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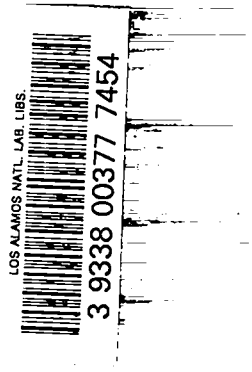

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ABSTRACT

The LAPH code retrieves photon production cross sections or photon production multiplicities and corresponding neutron interaction cross sections from ENDF/B (Evaluated Nuclear Data File/B). It then applies suitable weighting functions over G specified photon groups and N specified neutron broad groups to construct a G x N photon production matrix. Pointwise cross sections are first integrated over each photon energy group with constant or direct energy weighting, and then over each neutron fine group with constant weighting. Within each neutron broad group, arbitrary fine-group weighting functions are read from input. Resonance fine-group interaction cross sections and weighting functions are also read as input; at the Los Alamos Scientific Laboratory (LASL), these cross sections and weights are produced directly by a modification of the MC^2 code. Macroscopic photon production and photon energy production matrices are then computed. As an option, spatially dependent photon source vectors for transport calculations can be generated by using input scalar neutron flux vectors. Multiple zones can be accommodated with separate weighting functions for each zone. Different materials and reaction types for which photon production matrices are desired can be specified for each zone. Input is in DTF-IV format, and output photon source vectors are also in this format. A sample problem is included along with an indexed listing of the code. The code is written in FORTRAN IV for a CDC-6600 computer with a $65k_{10}$ memory.

I. INTRODUCTION AND SUMMARY

A national neutron data file now exists at the National Neutron Cross Section Center, Brookhaven National Laboratory, in a single format.[1,2] The file, called the Evaluated Nuclear Data File/B (ENDF/B), contains primarily neutron interaction cross sections, angular distributions, secondary energy distributions, thermal scattering laws, and other data of interest in reactor core neutronics analysis. Recently, however, with the expansion of the ENDF/B format to provide for photon production and photon interaction data,[2] the file is becoming increasingly important and useful in shield analysis and design. Included in the shielding interests are weapons and civil defense problems, as well as reactor shielding.

The ENDF/B data file is of real significance only when considered as part of what will be called the "ENDF/B system," which consists of not only the data file but also the data retrieval, checking, and processing codes. For neutron interaction data (ENDF/B Files 2 through 7), such codes are presently available in varying degrees of development, and the data are actually being extracted for use in neutronics calculations, such as transport, thermalization, and fast spectra problems. The photon files (14 through 16 and 23 through 27), however, are in their infancy with evaluated photon production data for only six materials[3,4] (sodium, magnesium, silicon, chlorine, potassium, and calcium) presently available in the ENDF/B format, and even these data have not been through a complete data testing procedure. Because of this, the publicly

released ENDF/B data file of 1969 contained no photon production data. One obvious requirement for checking the photon data in an integral manner, as well as a clear incentive for evaluators to place these data in the file, is to have a code to retrieve the data in a usable form for multigroup photon transport calculations. These are two motivations for the LAPH code.

Throughout this report, it is assumed that the reader is familiar with the ENDF/B system, since LAPH operates only within that system. Detailed descriptions of the data formats are given in the references cited above, and a review of the storage and retrieval of photon data in the ENDF/B system has been presented elsewhere.[5] Pertinent format information will be reviewed here as required, however.

Briefly, the LAPH code retrieves photon production cross sections or multiplicities and corresponding neutron interaction cross sections from the ENDF/B data file, applies suitable weighting functions over N specified neutron groups and G specified photon groups, and constructs a G x N photon production matrix. As an option, it operates on this matrix with flux vectors from a neutronics code, as well as with scalar multipliers such as atom number densities and effective photon group energies, to directly provide spatially dependent photon source terms for transport calculations. Figure 1 presents a schematic description of the code, where the input data are left of the dotted line. This schematic diagram is not intended to present the detailed logic of the code, which is given in Appendices A and B.

II. THEORY

A. Photon Production Data Format in ENDF/B

To understand the process of computing photon production matrices and photon source functions from the ENDF/B data file (the process is loosely called "theory"), it is helpful to review the form in which the data are received into LAPH; i.e., the form in which they are stored in the ENDF/B data file. Photon multiplicities are entered into ENDF/B File 15 in one of two options,[2] either directly in a manner analogous to File 5 or as transition probability arrays.

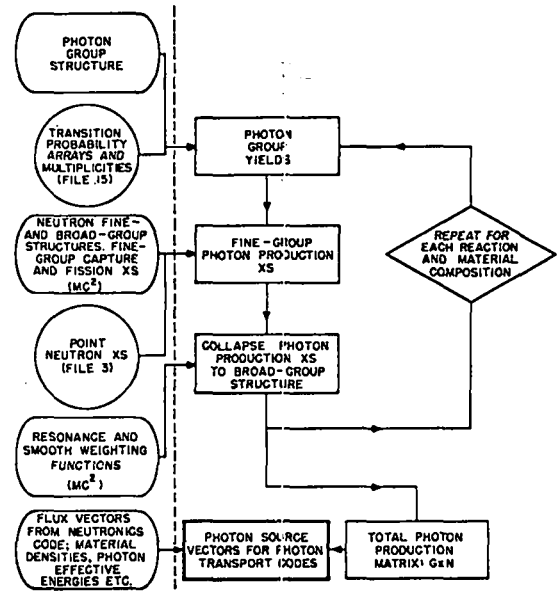

Fig. 1. LAPH code schematic.

Under Option 1 of File 15, the multiplicities are given by a normalized photon energy distribution and an associated total photon yield (units of photons) for an interaction. Normalized photon energy distributions are given according to allowable laws, of which two are presently instituted: viz., (Law 1) a tabulated probability density function vs photon energy, or (Law 2) a Dirac delta function in photon energy. In addition, the tabulated function (Law 1) is a function of incident neutron energy; hence, a two-dimensional table is used for tabulated probability functions. For either law, the yields are tabulated functions of incident neutron energy. New laws may be added later when deemed necessary; e.g., a normalized prompt fission-gamma spectrum may be useful.

For Option 2, a level is identified by a level sequence number and level energy. The only additional data (other than a few control parameters) needed to specify the photon energies and yields are (1) the nonzero transition probabilities to lower levels, (2) the gamma transition conditional probabilities if nonunity, and (3) the energies of the lower levels. These data are entered as doublets or triplets for each transition, depending

upon whether or not the conditional probabilities are unity. Thus, processes such as internal conversion can be accounted for very simply. Also, data listed for any level include only those for photons originating at the level. Further cascading is determined from the data for lower levels, so only the minimum required data are stored in the ENDF/B system. The LAPH code reconstructs the cascade.

An important limitation of the transition probability arrays is that they cannot be used to accurately predict photon production by neutrons at energies appreciably above that of the highest level for which the gamma decay scheme is well known. The reason for this is that, at higher energies, levels above the one for which the decay scheme is well known may be excited and cascade through lower levels. Thus, at these higher energies, the photon production must be accounted for under Option 1. In fact, LAPH will not use the transition probability arrays to calculate photon production at neutron (center of mass) energies above the highest level in the arrays; i.e., if ES_{max} is the highest level energy for which a transition probability array is given, no photon production will be calculated from the arrays for incident-neutron energies above $ES_{max} \times \frac{AWR + 1}{AWR}$, where AWR is the atomic weight ratio.

