-04	.3300000-01	.5100000-01	.5570727+01	.5000000-00
20	.1380000+02	.1500000-03	.3300000-01	.5100000-01	.5579374+01	.5000000-00
21	.1410000+02	.2000000-03	.3300000-01	.5100000-01	.5584755+01	.5000000-00
22	.1465000+02	.1500000-03	.3300000-01	.5100000-01	.5596950+01	.5000000-00
23	.1544000+02	.2300000-03	.3300000-01	.5100000-01	.5611358+01	.5000000-00
24	.1610000+02	.3400000-03	.3300000-01	.5100000-02	.5622229+01	.5000000-00
25	.1670000+02	.2700000-03	.3300000-01	.5100000-01	.5635050+01	.5000000-00
26	.1810000+02	.3400000-03	.3300000-01	.5100000-01	.5659745+01	.5000000-00
27	.1860000+02	.2000000-03	.3300000-01	.5100000-01	.5671616+01	.5000000-00
28	.1930000+02	.2900000-02	.3200000-01	.6400000-01	.5650612+01	.5000000-00

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RESONANCE REGION	ENERGY	WING CORRECTION	RESONANCE INTEGRAL
1	.1140000+01	.7820283-01	.2569187+02
2	.2035000+01	.1231838+00	.7272360+01
3	.2820000+01	.5552818-01	.7657145-00
4	.3160000+01	.1960827-00	.6483252+01
5	.3600000+01	.1796948-00	.7047697+01
6	.4840000+01	.7347368-01	.4332189+01
7	.5450000+01	.7935196-01	.1498480+01
8	.5800000+01	.5263452-01	.9648134-00
9	.6170000+01	.7144161-01	.1433871+01
10	.6380000+01	.1521756-00	.1255176+02
11	.7090000+01	.8235461-01	.3903812+01
12	.8790000+01	.1910066-00	.2172144+02
13	.9270000+01	.8250585-01	.2780046+01
14	.9700000+01	.4537276-01	.1073323+01
15	.1016000+02	.5054676-01	.1249670+01
16	.1060000+02	.2371414-01	.5962292-00
17	.1165000+02	.9476088-01	.9055056+01
18	.1240000+02	.1269441-00	.1458710+02
19	.1335000+02	.4046564-01	.1117875+01
20	.1380000+02	.5090289-01	.1575473+01
21	.1410000+02	.5729418-01	.2000546+01
22	.1465000+02	.4640331-01	.1399695+01
23	.1544000+02	.5281488-01	.1916663+01
24	.1610000+02	.3955774-01	.2533562+01
25	.1670000+02	.5171492-01	.1919378+01
26	.1810000+02	.5115416-01	.2048781+01
27	.1860000+02	.3562404-01	.1157127+01
28	.1930000+02	.1284034-00	.1277111+02

ABSORPTION RESONANCE INTEGRAL = .14790387+03

FISSION RESONANCE INTEGRAL = .84608492+02 REGION 1

RESONANCE ABSORPTION AND FISSION ALLOCATION TO FINE GROUPS

GROUP	ABSORPTION	FISSION	GROUP	ABSORPTION	FISSION
1	0.0000000	0.0000000	35	0.0000000	0.0000000
2	0.0000000	0.0000000	36	0.0000000	0.0000000
3	0.0000000	0.0000000	37	0.0000000	0.0000000
4	0.0000000	0.0000000	38	0.0000000	0.0000000
5	0.0000000	0.0000000	39	0.0000000	0.0000000
6	0.0000000	0.0000000	40	0.0000000	0.0000000
7	0.0000000	0.0000000	41	0.0000000	0.0000000
8	0.0000000	0.0000000	42	0.0000000	0.0000000
9	0.0000000	0.0000000	43	0.0000000	0.0000000
10	0.0000000	0.0000000	44	0.0000000	0.0000000
11	0.0000000	0.0000000	45	0.0000000	0.0000000
12	0.0000000	0.0000000	46	0.0000000	0.0000000
13	0.0000000	0.0000000	47	0.0000000	0.0000000
14	0.0000000	0.0000000	48	0.0000000	0.0000000
15	0.0000000	0.0000000	49	0.0000000	0.0000000
16	0.0000000	0.0000000	50	0.0000000	0.0000000
17	0.0000000	0.0000000	51	0.0000000	0.0000000
18	0.0000000	0.0000000	52	6.4840918-02	4.3227278-02
19	0.0000000	0.0000000	53	1.5717556+01	1.0289773+01
20	0.0000000	0.0000000	54	1.109786+01	5.5399932+00
21	0.0000000	0.0000000	55	2.5270222+01	9.5743038+00
22	0.0000000	0.0000000	56	2.6432510+01	1.7155036+01
23	0.0000000	0.0000000	57	5.6828562+00	3.4120600+00
24	0.0000000	0.0000000	58	1.5511230+01	6.4809272+00
25	0.0000000	0.0000000	59	4.8208266+00	1.6658225+00
26	0.0000000	0.0000000	60	1.0932527+01	7.9874860+00
27	0.0000000	0.0000000	61	2.7800623+00	2.103847+00
28	0.0000000	0.0000000	62	4.0180206+00	1.5063574+00
29	0.0000000	0.0000000	63	9.1575760-01	6.1913171-01
30	0.0000000	0.0000000	64	1.0120257+01	7.4853975+00
31	0.0000000	0.0000000	65	1.1305636+01	8.3621564+00
32	0.0000000	0.0000000	66	1.9543588+00	1.4455317+00
33	0.0000000	0.0000000	67	9.9316919-01	7.3459257-01
34	0.0000000	0.0000000	68	2.7426019-01	2.0285517-01

UNRESOLVED RES. ABS. INT. = .15086+03 UNRESOLVED RES. FIS. INT. = .10055+03

SELF SHIELDING FACTORS ARE SET TO UNITY BELOW 1.35 MEV AND ARE SFT TO .10146+01 ABOVE 1.35 MFV.

TAPE 1.D. NUMBER IS 11

URANIUM-236

NUCLEI DENSITY= .39017058-07 ATOMS*10E24/C.C.

SELF SHIELDING FACTORS ARE SET TO UNITY BELOW 1.35 MEV AND ARE SFT TO .10146+01 ABOVE 1.35 MEV.

TAPE I.O. NUMBER IS 12

U238* A 120266

NUCLEI DENSITY= .79930992-06 ATOMS*10E24/C.C.

PARTICLE RADII ARE .13500-01 .14500-01 .16000-01 .17000-01 .18500-01 .19500-01
.25000-01

DISTRIBUTION FRACTIONS .31300-03 .44700-03 .35100-03 .29900-03 .17500-03 .61000-04
.86000-04

LUMPED NUCLEI DENSITY FOR REGION 1 = .14963-02

LUMPED NUCLEI DENSITY FOR REGION 2 = .00000

TEMPERATURE = .29300+03

DANCOFF CORR. = .413000-00

NUMBER OF P WIDTHS= 5.0000000+00

MASS OF ABSORBER = 236.01

POTENTIAL SIGMA = 1.0700000+01

NUMBER OF RESOLVED= 95

GEOMETRY = 2

REGIONS	1	2	3	4	5
ATOMIC DENSITY =	.14963-02	.00000	.00000	.00000	.00000
MASS OF MODER.-1 =	.12000+02	.16000+02	.00000	.00000	.00000
SIGMA SCAT.-1 =	.23445-00	.90300-02	.00000	.00000	.00000
MASS OF MODER.-2 =	.23500+03	.12000+02	.00000	.00000	.00000
SIGMA SCAT.-2 =	.23797-00	.22555-00	.00000	.00000	.00000
RADIUS =	.00000	.59690-00	.00000	.00000	.00000

NUMBER	ENERGY	GAMMA-N	GAMMA-G	GAMMA-F	R-MESH	SPIN FACTOR
1	.1782300+04	.5066075-00	.2500000-01	.0000000	.5409814+01	.1000000+01
2	.1755800+04	.7123385-01	.2500000-01	.0000000	.7246969+01	.1000000+01
3	.1723000+04	.1411307-00	.2500000-01	.0000000	.6289377+01	.1000000+01
4	.1709400+04	.4961387-01	.2500000-01	.0000000	.7859497+01	.1000000+01
5	.1688300+04	.6985118-01	.2500000-01	.0000000	.7235473+01	.1000000+01
6	.1662100+04	.1589985-00	.2500000-01	.0000000	.6143409+01	.1000000+01
7	.1638200+04	.4047468-01	.2500000-01	.0000000	.8190049+01	.1000000+01
8	.1622900+04	.8862751-01	.2500000-01	.0000000	.6829573+01	.1000000+01
9	.1598200+04	.3198199-00	.2500000-01	.0000000	.5598288+01	.1000000+01
10	.1565000+04	.2373605-02	.2500000-01	.0000000	.1245783+02	.1000000+01
11	.1550000+04	.1968502-02	.2500000-01	.0000000	.1253349+02	.1000000+01
12	.1546000+04	.1965960-02	.2500000-01	.0000000	.1252447+02	.1000000+01
13	.1532000+04	.1957038-02	.2500000-01	.0000000	.1249281+02	.1000000+01
14	.1523100+04	.8195652-01	.2500000-01	.0000000	.6882974+01	.1000000+01
15	.1473800+04	.2303406-01	.2500000-01	.0000000	.9124367+01	.1000000+01
16	.1444100+04	.3420118-01	.2500000-01	.0000000	.8312498+01	.1000000+01
17	.1419700+04	.1130367-01	.2500000-01	.0000000	.1035593+02	.1000000+01
18	.1405100+04	.8246626-01	.2500000-01	.0000000	.6799985+01	.1000000+01
19	.1393600+04	.1679531-00	.2500000-01	.0000000	.5998185+01	.1000000+01
20	.1335700+04	.1461889-02	.2500000-01	.0000000	.1212723+02	.1000000+01
21	.1317200+04	.4718122-02	.2500000-01	.0000000	.1130219+02	.1000000+01
22	.1298500+04	.3603470-02	.2500000-01	.0000000	.1150114+02	.1000000+01
23	.1273200+04	.2854554-01	.2500000-01	.0000000	.8438843+01	.1000000+01
24	.1267000+04	.2669621-01	.2500000-01	.0000000	.8553178+01	.1000000+01
25	.1245100+04	.2293588-00	.2500000-01	.0000000	.5715884+01	.1000000+01
26	.1210900+04	.9047477-00	.2500000-01	.0000000	.5193142+01	.1000000+01
27	.1195000+04	.8296505-01	.2500000-01	.0000000	.6652297+01	.1000000+01
28	.1177600+04	.5833750-01	.2500000-01	.0000000	.7124936+01	.1000000+01
29	.1167500+04	.6833740-01	.2500000-01	.0000000	.6889122+01	.1000000+01
30	.1140400+04	.2296347-00	.2500000-01	.0000000	.5684382+01	.1000000+01
31	.1131500+04	.2354644-02	.2500000-01	.0000000	.1134576+02	.1000000+01
32	.1108900+04	.2351010-01	.2500000-01	.0000000	.8557096+01	.1000000+01
33	.1098400+04	.1159974+00	.2500000-01	.0000000	.6212988+01	.1000000+01
34	.1081100+04	.6576017-03	.2500000-01	.0000000	.1161309+02	.1000000+01
35	.1070500+04	.3271850-03	.2500000-01	.0000000	.1166644+02	.1000000+01
36	.1053900+04	.6492765-01	.2500000-01	.0000000	.6862918+01	.1000000+01
37	.1033320+04	.6426866-03	.2500000-01	.0000000	.1146864+02	.1000000+01
38	.1023000+04	.1279375-01	.2500000-01	.0000000	.9367221+01	.1000000+01
39	.1011300+04	.1272038-02	.2500000-01	.0000000	.1124645+02	.1000000+01
40	.1000300+04	.1265101-02	.2500000-01	.0000000	.1121403+02	.1000000+01
41	.9918000+03	.3495707-00	.3000000-01	.0000000	.5428161+01	.1000000+01
42	.9584000+03	.1547902-00	.2400000-01	.0000000	.5893546+01	.1000000+01
43	.9369000+03	.1499832-00	.2500000-01	.0000000	.5902688+01	.1000000+01
44	.9252000+03	.1003764-01	.2500000-01	.0000000	.9479920+01	.1000000+01
45	.9099000+03	.9049364-03	.2500000-01	.0000000	.1100899+02	.1000000+01