In ENDF/B data files[4] for sodium, magnesium, chlorine, potassium, and calcium (used for debugging purposes), the photon production at these higher energies was placed in a photon production reaction which was assigned MT = 110. A unit cross section was placed in File 3 for MT = 110, and the photon production cross sections (in barns) to produce a discrete photon of a given energy were placed in the yield table of File 15, Option 1, LF = 2.

The units for data stored in the ENDF/B file are:

Quantity	Units
energy	eV
angle	dimensionless cosine
cross section	barns
photon yields	photons

B. Photon Yields and Photon Production Cross Sections

Photon yields are either given directly as a function of neutron energy in Option 1 of File 15 or must be constructed by processing codes (including LAPH) from the transition probability arrays of Option 2. The construction process for a microscopic photon production cross section in the latter case is discussed in Appendix B of Ref. 2 (the general equation on p. 51 of Ref. 2 should have the variable TP substituted for A in all of the summations). For completeness, the discussion will be reviewed. Define

1. $\sigma_{j,i}(E)$ = cross section to produce the photon which arises from decay of level j to i, with incident-neutron energy E.
2. $\sigma_k(E)$ = neutron cross section for inelastic scattering to level k, for incident-neutron energy E.
3. $TP_{j,i}$ = probability of a direct transition from level j to level i, i < j.
4. $GP_{j,i}$ = conditional probability of photon emission in a direct transition from level j to level i, i < j.
5. $A_{j,i} = (TP_{j,i})(GP_{j,i})$.
6. ES_i = energy of level i.

Note that the photon production cross section is given for transition between specific levels, which implicitly determines the photon energy, rather than for a given photon energy. This scheme avoids ambiguity when two different transitions produce photons of the same energy. The photon energy is simply $E_\gamma = ES_j - ES_i$.

For the general case, all possible transitions must be considered, as well as the possibility of transitions not involving gamma-ray emission. Accounting for all possibilities leads to the expression given in Ref. 2, p. 51, viz.,

$$\sigma_{j,i}(E) = A_{j,i} \sum_{m_o=j}^{N} \sigma_{m_o} \overbrace{\left| \right|}^{n+1}_{\ell=1} \sum_{m_\ell=j}^{m_{\ell-1}-1} TP_{m_{\ell-1},m_\ell} , \quad (1)$$

where N = highest level such that $ES_N \leq E \frac{AWR}{AWR + 1}$. The requirement that $m_n \leq j + 1$ determines the range of the index n, and $(m_{\ell-1} - 1) > j$ is implicit.

This pointwise photon production cross section can then be written in the notation of Ref. 2 as $\sigma(E_\gamma \leftarrow E)$ for discrete photon energy $E_\gamma = ES_j - ES_i$. Recall that this construction scheme using Option 2 of File 15 does not apply at incident neutron energies $E > ES_{max} \times \frac{AWR + 1}{AWR}$. The energy ES_{max} is found by searching for the largest MT number in the set $\{5 \leq MT \leq 14 \text{ or } 51 \leq MT \leq 80\}$, and reading ES for that MT value.

Under Option 1 of File 15, the photon yield functions are first constructed from the tabulated yield at incident-neutron energy E, and a normalized photon energy distribution (which may be delta function in E_γ). These two components can be given for different photon distribution laws as subsections of one reaction type (MT number). Specifically, if $y_k(E)$ is the yield from subsection k, and $f_k(E_\gamma \leftarrow E)$ is the corresponding normalized photon energy distribution, the yield function is given by

$$y(E_\gamma \leftarrow E) = \sum_{k=1}^{NK} y_k(E)\ f_k(E_\gamma \leftarrow E) \qquad (2)$$

(photons/eV).

The $y_k(E)$ have units of photons, and the $f_k(E_\gamma \leftarrow E)$ have units of eV^{-1}. Having the yield function, the pointwise differential photon production cross section is determined as

$$\frac{d\sigma(E_\gamma \leftarrow E)}{dE_\gamma} = \sigma(E)\ y(E_\gamma \leftarrow E) \qquad (3)$$

(b-photons/eV),

where $\sigma(E)$ is the interaction cross section for the appropriate reaction type from Files 2 and 3.

Once the differential photon production cross sections are determined, they are integrated over arbitrary neutron and photon energy groups, with selected appropriate weighting functions, to determine a photon production cross-section matrix. In the discussion below, the subscripts and superscripts are defined as follows:

g = photon energy group, g = 1,2,...,G

ℓ = neutron fine group, ℓ = 1,2,...,L

n = neutron broad group, n = 1,2,...,N

k = partial yield index, k = 1,2,...,NK

p = reaction type (MT number)

i = material number

j = zone number, j = 1,2,...,IZM

m = spatial mesh interval, m = 1,2,...,IM

r = resolved resonance component

s = unresolved-resonance and smooth components.

The lower energy limit of a group is denoted by E_g, E_ℓ, or E_n. The indices i and j will be suppressed for a while to avoid too clumsy a notation, but they are implicit.

Two weighting options, called tracks, are available to compute the photon yield in a group, g, as follows:

Track 1 is a constant weighting, i.e.,

$$Y_g^p(E) = \int_{E_g}^{E_{g+1}} dE_\gamma\ Y^p(E_\gamma \leftarrow E) \qquad (4)$$

(photons),

where $Y^p(E_\gamma \leftarrow E)$ may be a Dirac delta function. On this track, the photon group energy yield, $\tilde{Y}_g^p(E)$, is computed by using an arbitrary group effective energy, $\bar{E}_g$, which is an input quantity. However, the code still calculates the energy-weighted yield on Track 2 and provides the user with a listing of the average (yield-weighted) energy, $\hat{E}_g^p$, in each group. In effect, on Track 1, the photon energy yield is

$$\tilde{Y}_g^p(E) = Y_g^p(E)\ \bar{E}_g \qquad (eV). \qquad (5)$$

If a value of $\bar{E}_g$ is not in the interval $[E_g, E_{g+1}]$, the code will assume the median group energy, $\bar{E}_g = \frac{1}{2}(E_g + E_{g+1})$, and proceed with this calculated value vice the input value.

Track 2 is an energy-weighted yield, i.e.,

$$\tilde{Y}_g^p(E) = \int_{E_g}^{E_{g+1}} dE_\gamma\ Y^p(E_\gamma \leftarrow E)\ E_\gamma \qquad (eV), \quad (6)$$

and

$$Y_g^p(E) = 2\left[\tilde{Y}_g^p(E)\right]\left[E_{g+1} + E_g\right]^{-1} \qquad (7)$$

(photons).