46	.9051000+03	.5114430-01	.2500000-01	.0000000	.7038911+01	.1000000+01
47	.8913000+03	.1044913-02	.2500000-01	.0000000	.1091529+02	.1000000+01
48	.8665000+03	.3532365-02	.2500000-01	.0000000	.1032395+02	.1000000+01
49	.8562000+03	.8193051-01	.2500000-01	.0000000	.6412126+01	.1000000+01
50	.8510000+03	.5834381-01	.2500000-01	.0000000	.6806254+01	.1000000+01
51	.8216000+03	.5876031-01	.3200000-01	.0000000	.6629752+01	.1000000+01
52	.7909000+03	.5062130-02	.1500000-01	.0000000	.1223388+02	.1000000+01
53	.7792000+03	.1674849-02	.2500000-01	.0000000	.1040020+02	.1000000+01
54	.7651000+03	.6638506-02	.2500000-01	.0000000	.9511599+01	.1000000+01
55	.7322600+03	.1353015-02	.2500000-01	.0000000	.1029895+02	.1000000+01
56	.7301000+03	.1621222-02	.2500000-01	.0000000	.1023782+02	.1000000+01
57	.7218000+03	.1208985-02	.2500000-01	.0000000	.1028988+02	.1000000+01
58	.7085000+03	.2102795-01	.3300000-01	.0000000	.7542370+01	.1000000+01
59	.6933000+03	.3686283-01	.2200000-01	.0000000	.7308377+01	.1000000+01
60	.6770000+03	.9106728-03	.2500000-01	.0000000	.1018207+02	.1000000+01
61	.6612000+03	.1208549+00	.2400000-01	.0000000	.5916053+01	.1000000+01
62	.6287000+03	.4011822-02	.2500000-01	.0000000	.9459992+01	.1000000+01
63	.6200000+03	.2967976-01	.2400000-01	.0000000	.7384830+01	.1000000+01
64	.5952000+03	.8050918-01	.2400000-01	.0000000	.6204660+01	.1000000+01
65	.5802000+03	.3131354-01	.2500000-01	.0000000	.7207310+01	.1000000+01
66	.5561000+03	.7074532-03	.2200000-01	.0000000	.1035914+02	.1000000+01
67	.5355000+03	.3933948-01	.2800000-01	.0000000	.6773362+01	.1000000+01
68	.5186000+03	.4326830-01	.2500000-01	.0000000	.6721411+01	.1000000+01
69	.4889000+03	.4422217-03	.2500000-01	.0000000	.9484792+01	.1000000+01
70	.4787000+03	.3063090-02	.1800000-01	.0000000	.1036040+02	.1000000+01
71	.4633000+03	.5165857-02	.2500000-01	.0000000	.8682161+01	.1000000+01
72	.4542000+03	.4901753-03	.2000000-01	.0000000	.1036742+02	.1000000+01
73	.4342000+03	.8960110-02	.1800000-01	.0000000	.8988509+01	.1000000+01
74	.4103000+03	.1823028-01	.4000000-01	.0000000	.6795102+01	.1000000+01
75	.3976000+03	.6978968-02	.2500000-01	.0000000	.8217704+01	.1000000+01
76	.3769000+03	.1145421-02	.2500000-01	.0000000	.8831817+01	.1000000+01
77	.3479000+03	.7460831-01	.2400000-01	.0000000	.5976115+01	.1000000+01
78	.3111000+03	.9877295-03	.2500000-01	.0000000	.8502426+01	.1000000+01
79	.2911000+03	.1620857-01	.1900000-01	.0000000	.7500691+01	.1000000+01
80	.2737000+03	.2531214-01	.2300000-01	.0000000	.6767130+01	.1000000+01
81	.2639000+03	.2274300-03	.2500000-01	.0000000	.8323028+01	.1000000+01
82	.2374000+03	.2850441-01	.2300000-01	.0000000	.6543772+01	.1000000+01
83	.2086000+03	.5632766-01	.2500000-01	.0000000	.5916445+01	.1000000+01
84	.1896000+03	.1445801-00	.2300000-01	.0000000	.5424018+01	.1000000+01
85	.1657000+03	.2960664-02	.2400000-01	.0000000	.7463871+01	.1000000+01
86	.1457000+03	.7000963-03	.2400000-01	.0000000	.7521845+01	.1000000+01
87	.1169000+03	.2594887-01	.2200000-01	.0000000	.6163633+01	.1000000+01
88	.1027000+03	.6688506-01	.2400000-01	.0000000	.5575413+01	.1000000+01
89	.8950000+02	.8514399-04	.2400000-01	.0000000	.7026981+01	.1000000+01
90	.8110000+02	.1981222-02	.2100000-01	.0000000	.7022202+01	.1000000+01
91	.6620000+02	.2505992-01	.2400000-01	.0000000	.5855834+01	.1000000+01
92	.3670000+02	.3101723-01	.2600000-01	.0000000	.5548295+01	.1000000+01
93	.2100000+02	.8523591-02	.2600000-01	.0000000	.5684985+01	.1000000+01
94	.1020000+02	.1405247-05	.2600000-01	.0000000	.5633856+01	.1000000+01
95	.6670000+01	.1523754-02	.2600000-01	.0000000	.5484220+01	.1000000+01

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RESONANCE REGION	ENERGY	WING CORRECTION	RESONANCE INTEGRAL
1	.1782300+04	.3431387-03	.3040505-01
2	.1755800+04	.8729981-04	.2448125-01
3	.1723000+04	.1818625-03	.2913372-01
4	.1709400+04	.6410805-04	.2321136-01
5	.1688300+04	.9478454-04	.2634131-01
6	.1662100+04	.2199423-03	.3183169-01
7	.1638200+04	.5884480-04	.2349851-01
8	.1622900+04	.1317728-03	.3017564-01
9	.1598200+04	.3922372-03	.3684702-01
10	.1565000+04	.3859167-05	.3614863-02
11	.1550000+04	.3294333-05	.3102170-02
12	.1546000+04	.3264669-05	.3114519-02
13	.1532000+04	.3359342-05	.3158397-02
14	.1523100+04	.1408458-03	.3365501-01
15	.1473800+04	.4344763-04	.2252875-01
16	.1444100+04	.6786274-04	.2825918-01
17	.1419700+04	.2343932-04	.1576931-01
18	.1405100+04	.1758948-03	.3959315-01
19	.1393000+04	.3612672-03	.4559617-01
20	.1335700+04	.3510332-05	.3161564-02
21	.1317200+04	.1167508-04	.9341536-02
22	.1298500+04	.9257656-05	.7627573-02
23	.1273200+04	.7715319-04	.3354730-01
24	.1267000+04	.7321922-04	.3281698-01
25	.1245100+04	.5628898-03	.5898494-01
26	.1210900+04	.6189479-03	.6668363-01
27	.1195000+04	.2632246-03	.5477915-01
28	.1177600+04	.1925444-03	.5143026-01
29	.1167500+04	.2287330-03	.5470327-01
30	.1140400+04	.6419167-03	.7026004-01
31	.1131500+04	.8557990-05	.6864404-02
32	.1108900+04	.8940125-04	.4002449-01
33	.1098400+04	.4510781-03	.6930596-01
34	.1081100+04	.2694489-05	.2238972-02
35	.1070500+04	.1380845-05	.1150996-02
36	.1053900+04	.2856507-03	.6618189-01
37	.1033200+04	.2955218-05	.2397874-02
38	.1023000+04	.6015165-04	.3300797-01
39	.1011300+04	.6180514-05	.4833541-02
40	.1000300+04	.6268216-05	.4914684-02
41	.9918000+03	.9731865-03	.1132929+00
42	.9584000+03	.7935091-03	.9173252-01