The calculation in Eq. 6 is also performed on Track 1, where the average energy in each group is computed by

$$\hat{E}_g^p = \frac{\int_{E_g}^{E_{g+1}} dE_\gamma \, Y^p(E_\gamma \leftarrow E) \, E_\gamma}{\int_{E_g}^{E_{g+1}} dE_\gamma \, Y^p(E_\gamma \leftarrow E)} \quad \text{(eV)}. \quad (8)$$

The photon energy group structure is arbitrary, and is specified by an input energy mesh, starting at the highest energy. Likewise, the neutron energy group structures are arbitrary, except that the fine-group energy mesh points must have the broad-group mesh points as a subset. In practice, the neutron group structures are usually the corresponding structures in a spectrum-averaging code such as MC^2. In fact, a version of the MC^2 code[6] has been modified to output pertinent portions of the LAPH input. The photon energy mesh for the integrations on Tracks 1 and 2 is the overlay of the photon group energy mesh and the E_γ mesh for the $f_k(E_\gamma \leftarrow E)$ in File 15. The simple trapezoidal rule is used for the integration. The $Y_g^p(E)$ are evaluated at every tabulated neutron energy in File 15.

There is one approximation inherent in using data for a continuous photon spectrum. For any incident-neutron energy E, between two neutron energies E_1 and E_2 at which photon energy distributions are tabulated, there may be a component of the photon distribution up to energy $E_2 + Q$. Here, Q has its usual meaning--the reaction energy. Thus, photons can be constructed at energies greater than E + Q (the theoretical maximum) from this interpolated energy distribution. This problem occurs for any interpolation scheme between incident-neutron energies, and minimizing the induced error depends upon the evaluator having entered the data in the ENDF/B file with a fine enough incident-neutron energy mesh. (The same problem occurs for secondary neutron distributions in ENDF/B File 5.)

Having averaged the yields over each photon group, the averaging over each neutron fine group proceeds along one of two tracks. The track used is determined by a combination of the reaction type (MT) number and by an input option. Briefly, for fission and capture (MT = 18 and = 102), respectively, the cross-section averaging over a neutron fine group may be performed in the resonance region by a spectrum-averaging code, or the resonance parameters may be ignored (or be nonexistent) and all cross-section averaging will be done internally by LAPH.

Track A, which is always used except possibly for fission and capture, uses a constant weighting over a neutron fine group to calculate the photon production cross section, $\tau_{g,\ell}^p$, as follows:

$$\tau_{g,\ell}^p = (\Delta E_\ell)^{-1} \int_{E_\ell}^{E_{\ell+1}} dE \, \sigma^p(E) \, Y_g^p(E) \quad \text{(b-photons)}, \quad (9)$$

where $\Delta E_\ell = E_{\ell+1} - E_\ell$, and $\sigma^p(E)$ is the neutron interaction cross section for reaction type p (from ENDF/B File 3). The photon energy production cross section is, similarly,

$$\tilde{\tau}_{g,\ell}^p = (\Delta E_\ell)^{-1} \int_{E_\ell}^{E_{\ell+1}} dE \, \sigma^p(E) \, \bar{Y}_g^p(E) \quad \text{(b-eV)}. \quad (10)$$

Track B, which is used only for fission and capture and only then if this track is chosen by the input option, uses input values of the cross section averaged over the neutron fine group, as follows:

$$\rho_{g,\ell}^{p,r} = (\Delta E_\ell)^{-1} \, \overline{\sigma}_\ell^{p,r} \int_{E_\ell}^{E_{\ell+1}} dE \, Y_g^p(E)$$

$$\rho_{g,\ell}^{p,s} = (\Delta E_\ell)^{-1} \, \overline{\sigma}_\ell^{p,s} \int_{E_\ell}^{E_{\ell+1}} dE \, Y_g^p(E) \quad \text{(b-photons)}, \quad (11)$$

where p = 18 or = 102. Here $\overline{\sigma}_\ell^p$ is the cross section averaged over group ℓ by a spectrum-averaging code, while $\rho_{g,\ell}^p$ denotes the photon production cross section (resonance, or smooth plus unresolved resonance). Similarly,

$$\tilde{\rho}_{g,\ell}^{p,r} = (\Delta E_\ell)^{-1} \, \overline{\sigma}_\ell^{p,r} \int_{E_\ell}^{E_{\ell+1}} dE \, \bar{Y}_g^p(E)$$

$$\tilde{\rho}_{g,\ell}^{p,s} = (\Delta E_\ell)^{-1} \, \overline{\sigma}_\ell^{p,s} \int_{E_\ell}^{E_{\ell+1}} dE \, \bar{Y}_g^p(E) \quad \text{(b-eV)}. \quad (12)$$

This track normally would not be used, for example, if resonance data were not given in ENDF/B File 2 for the materials considered. If it is used, it must be used over the entire neutron energy range, i.e., both tracks cannot be used for a given reaction. Also, the same track must be used for both fission and capture.

The above integrations on Tracks A and B are performed by the trapezoidal rule, using a mesh determined by the overlay of the fine-group energy mesh and the cross-section mesh in File 3.

Having computed the photon production cross-section elements for the neutron fine-group structure, it remains to find a weighted average over the broad groups. These broad groups would normally correspond to the groups used in a neutron transport calculation from which the fluxes are obtained for use in determining the photon source. Weighting of the fine-group photon production cross sections is done with arbitrary sets of input weights, one set for the smooth cross sections and one for the resonance cross sections. The latter set, of course, is used only if Track B is chosen. In practice, the smooth cross-section weights are usually the fine-group fluxes from an infinite medium (zero-dimensional), one-dimensional, or other appropriate spectrum. Also, the resonance weights are usually those from the same spectrum-averaging code. At LASL, both sets of weights are output by the modified MC^2 code referred to above. Denoting the smooth weights by w_ℓ^s and the resonance weights by w_ℓ^r, the elements of the G x N microscopic photon production matrix for reaction type p are

$$\sigma^p_{g,n} = \left[\sum_{\ell\in n} \tau^p_{g,\ell}\, w^s_\ell\right]\left[\sum_{\ell\in n} w^s_\ell\right]^{-1} + \left[\sum_{\ell\in n} \sigma^{p,r}_{g,\ell}\, w^r_\ell\right]\left[\sum_{\ell\in n} w^r_\ell\right]^{-1} + \left[\sum_{\ell\in n} \sigma^{p,s}_{g,\ell}\, w^s_\ell\right]\left[\sum_{\ell\in n} w^s_\ell\right]^{-1}, \qquad (13)$$

and analogous elements $\tilde{\sigma}^p_{g,n}$ for the energy production matrix. In the calculation of $\sigma^p_{g,n}$, the code actually performs the calculation differently from the direct way shown in Eq. (13) by normalizing the weights ahead of time.

Though it is not explicitly indicated in the notation, these cross sections are determined by LAPH for materials in all the specified spatial zones of the problem. Options are available, however, to specify for each zone those materials for which photon production cross sections are desired and for each material to specify which reaction types are to be included in the calculation of the photon production cross sections. A problem arises for materials for which data are given for both total inelastic scattering (MT = 4) and for the individual levels and continuum (MT = 5 through 15, and 51 through 80). If the specific reaction types to be used by LAPH are explicitly given as input, there is no problem. However, under the flag MT = -1 (see discussion of input in Sec. III), which loosely means use all MT numbers for which photon production data are given in File 15, the code must make a decision concerning inelastic scattering. If photon production data are given in File 15 for MT = 4, it chooses to use these data only if data are not given for any MT in $\{5 \le MT \le 15 \text{ or } 51 \le MT \le 80\}$. Thus, when data are given for one or more of the individual levels and the user prefers to use the data in MT = 4, he must explicitly list the MT numbers desired. The flag MT = 0 means to ignore photon production from this material, and the material need not appear on the input ENDF/B data tape.