43	1	.9369000+03	.8573153-03	.9899316-01
44	1	.9252000+03	.6051161-04	.3415396-01
45	1	.9099000+03	.5657672-05	.4308078-02
46	1	.9051000+03	.3217322-03	.8347797-01
47	1	.8913000+03	.6973445-05	.5156504-02
48	1	.8665000+03	.2514447-04	.1683261-01
49	1	.8562000+03	.5916193-03	.1062129+00
50	1	.8510000+03	.4356749-03	.9834755-01
51	1	.8216000+03	.6118822-03	.1248857+00
52	1	.7909000+03	.2728233-04	.2470084-01
53	1	.7792000+03	.1562652-04	.1055790-01
54	1	.7651000+03	.6496638-04	.3657959-01
55	1	.7322600+03	.1471175-04	.9775804-02
56	1	.7301000+03	.1781969-04	.1166307-01
57	1	.7218000+03	.1349279-04	.9038685-02
58	1	.7085000+03	.3223422-03	.1043178+00
59	1	.6933000+03	.4035948-03	.1167044+00
60	1	.6770000+03	.1189292-04	.7828929-02
61	1	.6612000+03	.1368213-02	.1852282-00
62	1	.6287000+03	.6317830-04	.3570567-01
63	1	.6200000+03	.4737344-03	.1409942-00
64	1	.5952000+03	.1405717-02	.2114482-00
65	1	.5802000+03	.6148652-03	.1680791-00
66	1	.5561000+03	.1336950-04	.9051250-02
67	1	.5355000+03	.1037512-02	.2318667-00
68	1	.5186000+03	.1119753-02	.2393003-00
69	1	.4889000+03	.1303228-04	.7424222-02
70	1	.4787000+03	.6853859-04	.4662938-01
71	1	.4633000+03	.1765842-03	.8139439-01
72	1	.4542000+03	.1396981-04	.9470932-02
73	1	.4342000+03	.2562539-03	.1293929-00
74	1	.4103000+03	.1341903-02	.3028085-00
75	1	.3976000+03	.3466078-03	.1407579-00
76	1	.3769000+03	.6563955-04	.3148042-01
77	1	.3479000+03	.3410140-02	.6031030-00
78	1	.3111000+03	.9150133-04	.4008482-01
79	1	.2911000+03	.1325938-02	.4194423-00
80	1	.2737000+03	.2946672-02	.6514291-00
81	1	.2639000+03	.3163982-04	.1321549-01
82	1	.2374000+03	.4783594-02	.9117557-00
83	1	.2086000+03	.7262368-02	.1584871+01
84	1	.1896000+03	.8630584-02	.2147325+01
85	1	.1657000+03	.1261092-02	.3911881-00
86	1	.1457000+03	.4167091-03	.1307904-00
87	1	.1169000+03	.1346953-01	.3457729+01
88	1	.1027000+03	.2088366-01	.6431603+01
89	1	.8950000+02	.1700667-03	.4325029-01
90	1	.8110000+02	.4444976-02	.1119548+01
91	1	.6620000+02	.3354761-01	.1084733+02
92	1	.3670000+02	.7689104-01	.3796705+02
93	1	.2100000+02	.1217713+00	.5407133+02
94	1	.1020000+02	.6823831-03	.5516052-01
95	1	.6670000+01	.1682277-00	.1201966+03

ABSORPTION, RESONANCE INTEGRAL = .24529110+03

FISSION RESONANCE INTEGRAL = .00000000 REGION 1

RESONANCE ABSORPTION AND FISSION ALLOCATION TO FINE GROUPS

GROUP	ABSORPTION	FISSION	GROUP	ABSORPTION	FISSION
1	0.0000000	0.0000000	35	2.5592516-01	0.0000000
2	0.0000000	0.0000000	36	3.4429230-01	0.0000000
3	0.0000000	0.0000000	37	0.4254641-01	0.0000000
4	0.0000000	0.0000000	38	7.3503569-01	0.0000000
5	0.0000000	0.0000000	39	0.3322792-01	0.0000000
6	0.0000000	0.0000000	40	7.8914185-01	0.0000000
7	0.0000000	0.0000000	41	6.0748808-01	0.0000000
8	0.0000000	0.0000000	42	1.0654656+00	0.0000000
9	0.0000000	0.0000000	43	1.5735635+00	0.0000000
10	0.0000000	0.0000000	44	3.7334160+00	0.0000000
11	0.0000000	0.0000000	45	5.2075610-01	0.0000000
12	0.0000000	0.0000000	46	9.8088738+00	0.0000000
13	0.0000000	0.0000000	47	1.2432465+00	0.0000000
14	0.0000000	0.0000000	48	1.0826057+01	0.0000000
15	0.0000000	0.0000000	49	1.9277152-02	0.0000000
16	0.0000000	0.0000000	50	5.6929858-01	0.0000000
17	0.0000000	0.0000000	51	3.7331242+01	0.0000000
18	0.0000000	0.0000000	52	2.1438320-01	0.0000000
19	0.0000000	0.0000000	53	5.3806736+01	0.0000000
20	0.0000000	0.0000000	54	9.6749497-02	0.0000000
21	0.0000000	0.0000000	55	4.4195382-04	0.0000000
22	0.0000000	0.0000000	56	2.4153031-01	0.0000000
23	0.0000000	0.0000000	57	1.1601926+02	0.0000000
24	0.0000000	0.0000000	58	3.5869793+00	0.0000000
25	0.0000000	0.0000000	59	2.6030780-01	0.0000000
26	0.0000000	0.0000000	60	1.4330466-01	0.0000000
27	0.0000000	0.0000000	61	0.0000000	0.0000000
28	0.0000000	0.0000000	62	0.0000000	0.0000000
29	0.0000000	0.0000000	63	0.0000000	0.0000000
30	0.0000000	0.0000000	64	0.0000000	0.0000000
31	0.0000000	0.0000000	65	0.0000000	0.0000000
32	0.0000000	0.0000000	66	0.0000000	0.0000000
33	0.0000000	0.0000000	67	0.0000000	0.0000000
34	0.0000000	0.0000000	68	0.0000000	0.0000000