Given the set of reaction types, {MT}, for which photon production cross sections are desired, the total microscopic photon production cross-section matrix of material i is given by

$$\left[\sigma_{g,n}\right]_i = \left[\sum_{p\in\{MT\}} \sigma^p_{g,n}\right]_i \equiv \sum_{p\in\{MT\}} \left[\sigma_{g,n}\right]_{i,p} \qquad \text{(b-photons)}, \qquad (14)$$

where the subscript i, which has always been implicit in $\sigma^p_{g,n}$, is no longer suppressed. The energy production matrix $[\tilde{\sigma}_{g,n}]_i$ has an analogous definition. When either matrix is used below, the subscripts g and n will be suppressed unless desired for clarity.

In photon source calculations, the quantity usually of more interest than the microscopic photon production matrix, $[\sigma]_i$, is the macroscopic matrix given by

$$[\Sigma]_{i,j} = A_{i,j}[\sigma]_i \qquad \text{(photons/cm)}, \qquad (15)$$

where the scalar $A_{i,j}$ is the number density of the ith material in the jth region (units of b^{-1}-cm^{-1}). In all the following discussions, it is implicit that an exactly analogous development applies to the energy production matrix.

C. Spatially Dependent Photon Sources

To determine a spatially dependent photon source from the macroscopic photon production matrix, an appropriate flux vector must be known. Denoting this N-dimensional (column) vector by $[\phi(\vec{r})]_N$, where $\vec{r}$ symbolizes the spatial dependence, the photon source vector is given by

$$[\hat{S}(\vec{r})]_G = [\Sigma]_{GxN}[\phi(\vec{r})]_N \qquad (16)$$

$$\text{(photons/cm}^3\text{-sec)}.$$

In practice, the multigroup flux vectors $[\phi(\vec{r})]$ are calculated at discrete mesh intervals, Δr_m, and usually in one dimension (e.g., by the DTF-IV code[7]). Also, the fluxes are usually calculated for an arbitrarily normalized neutron source term, so the eigenfunctions generally require a renormalization factor, C, to account for the actual reactor power. The source is then given by

$$[S]_{i,m,p} = C[\Sigma]_{i,m,p}[\phi]_m , \qquad (17)$$

where j is implicitly determined by m. For most applications, the source vector of interest for a photon transport calculation is

$$[S]_m = C\left[\sum_i \sum_p \Sigma_{i,m,p}\right]\left[\phi\right]_m \qquad (18)$$

$$\text{(photons/cm}^3\text{-sec)},$$

and its energy production analog $[\tilde{S}]_m$ (eV/cm^3-sec). These source terms are listed under some output options by photon group at each mesh interval. Also, as an option, they may be output in formats suitable for the DTF-IV (photon transport) code.

III. INPUT INSTRUCTIONS

A. Background

Input to LAPH is generally in the DTF-IV format system, with the exception of the title and parameter cards at the beginning of the data. The DTF-IV system consists of a basic 12-column field, but the first three columns are reserved for a control flag, and the remaining nine columns are a data field. There are seven possible controls in the first column of the three-column subfield as follows:

0 or blank = normal input; the nine columns for data are read in normal FORTRAN E, F, or I format.

1 = repeat; the number in the data field is repeated the number of times specified by the integer NN in the second and third columns of the control field.

2 = interpolate; the number of interpolates, NN, specified in the second and third columns of the control field are placed between the number in the data field and the number in the succeeding data field.

3 = terminate; ends the data block--each data block must have this flag at the end.

4 = fill remainder of data block with the number in the data field.

5 = repeat the number in the data field 10*NN times.

9 = skip to next card.

Whether the data in the data field is integer or real is indicated by the first letter of the block name in the usual FORTRAN tradition.

A problem regarding terminology arises for LAPH when using DTF-IV input along with ENDF/B input, because the term material has a different meaning in each case. No completely satisfactory resolution was found, but by sacrificing purity for consistency, the term material in DTF-IV has been replaced by the term nuclide, which is consistent with the usage in MC[2], another code which is linked to LAPH. Also departing from DTF usage, "nuclide" does not include a mixture of nuclides. In LAPH, the term material is used strictly in the sense of a MAT in the ENDF/B system.

Units for input should be as follows:

Energy:	eV
Number density:	atoms/b-cm
Flux:	n/cm^2-sec
Length:	cm

The code has many error triggers which will lead to a call to the subroutine ERROR. The type of error encountered will be identified on the output listing by an error number. A brief description of this error can then be found in the comment card in ERROR for the corresponding error number (cf. listing in Appendix B).

B. Input Data Format

Data blocks are given in Table I in order of input, preceded by the corresponding variable name in LAPH. For the parameter table, the location (order) of the parameter is given first.

C. Array Size Restrictions

To keep the code operable on computers with small-size memories, restrictions must be placed on array sizes. The restrictions are presently as follows:

$$\begin{aligned} NFG &\leq 99 \\ NBG &\leq 99 \\ NGG &\leq 49 \\ IZM &\leq 10 \\ IM &\leq 100 \\ MS &\leq 50 \end{aligned}$$

D. Computer Requirements and Running Times

The LAPH code is presently operational on a CDC 6600 which has $65k_{10}$ memory and uses the full core. It requires no special hardware or software but does use a disk and one magnetic tape, viz., Tape 20 which is the ENDF/B data tape in Mode 3 (BCD card-image format in standard arrangement). The central processor time required for a problem with three regions, six materials, 10 mesh points, 26 neutron groups, and 11 photon groups, including calculation of both photon production matrices and photon source vectors (cf. the sample problem, Sec. III.E) was 3.5 min. All coding is in FORTRAN IV and should be compatible with FORTRAN compilers on other computers.

E. Sample Problem Input and Output

A sample problem for an infinite-slab physically unreal shield configuration is included for illustrative purposes. (The problem choice is restricted by the available ENDF/B data.) The shield

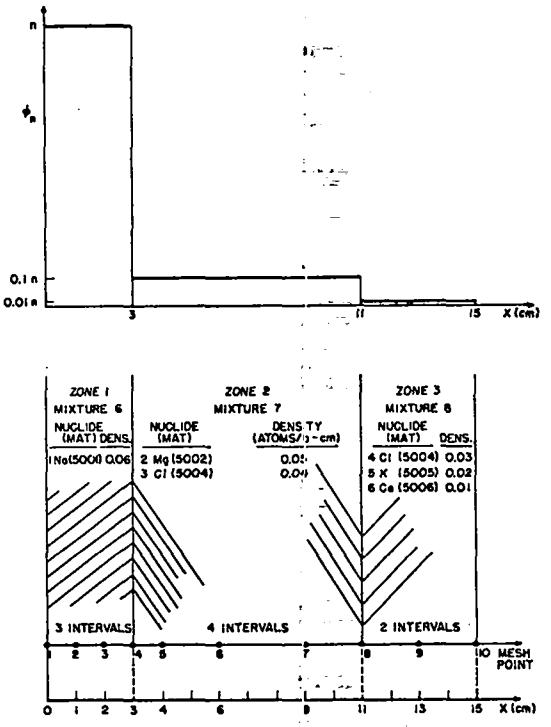

Fig. 2. Sample problem diagram.

configuration and composition are given in Fig. 2, and the corresponding input data are shown in Table II. Photon production from selected reactions was chosen as follows:

	Nuclide	MAT No.	MT Nos.
1	Na	5001	110
2	Mg	5002	102
3	Cl	5004	5→14 and 51→53
4	Cl	5004	0 (no reactions)
5	K	5005	-1 (all reactions)
6	Ca	5006	15

In the input for EG(10), there is a deliberate error giving the average gamma energy in the tenth group as 0.07 MeV instead of 0.7 MeV. In this case, the code will replace the value with the group median energy and proceed. This error is flagged in the sample output shown in Table III. Headings for the data blocks on the output listing are self-explanatory. A listing of the complete data deck for the sample problem is shown in Table II.

TABLE I

INPUT DATA FORMAT

A. Title Card (I6,11A6): Any integer for problem identification, and any BCD information for identification of output.

B. Integer Parameters (12I6):

Location	Name	Definition
1	NGG	Number of gamma groups.
2	NFG	Number of neutron fine groups.
3	NBG	Number of neutron broad groups.
4	IZM	Number of zones.
5	IM	Number of intervals.
6	MS	Number of mixture specifications (= length of mix tables).
7	MCR	Number of nuclides for which distinct fine-group cross sections and weighting functions are input.
8	MM	Number of reaction types, MT (= length of MT table).
9	NPM	Total number of nuclides plus mixtures.
10	IRES	Special resonance weighting option to be used? (0/1 = no/yes; 0 = Track A, 1 = Track B.)
11	IWØ	= 0, photon effective average energy for each group is input (Track 1).
		= 1, photon energy weighting function is yield function (Track 2).
12	IØØ	= 0, print $[\sigma_{g,n}]_{i,j}$ for each material i and zone j, and $\sum_i A_{i,j}[\sigma_{g,n}]_{i,j}$, the macroscopic matrices for each zone j.
		= 1, print all of Option 0 plus the source vector, $C \sum_i A_{i,j}[\sigma_{g,n}]_{i,j}\,[\phi]_m$, at each spatial point m. Note that m determines j.
		= 2, print all of Option 1 and punch the DTF-IV input source cards (cf. discussion of DTF-IV option).
		= 3, print only the matrix $\sum_i A_{i,j}[\sigma_{g,n}]_{i,j}$ for each zone j, along with the source vector $C \sum_i A_{i,j}[\sigma_{g,n}]_{i,j}\,[\phi]_m$.
		= 4, print all of Option 3 and punch the DTF input source cards.
		= 10, same as IØØ = 0, substituting the energy production matrices $[\tilde{\sigma}_{g,n}]_{i,j}$, etc.
		= 11, " " = 1, " " " "
		= 12, " " = 2, " " " "
		= 13, " " = 3, " " " "
		= 14, " " = 4, " " " "
		= 20, do both Options 0 and 10 (i.e., print both photon production and photon energy production matrices).
		= 21, do both Options 1 and 11.
		= 22, " " " 2 and 12.
		= 23, " " " 3 and 13.
		= 24, " " " 4 and 14.

[Note: The 2X series of output options requires an insignificant addition to the central processor time compared to the X or 1X series.]

TABLE I (continued)

C. Data Blocks (DTF-IV system): Dimension of variable is given if it is predetermined.

Name and Dimension	Definition
C(1)	Renormalization constant for $[\phi]$.
NMAT(IZM)	Number of materials in each zone for which photon production cross sections are desired.
NNM(2*MCR)	Nuclide sequence numbers (for mix table) and corresponding material (MAT) numbers, in successive pairs.
MZT(MCR)	For each MAT number in the NNM block, MZT is the number of values of MT to be entered in the next (MTN) block.
MTN(MM)	MT numbers for each MAT number given in the NNM block. MT = -1 means use all MT numbers for which photon production data exist in File 15, except possibly MT = 4 (cf. Sec. II.B). MT = 0 means calculate no photon production for this material.

If, and only if, IWØ = 0, the following data block appears:

EG(NGG)	Effective average energy, $\overline{E}_g$, for each gamma group. [Same for all materials and reaction types. Code checks that $E_g \leq \overline{E}_g \leq E_{g+1}$.]
EMG(NGG+1)	Gamma group energy mesh, in decreasing magnitude of energy.

The following eight data blocks will normally be punched by MC^2.

EMNF(NFG+1)	Neutron fine-group energy mesh, in decreasing magnitude of energy.
EMNB(NBG+1)	Neutron broad-group energy mesh, in decreasing magnitude of energy.

One set of the following six data blocks for each zone. Each block is preceded by a title card in 12A6 format.

LOOP ON ZONES [IZM]

LOOP ON MAT's [NMAT(IZM)]

RXSC(NFG)[ab]	Fine-group resonance capture cross sections, $\overline{\sigma}_\ell^{102,r}$, starting at top group. First card is a title card in 12A6 format.
RXSF(NFG)[ab]	Fine-group resonance fission cross sections, $\overline{\sigma}_\ell^{18,r}$, starting at top group. First card is a title card in 12A6 format.
SXSC(NFG)[b]	Fine-group smooth (including unresolved resonance) capture cross sections, $\overline{\sigma}_\ell^{102,s}$, starting at top group. First card is a title card in 12A6 format.
SXSF(NFG)[b]	Fine-group smooth (including unresolved resonance) fission cross sections, $\overline{\sigma}_\ell^{18,s}$, starting at top group. First card is a title card in 12A6 format.
RW(NFG)[ab]	Fine-group resonance weighting functions for the zone, starting at top group. First card is a title card in 12A6 format.
SW(NFG)	Fine-group smooth (flux) weighting functions for the zone, starting at top group. First card is a title card in 12A6 format.

The following six data blocks are identical to their homologous blocks in DTF-IV. In fact, for many LAPH problems, they will be identical to those for the DTF-IV problem used to compute the neutron flux vectors.

R(IM+1)	Radii of the spatial mesh points.
MA(IM)	Zone numbers for each interval.
MZ(IZM)	Mixture number in each zone.
MB(MS)	Mixture numbers for mix table.
MC(MS)	Mix command: Specification of nuclides in the mixtures.
XMD(MS)	Mix density of the nuclide in the mixtures.

Lastly, the data block for the neutron flux vectors appears in a format exactly like that used for DTF-IV flux dumps, i.e.,

PHI(IM,NBG)	Normalized neutron fluxes by columns (i.e., by mesh interval and then by neutron broad groups).

[a] These should be entered even for nonresonance materials. In such case, any numbers may be used to fill the fields, but MC^2 will automatically output zeros in this block.

[b] Delete this data block if IRES = 0.