UNRESOLVED RES. ABS. INT. = .11022+01 UNRESOLVED RES. FIS. INT. = .000000

OUTPUT FROM GAM CASE 1 HTGR LATTICE CELL CALCULATION - HTLTR WCKUP T =20 C 000000000000 PAGE 10

SELF SHIELDING FACTORS ARE SET TO UNITY BELOW 1.35 MEV AND ARE SFT TO .10066+01 ABOVE 1.35 MEV.

TAPE I.D. NUMBER IS 22

NITROGEN

NUCLEI DENSITY= .17934746-04 ATOMS*10E24/C.C.

SELF SHIELDING FACTORS ARE SET TO UNITY BELOW 1.35 MEV AND ARE SFT TO .10146+01 ABOVE 1.35 MEV.

TAPE I.D. NUMBER IS 23

016 AL042966

NUCLEI DENSITY= .73165157-03 ATOMS*10E24/C.C.

THE FLUXES AND CURRENT TERMS ARE CALCULATED USING THE B-1 APPROXIMATION

K= .999999999-10

GROUP	FLUX	CURRENT TERM
1	.12591811-02	.55608515-12
2	.49706355-02	.25510321-11
3	.15400681-01	.88826571-11
4	.22798466-01	.75446980-11
5	.31314963-01	.86719923-11
6	.57943464-01	.17279154-10
7	.76482648-01	.21059027-10
8	.88621669-01	.22389615-10
9	.87058779-01	.18692392-10
10	.85043752-01	.16205618-10
11	.85989701-01	.15044586-10
12	.83011355-01	.13270376-10
13	.78914976-01	.11399367-10
14	.77154387-01	.10583256-10
15	.74674707-01	.96723928-11
16	.72202382-01	.89210995-11
17	.69444468-01	.82721610-11
18	.69821261-01	.80712428-11
19	.67392553-01	.75890431-11
20	.64951388-01	.69491475-11
21	.64579694-01	.68627486-11
22	.64780901-01	.69027557-11
23	.66309109-01	.72412153-11
24	.66051725-01	.71268971-11
25	.65826421-01	.70586206-11
26	.65724515-01	.70275997-11
27	.65512599-01	.69647492-11
28	.65440018-01	.69458628-11
29	.65421682-01	.69286204-11
30	.65238280-01	.68789004-11
31	.65264029-01	.68942742-11
32	.65283542-01	.68885147-11
33	.64956763-01	.68147264-11
34	.64890230-01	.68317530-11
35	.64815642-01	.68169000-11
36	.64624333-01	.67820335-11
37	.64476756-01	.67700046-11
38	.64339819-01	.67534444-11
39	.63826427-01	.66617405-11
40	.63567497-01	.66611996-11

GROUP	FLUX	CURRENT TERM
41	.63244103-01	.66183037-11
42	.62389325-01	.64741605-11
43	.61697880-01	.64237708-11
44	.60769896-01	.62993266-11
45	.60576528-01	.63559783-11
46	.59139125-01	.60758355-11
47	.58871619-01	.61712292-11
48	.57489403-01	.59113018-11
49	.56589995-01	.58691746-11
50	.56165949-01	.58701875-11
51	.56151444-01	.59017760-11
52	.53090712-01	.52892866-11
53	.49984167-01	.49748533-11
54	.50028395-01	.52908880-11
55	.49700660-01	.51975664-11
56	.49385210-01	.51593434-11
57	.49218448-01	.51596218-11
58	.48959287-01	.51221775-11
59	.48881226-01	.51321536-11
60	.48710702-01	.51043810-11
61	.48631609-01	.51055315-11
62	.48528186-01	.50916986-11
63	.48448496-01	.50855683-11
64	.48246105-01	.50526788-11
65	.47926969-01	.50068204-11
66	.47628334-01	.49787425-11
67	.47291697-01	.49397255-11
68	.46873889-01	.48875580-11