TABLE II

SAMPLE PROBLEM INPUT

```
 71168 SAMPLE PROBL, 3 ZONE, 5 MAT, 9 INTERVAL, GAMMA SOURCE                ID TITLE
    11    52    26     3     9     9     6    18     9     1     0    21 PARAMS.
    1.0 E+123                                                              C
          1           2          33                                       NMAT
          1        5001           2        5002           3        5004   1 NNM
          4        5004           5        5005           6        5006   2 NNM
3                                                                          3 NNM
102       1           13103       13                                       1 MZT
        110         102           5           6           7           8   1 MTN
          9          10          11          12          13          14   2 MTN
         51          52          53           0          -1          15   3 MTN
3                                                                          4 MTN
    8.5 E+06    6.0 E+06    4.5 E+06    3.5 E+06    2.8 E+06    2.4 E+06   1  EG
    2.0 E+06    1.6 E+06    1.1 E+06   0.07 E+06  0.45 E+063               2  EG
   10.0 E+06    7.0 E+06    5.0 E+06    4.0 E+06    3.0 E+06    2.6 E+06   1 FMG
    2.2 E+06    1.8 E+06   1.35 E+06    0.9 E+06    0.5 E+06    0.4 E+06   2 FMG
3                                                                          3 FMG
    1.5 E+07   1.17E+07    9.10E+06    7.09E+06    5.52E+06    4.30E+06   1EMNF
    3.35E+06   2.61E+06    2.03E+06    1.58E+06    1.23E+06    9.59E+05   2EMNF
    7.47E+05   5.82E+05    4.53E+05    3.53E+05    2.75E+05    2.14E+05   3EMNF
    1.67E+05   1.30E+05    1.01E+05    7.87E+04    6.13E+04    4.77E+04   4EMNF
    3.72E+04   2.90E+04    2.26E+04    1.76E+04    1.37E+04    1.07E+04   5EMNF
    8.30E+03   6.46E+03    5.03E+03    3.92E+03    3.05E+03    2.38E+03   6EMNF
    1.85E+03   1.44E+03    1.12E+03    8.74E+02    6.81E+02    5.30E+02   7EMNF
    4.13E+02   3.22E+02    2.51E+02    1.95E+02    1.52E+02    1.18E+02   8EMNF
    9.22E+01   7.18E+01    5.59E+01    4.35E+01   3.39E+013                9EMNF
    1.50E+07   9.10E+06    5.52E+06    3.35E+06    2.61E+06    1.23E+06   1EMNB
    7.47E+05   4.53E+05    2.75E+05    1.67E+05    1.01E+05    6.13E+04   2EMNB
    3.72E+04   2.26E+04    1.37E+04    8.30E+03    5.03E+03    3.05E+03   3EMNB
    1.85E+03   1.12E+03    6.81E+02    4.13E+02    2.51E+02    1.52E+02   4EMNB
    9.22E+01   5.59E+01   3.39E+013                                       5EMNB
RESONANCE CAPTURE CROSS SECTION FOR NA IN ZONE1
    0.         0.          0.          0.          0.          0.        RXSC  1
    0.         0.          0.          0.          0.          0.        RXSC  2
    0.         0.          0.          0.          0.          0.        RXSC  3
    0.         0.          0.          0.          0.          0.        RXSC  4
    0.         0.          0.          0.          0.          0.        RXSC  5
    0.         0.          0.          0.          0.          0.        RXSC  6
    0.         0.          0.          0.          0.          0.        RXSC  7
    0.         0.          0.          0.          0.          0.        RXSC  8
    0.         0.          0.          0.  3                            RXSC  9
RESONANCE FISSION CROSS SECTION FOR NA IN ZONE 1
    0.         0.          0.          0.          0.          0.        RXSF  1
    0.         0.          0.          0.          0.          0.        RXSF  2
    0.         0.          0.          0.          0.          0.        RXSF  3
    0.         0.          0.          0.          0.          0.        RXSF  4
    0.         0.          0.          0.          0.          0.        RXSF  5
    0.         0.          0.          0.          0.          0.        RXSF  6
    0.         0.          0.          0.          0.          0.        RXSF  7
    0.         0.          0.          0.          0.          0.        RXSF  8
    0.         0.          0.          0.  3                            RXSF  9
SMOOTH CAPTURE CROSS SECTION FOR NA IN ZONE 1
    0.         0.          0.          0.          0.          0.      UR+SC  1
    0.         0.          0.         1.05E-04    1.54E-04   2.48E-04UR+SC  2
    3.42E-04   2.94E-04    2.88E-04    4.45E-04    6.09E-04   7.68E-04UR+SC  3
    8.81E-04   7.12E-04    2.29E-04    3.94E-04    1.83E-03   1.38E-03UR+SC  4
    2.17E-03   4.47E-04    4.94E-04    5.88E-04    7.45E-04   9.81E-04UR+SC  5
    1.34E-03   1.99E-03    4.94E-03    4.13E-02    1.82E-01   2.92E-02UR+SC  6
    1.19E-02   7.77E-03    6.38E-03    5.80E-03    5.56E-03   5.58E-03UR+SC  7
    5.86E-03   6.23E-03    6.83E-03    7.50E-03    8.23E-03   9.05E-03UR+SC  8
    1.02E-02   1.15E-02    1.30E-02   1.47E-023                        UR+SC  9
SMOOTH FISSION CROSS SECTION FOR NA IN ZONE  1
```

TABLE II (continued)

```
    0.          0.          0.          0.          0.          0.      UR+SF  1
    0.          0.          0.          0.          0.          0.      UR+SF  2
    0.          0.          0.          0.          0.          0.      UR+SF  3
    0.          0.          0.          0.          0.          0.      UR+SF  4
    0.          0.          0.          0.          0.          0.      UR+SF  5
    0.          0.          0.          0.          0.          0.      UR+SF  6
    0.          0.          0.          0.          0.          0.      UR+SF  7
    0.          0.          0.          0.          0.          0.      UR+SF  8
    0.          0.          0.          0.      3                       UR+SF  9
RESONANCE WEIGHTING FUNCTIONS FOR ZONE 1
    2.05E-02    1.06E-01    3.55E-01    8.53E-01    1.58E+00    2.42E+00RW     1
    3.28E+00    3.93E+00    4.47E+00    4.59E+00    4.66E+00    5.18E+00RW     2
    6.10E+00    7.07E+00    7.18E+00    7.16E+00    6.64E+00    6.13E+00RW     3
    5.33E+00    4.50E+00    3.67E+00    3.14E+00    2.60E+00    2.30E+00RW     4
    1.85E+00    1.61E+00    1.30E+00    8.79E-01    6.15E-01    4.38E-01RW     5
    3.26E-01    5.81E+01    3.16E+01    1.83E+01    1.33E+01    1.01E+01RW     6
    6.13E+00    2.89E+00    1.22E+00    5.17E-01    2.30E-01    9.48E-02RW     7
    3.27E-02    1.24E-02    3.68E-03    1.46E-03    5.89E-04    1.87E-04RW     8
    8.21E-05    2.23E-05    9.00E-06    3.51E-063                   RW     9
UNRESOLVED PLUS SMOOTH WEIGHTING FUNCTIONS FOR ZONE 1
    1.34E-02    6.79E-02    2.26E-01    5.48E-01    1.02E+00    1.55E+00SW     1
    2.26E+00    2.70E+00    3.01E+00    3.46E+00    4.24E+00    5.71E+00SW     2
    6.82E+00    8.94E+00    8.74E+00    9.08E+00    7.81E+00    6.70E+00SW     3
    5.77E+00    5.35E+00    4.20E+00    3.80E+00    2.54E+00    2.75E+00SW     4
    1.55E+00    1.31E+00    1.52E+00    9.42E-01    6.01E-01    3.66E-01SW     5
    2.23E-01    1.96E-01    1.08E-01    2.90E-02    1.12E-02    6.20E-02SW     6
    7.25E-02    4.34E-02    2.29E-02    1.37E-02    6.67E-03    3.19E-03SW     7
    1.63E-03    6.69E-04    2.67E-04    1.14E-04    6.73E-05    2.04E-05SW     8
    1.31E-05    3.19E-06    2.35E-06    8.25E-073                   SW     9
RESONANCE CAPTURE CROSS SECTION FOR MG IN ZONE2
    0.          0.          0.          0.          0.          0.      RXSC   1
    0.          0.          0.          0.          0.          0.      RXSC   2
    0.          0.          0.          0.          0.          0.      RXSC   3
    0.          0.          0.          0.          0.          0.      RXSC   4
    0.          0.          0.          0.          0.          0.      RXSC   5
    0.          0.          0.          0.          0.          0.      RXSC   6
    0.          0.          0.          0.          0.          0.      RXSC   7
    0.          0.          0.          0.          0.          0.      RXSC   8
    0.          0.          0.          0.      3                       RXSC   9
RESONANCE FISSION CROSS SECTION FOR MG IN ZONE 2
    0.          0.          0.          0.          0.          0.      RXSF   1
    0.          0.          0.          0.          0.          0.      RXSF   2
    0.          0.          0.          0.          0.          0.      RXSF   3
    0.          0.          0.          0.          0.          0.      RXSF   4
    0.          0.          0.          0.          0.          0.      RXSF   5
    0.          0.          0.          0.          0.          0.      RXSF   6
    0.          0.          0.          0.          0.          0.      RXSF   7
    0.          0.          0.          0.          0.          0.      RXSF   8
    0.          0.          0.          0.      3                       RXSF   9
SMOOTH CAPTURE CROSS SECTION FOR MG IN ZONE2
    2.48E-04    3.02E-04    3.68E-04    4.47E-04    5.45E-04    6.63E-04UR+SC  1
    8.08E-04    9.83E-04    1.29E-03    1.87E-03    2.72E-03    3.63E-03UR+SC  2
    4.34E-03    4.91E-03    5.28E-03    5.41E-03    5.42E-03    5.36E-03UR+SC  3
    5.27E-03    5.39E-03    5.65E-03    6.06E-03    6.60E-03    7.72E-03UR+SC  4
    2.02E-02    4.59E-02    1.88E-02    1.44E-02    2.02E-02    3.19E-02UR+SC  5
    7.61E-02    4.63E-02    1.74E-02    1.44E-02    7.86E-03    7.65E-03UR+SC  6
    1.99E-02    2.31E-01    3.88E-02    1.76E-02    1.58E-02    1.94E-02UR+SC  7
    2.84E-02    2.72E-02    2.54E-02    2.96E-02    3.78E-02    3.81E-02UR+SC  8
    4.53E-02    5.29E-02    6.57E-02    6.75E-023                   UR+SC  9
SMOOTH FISSION CROSS SECTION FOR MG IN ZONE  2
    0.          0.          0.          0.          0.          0.      UR+SF  1
    0.          0.          0.          0.          0.          0.      UR+SF  2
```

TABLE II (continued)

```
    0.          0.          0.          0.          0.          0.      UR+SF  3
    0.          0.          0.          0.          0.          0.      UR+SF  4
    0.          0.          0.          0.          0.          0.      UR+SF  5
    0.          0.          0.          0.          0.          0.      UR+SF  6
    0.          0.          0.          0.          0.          0.      UR+SF  7
    0.          0.          0.          0.          0.          0.      UR+SF  8
    0.          0.          0.          0.       3                      UR+SF  9
RESONANCE CAPTURE CROSS SECTION FOR CL IN ZONE2
    0.          0.          0.          0.          0.          0.      RXSC   1
    0.          0.          0.          0.          0.          0.      RXSC   2
    0.          0.          0.          0.          0.          0.      RXSC   3
    0.          0.          0.          0.          0.          0.      RXSC   4
    0.          0.          0.          0.          0.          0.      RXSC   5
    0.          0.          0.          0.          0.          0.      RXSC   6
    0.          0.          0.          0.          0.          0.      RXSC   7
    0.          0.          0.          0.          0.          0.      RXSC   8
    0.          0.          0.          0.       3                      RXSC   9
RESONANCE FISSION CROSS SECTION FOR CL IN ZONE 2
    0.          0.          0.          0.          0.          0.      RXSF   1
    0.          0.          0.          0.          0.          0.      RXSF   2
    0.          0.          0.          0.          0.          0.      RXSF   3
    0.          0.          0.          0.          0.          0.      RXSF   4
    0.          0.          0.          0.          0.          0.      RXSF   5
    0.          0.          0.          0.          0.          0.      RXSF   6
    0.          0.          0.          0.          0.          0.      RXSF   7
    0.          0.          0.          0.          0.          0.      RXSF   8
    0.          0.          0.          0.       3                      RXSF   9
SMOOTH CAPTURE CROSS SECTION FOR CL IN ZONE 2
    0.          0.          0.          0.          0.          0.      UR+SC  1
    0.          0.          0.          0.          0.          0.      UR+SC  2
    0.          0.          0.          0.          0.          0.      UR+SC  3
    0.          0.          0.          0.          0.          0.      UR+SC  4
    0.          0.          0.          0.          0.          0.      UR+SC  5
    0.          0.          0.          0.          0.          0.      UR+SC  6
    0.          0.          0.          0.          0.          0.      UR+SC  7
    0.          0.          0.          0.          0.          0.      UR+SC  8
    0.          0.          0.          0.       3                      UR+SC  9
SMOOTH FISSION CROSS SECTION FOR CL IN ZONE  2
    0.          0.          0.          0.          0.          0.      UR+SF  1
    0.          0.          0.          0.          0.          0.      UR+SF  2
    0.          0.          0.          0.          0.          0.      UR+SF  3
    0.          0.          0.          0.          0.          0.      UR+SF  4
    0.          0.          0.          0.          0.          0.      UR+SF  5
    0.          0.          0.          0.          0.          0.      UR+SF  6
    0.          0.          0.          0.          0.          0.      UR+SF  7
    0.          0.          0.          0.          0.          0.      UR+SF  8
    0.          0.          0.          0.       3                      UR+SF  9
RESONANCE WEIGHTING FUNCTIONS FOR ZONE 2
    2.13E-02    1.10E-01    3.70E-01    8.88E-01    1.64E+00    2.52E+00RW     1
    3.42E+00    4.10E+00    4.66E+00    4.80E+00    4.87E+00    5.42E+00RW     2
    6.40E+00    7.43E+00    7.56E+00    7.54E+00    7.01E+00    6.48E+00RW     3
    5.64E+00    4.76E+00    3.89E+00    3.33E+00    2.77E+00    2.44E+00RW     4
    1.97E+00    1.71E+00    1.38E+00    9.41E-01    6.59E-01    4.70E-01RW     5
    3.51E-01    6.02E+01    3.27E+01    1.90E+01    1.38E+01    1.04E+01RW     6
    6.36E+00    3.06E+00    1.32E+00    5.63E-01    2.53E-01    1.04E-01RW     7
    3.61E-02    1.38E-02    4.12E-03    1.64E-03    6.62E-04    2.06E-04RW     8
    8.70E-05    2.17E-05    7.51E-06    2.68E-063                   RW     9
UNRESOLVED PLUS SMOOTH WEIGHTING FUNCTIONS FOR ZONE 2
    1.36E-02    6.85E-02    2.28E-01    5.53E-01    1.03E+00    1.56E+00SW     1
    2.28E+00    2.73E+00    3.05E+00    3.51E+00    4.30E+00    5.80E+00SW     2
    6.93E+00    9.11E+00    8.91E+00    9.26E+00    7.97E+00    6.85E+00SW     3
    5.90E+00    5.47E+00    4.29E+00    3.89E+00    2.61E+00    2.83E+00SW     4
```