GROUP	PHI(0,0) TERM	PHI(1,1) TERM	PHI(2,0) TERM	AGE
1	.35589013-00	.47150934+01	.23446218+02	.65880496+02
2	.14048814+01	.21630418+02	.14251692+03	.10144409+03
3	.43527896+01	.75316809+02	.63982008+03	.14699081+03
4	.64436714+01	.63972139+02	.66973107+03	.10393625+03
5	.88507416+01	.75226380+02	.74888705+03	.84612915+02
6	.16376919+02	.14651142+03	.15458652+04	.94392917+02
7	.21616763+02	.17856129+03	.22177029+04	.10259181+03
8	.25047690+02	.18984345+03	.27666203+04	.11045411+03
9	.24605960+02	.15849439+03	.28042539+04	.11396645+03
10	.24036441+02	.13740882+03	.28112686+04	.11695860+03
11	.24303800+02	.12756434+03	.29385003+04	.12090703+03
12	.23462012+02	.11252065+03	.29324429+04	.12498685+03
13	.22304227+02	.96656206+02	.28752337+04	.12890980+03
14	.21806621+02	.89736333+02	.29080421+04	.13335592+03
15	.21105774+02	.82013045+02	.29116095+04	.13795321+03
16	.20407005+02	.75642767+02	.29107647+04	.14263555+03
17	.19627519+02	.70140360+02	.28917700+04	.14733242+03
18	.19734014+02	.68436757+02	.30031429+04	.15218104+03
19	.19047573+02	.64348145+02	.29902123+04	.15698652+03
20	.18357611+02	.58922415+02	.29638553+04	.16145102+03
21	.18252558+02	.58189833+02	.30298919+04	.16599821+03
22	.18309426+02	.58529055+02	.31248833+04	.17067074+03
23	.18741353+02	.61398882+02	.32917771+04	.17564245+03
24	.18668607+02	.60446528+02	.33712099+04	.18058176+03
25	.18604928+02	.59850647+02	.34503552+04	.18545382+03
26	.18576126+02	.59587619+02	.35354975+04	.19032480+03
27	.18516231+02	.59054703+02	.36142301+04	.19519253+03
28	.18495716+02	.58894565+02	.37004983+04	.20007325+03
29	.18490534+02	.58748364+02	.37892086+04	.20492694+03
30	.18438698+02	.58326785+02	.38676886+04	.20975931+03
31	.18445975+02	.58457141+02	.39590232+04	.21462801+03
32	.18451491+02	.58406303+02	.40498815+04	.21948803+03
33	.18359131+02	.57782649+02	.41175032+04	.22427548+03
34	.18340326+02	.57927017+02	.42033909+04	.22918844+03
35	.18319245+02	.57801078+02	.42871311+04	.23402334+03
36	.18265174+02	.57505442+02	.43621649+04	.23882415+03
37	.18223464+02	.57403447+02	.44422830+04	.24376721+03
38	.18184760+02	.57263032+02	.45206887+04	.24859764+03
39	.18039657+02	.56485467+02	.45716635+04	.25342297+03
40	.17966474+02	.56480880+02	.46404179+04	.25828205+03

GROUP	PHI(0,0) TERM	PHI(1,1) TERM	PHI(2,0) TERM	AGE
41	.17875072+02	.56117162+02	.47035641+04	.26313540+03
42	.17633480+02	.54894958+02	.47235544+04	.26787419+03
43	.17438053+02	.54467701+02	.47558513+04	.27272834+03
44	.17175771+02	.53412528+02	.47650663+04	.27742953+03
45	.17121118+02	.53892884+02	.48338825+04	.28233450+03
46	.16714856+02	.51517529+02	.47971951+04	.28760187+03
47	.16639249+02	.52326380+02	.48572487+04	.29191513+03
48	.16248585+02	.50122434+02	.48188298+04	.29656918+03
49	.15994380+02	.49765233+02	.48201995+04	.30136833+03
50	.15874529+02	.49773821+02	.48607310+04	.30619686+03
51	.15870430+02	.50041662+02	.49374258+04	.31110851+03
52	.15005356+02	.44848312+02	.47343697+04	.31551198+03
53	.14127334+02	.42182207+02	.45185616+04	.31984532+03
54	.14139834+02	.44861890+02	.45926033+04	.32479694+03
55	.14047205+02	.44070609+02	.46310703+04	.32967914+03
56	.13958047+02	.43740512+02	.46692531+04	.33452051+03
57	.13910914+02	.43748873+02	.47215666+04	.33941454+03
58	.13837666+02	.43431380+02	.47641815+04	.34429084+03
59	.13815603+02	.43515969+02	.48245354+04	.34920918+03
60	.13767407+02	.43280483+02	.48749258+04	.35409179+03
61	.13745052+02	.43290238+02	.49346131+04	.35901014+03
62	.13715821+02	.43172948+02	.49918570+04	.36394883+03
63	.13693298+02	.43120967+02	.50501060+04	.36880130+03
64	.13636095+02	.42842094+02	.50968514+04	.37377647+03
65	.13545896+02	.42453257+02	.51285637+04	.37860647+03
66	.13461491+02	.42215183+02	.51624295+04	.38349613+03
67	.13366344+02	.41884355+02	.51910535+04	.38836747+03
68	.13248257+02	.41442022+02	.52091805+04	.39319742+03

THE FOLLOWING DATA HAS BEEN AVERAGED TO PROVIDE DATA FOR 1 FAST GROUP
 OVER THE ENERGY RANGE FROM 10 MEV. TO .68256032-00E.V.

DIFFUSION COEFFICIENT	=	.12963728+01
SIGMA TRANSPORT	=	.25712768-00
SIGMA ABSORPTION	=	.10893856-02
SIGMA CAPTURE	=	.93516281-03
SIGMA FISSION	=	.15422282-03
NU-SIGMA FISSION	=	.37539443-03
AVERAGE NU	=	.24341042+01
P(0)-TRANSFER	=	.25780454-02
P(1)-TRANSFER	=	-.22856055-02
INELASTIC TRANSFER	=	.17428492-05
N-2N TRANSFER	=	.00000000
TOTAL SIGMA REMOVAL	=	.36691738-02
TOTAL SIGMA OUT	=	.25797882-02
IN-GROUP TRANSFERS	=	.29875432-00

BROAD GROUP MACROSCOPIC AVERAGED CROSS-SECTIONS

GROUP	DIFF. COEF.	SIGMA TRANSPORT	FISSION SOURCE	SIGMA REMOVAL	SIGMA OUT
1	.29831571+01	.11173844+00	.57308519-00	.27144663-01	.27068042-01
2	.12838424+01	.25963726-00	.42690913-00	.83042464-02	.81996159-02
3	.10431230+01	.31955323-00	.00000000	.74102104-02	.52831464-02

BROAD GROUP MACROSCOPIC AVERAGED CROSS-SECTIONS

GROUP	SIGMA ABSORPTION	SIGMA CAPTURE	SIGMA FISSION	NU-SIGMA FISSION	AVERAGE NU
1	.76621135-04	.60319608-04	.16301527-04	.44938190-04	.27566858+01
2	.10463056-03	.76373152-04	.28257409-04	.69183774-04	.24483409+01
3	.21270640-02	.18387935-02	.28827056-03	.70049720-03	.24299990+01

BUCKLING AND K INFINITE

FAST GROUP PARAMETERS

ETA TIMES F	ESC TO THEM PROB	DEL U238	DEL TH232	AGE
.34459-00	.70310-00	.33301-04	.38238-02	.29386+03

THERMAL GROUP PARAMETERS • MATERIAL BUCKLING , AND K-INFINITE

ETA TIMES F	DIF LENGTH**2	K-INFINITE	BUCKLING
.14885+01	.13711+03	.11489+01	.34550-03

BROAD GROUP MACROSCOPIC AVERAGED CROSS-SECTIONS

GROUP		P(0) TRANSFER	P(1) TRANSFER	INELASTIC TRANSFER	N-2N TRANSFER	TOTAL TRANSFER
FROM 1 TO 1	1	.10503867+00	.53815287-01	.51438508-03	.27205207-07	.10555311+00
FROM 1 TO 2	2	.25602138-01	-.19078711-01	.14548369-02	.52277589-07	.27057080-01
FROM 1 TO 3	3	.00000000	.00000000	.51271366-05	.11579270-11	.51271389-05
FROM 1 TO 4	4	.00000000	.00000000	.58353154-05	.00000000	.58353154-05
FROM 2 TO 2	2	.28426869-00	.69326001-01	.14963364-03	.00000000	.28441832-00
FROM 2 TO 3	3	.80779073-02	-.71559554-02	.11873187-03	.00000000	.81966392-02
FROM 2 TO 4	4	.00000000	.00000000	.29767565-05	.00000000	.29767565-05
FROM 3 TO 3	3	.33027915-00	.60475314-01	.00000000	.00000000	.33027915-00
FROM 3 TO 4	4	.52831464-02	-.46838543-02	.00000000	.00000000	.52831464-02

CROSS SECTION DATA FOR HFN CODE

GEOMETRY = S A = .00000 E = .00000 EXTRAPOLATION CONST. = .00000

0 5	13881	.29332+01	.00000	.27145-01	.44938-04	.57309-00	1
0 5	13886	.12836+01	.00000	.83042-02	.69184-04	.42691-00	2
0 5	13895	.10431+01	.00000	.74102-02	.70050-03	.00000	3
0 5	13902	.99244+00	.00000	.72383-02	.10774-01		4
0 5	13904	.00000	.27057-01	.00000	.51271-05	.81966-02	3- 3
0 4	13915	.56353-05	.29768-05	.52831-02	.00000	.00000	3- 4

CROSS SECTION DATA FOR DTF CODE

G= 04 L=07 NUCLIDE NO.00001		ISO GAMTFC	
.70621-04	.44938-04	.13270-00	.10555+00
.00000	.10463-03	.09184-04	.29272-00
.00000	.00000	.21271-02	.70050-03
.81966-02	.51271-05	.00000	.72383-02
.32670-00	.52831-02	.29768-05	.58353-05

G= 04 L=07 NUCLIDE NO.00002		ANISO	
-.11575-01	.00000	.17938-01	.00000
.00000	-.20723-01	.00000	.23109-01
.00000	.00000	-.18597-01	.00000
-.23653-02	.00000	.00000	-.00000
.00000	-.15613-02	.00000	.00000

INTERMEDIATE INTEGRALS

WEIGHTING FACTORS USED FOR EACH BROAD GROUP

GROUP	ALPHA(FLUX)	BETA(CURRENT TERM)	GAMMA(LEAKAGE*FLUX)	AVE NEUTRON VELOCITY(M/SEC)
1	.29879171-00	.89134260-10	-.29879170-10	.20698003+08
2	.17010921+01	.21839342-09	-.17010920-09	.26868813+07
3	.19059511+01	.19881414-09	-.19059510-09	.55026431+05

AVERAGE NEUTRON VELOCITY FOR ONE FAST GROUP = .11069530+06 METERS/SEC

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