TABLE II (continued)

```
    1.59E+00    1.35E+00    1.57E+00    9.74E-01    6.23E-01    3.79E-01SW      5
    2.31E-01    2.03E-01    1.12E-01    3.00E-02    1.15E-02    6.41E-02SW      6
    7.66E-02    4.69E-02    2.49E-02    1.50E-02    7.33E-03    3.51E-03SW      7
    1.81E-03.   7.54E-04    2.99E-04    1.29E-04    7.74E-05    2.25E-05SW      8
    1.42E-05    3.12E-06    1.96E-06    6.46E-073                   SW      9
RESONANCE CAPTURE CROSS SECTION FOR CL IN ZONE3
    0.          0.          0.          0.          0.          0.      RXSC    1
    0.          0.          0.          0.          0.          0.      RXSC    2
    0.          0.          0.          0.          0.          0.      RXSC    3
    0.          0.          0.          0.          0.          0.      RXSC    4
    0.          0.          0.          0.          0.          0.      RXSC    5
    0.          0.          5.58E-05    5.05E-01    5.44E-01    5.28E-01RXSC    6
    5.48E-01    7.42E-01    7.27E-01    8.59E-01    8.54E-01    7.32E-01RXSC    7
    8.44E-01    9.20E-01    1.05E+00    1.14E+00    4.24E-01    2.64E+00RXSC    8
    1.33E+00    2.63E+00    1.35E-01    6.25E+003                   RXSC    9
RESONANCE FISSION CROSS SECTION FOR CL IN ZONE 3
    0.          0.          0.          0.          0.          0.      RXSF    1
    0.          0.          0.          0.          0.          0.      RXSF    2
    0.          0.          0.          0.          0.          0.      RXSF    3
    0.          0.          0.          0.          0.          0.      RXSF    4
    0.          0.          0.          0.          0.          0.      RXSF    5
    0.          0.          0.          0.          0.          0.      RXSF    6
    0.          0.          0.          0.          0.          0.      RXSF    7
    0.          0.          0.          0.          0.          0.      RXSF    8
    0.          0.          0.          0.       3                      RXSF    9
SMOOTH CAPTURE CROSS SECTION FOR CL IN ZONE3
    3.57E-03    4.55E-03    6.08E-03    8.14E-03    1.14E-02    1.74E-02UR+SC   1
    2.74E-02    4.16E-02    6.51E-02    1.12E-01    1.47E-01    1.50E-01UR+SC   2
    1.41E-01    1.34E-01    1.33E-01    1.39E-01    1.49E-01    1.62E-01UR+SC   3
    1.78E-01    1.98E-01    2.29E-01    2.74E-01    3.25E-01    3.76E-01UR+SC   4
    4.31E-01    4.88E-01    5.45E-01    6.00E-01    6.52E-01    7.00E-01UR+SC   5
    7.43E-01    7.84E-01    8.21E-01    3.64E-01    3.32E-01    3.03E-01UR+SC   6
    2.72E-01    2.43E-01    2.17E-01    1.30E-01    0.          0.      UR+SC   7
    0.          0.          0.          0.          0.          0.      UR+SC   8
    0.          0.          0.          0.       3                      UR+SC   9
SMOOTH FISSION CROSS SECTION FOR CL IN ZONE 3
    1.10E+00    1.01E+00    1.02E+00    7.50E-01    5.68E-01    5.63E-01UR+SF   1
    5.43E-01    5.72E-01    4.81E-01    1.77E-01    2.63E-02    7.85E-03UR+SF   2
    1.24E-03    4.04E-04    0.          0.          0.          0.      UR+SF   3
    0.          0.          0.          0.          0.          0.      UR+SF   4
    0.          0.          0.          0.          0.          0.      UR+SF   5
    0.          0.          0.          0.          0.          0.      UR+SF   6
    0.          0.          0.          0.          0.          0.      UP+SF   7
    0.          0.          0.          0.          0.          0.      UR+SF   8
    0.          0.          0.          0.       3                      UR+SF   9
RESONANCE CAPTURE CROSS SECTION FOR  K IN ZONE3
    0.          0.          0.          0.          0.          0.      RXSC    1
    0.          0.          0.          0.          0.          0.      RXSC    2
    0.          0.          0.          0.          0.          0.      RXSC    3
    0.          0.          0.          0.          0.          0.      RXSC    4
    0.          0.          0.          0.          0.          0.      RXSC    5
    0.          0.          0.          0.          0.          0.      RXSC    6
    0.          0.          0.          4.71E-06    1.22E-05    4.63E-05RXSC    7
    1.22E-03    4.08E+00    6.79E+00    4.75E+00    9.24E+00    4.35E+00RXSC    8
    6.07E+00    8.74E+00    2.04E+01    1.40E+013                   RXSC    9
RESONANCE FISSION CROSS SECTION FOR  K IN ZONE 3
    0.          0.          0.          0.          0.          0.      RXSF    1
    0.          0.          0.          0.          0.          0.      RXSF    2
    0.          0.          0.          0.          0.          0.      RXSF    3
    0.          0.          0.          0.          0.          0.      RXSF    4
    0.          0.          0.          0.          0.          0.      RXSF    5
    0.          0.          0.          0.          0.          0.      RXSF    6
```

TABLE II (continued)

```
    0.          0.          0.          7.68E-04    1.99E-03    7.02E-03RXSF   7
    3.95E-02    8.78E+00    9.89E+00    1.14E+01    1.46E+01    1.71E+01RXSF   8
    2.15E+01    5.01E+01    1.57E+01    3.25E+003                       RXSF   9
SMOOTH CAPTURE CROSS SECTION FOR  K IN ZONE3
    0.          0.          0.          0.          0.          0.      UR+SC  1
    0.          0.          0.          1.91E-02    4.18E-02    6.35E-02UR+SC  2
    8.73E-02    1.07E-01    1.33E-01    1.56E-01    1.80E-01    1.94E-01UR+SC  3
    2.09E-01    2.16E-01    2.18E-01    2.26E-01    2.76E-01    3.74E-01UR+SC  4
    4.88E-01    6.02E-01    7.13E-01    8.27E-01    9.43E-01    1.07E+00UR+SC  5
    1.18E+00    1.31E+00    1.47E+00    1.68E+00    1.94E+00    2.21E+00UR+SC  6
    2.52E+00    2.88E+00    3.66E+00    2.49E+00    4.61E+00    6.26E+00UR+SC  7
    3.70E+00    1.92E+00    3.66E-01    0.          0.          0.      UR+SC  8
    0.          0.          0.          0.       3                      UR+SC  9
SMOOTH FISSION CROSS SECTION FOR  K IN ZONE  3
    2.61E+00    2.46E+00    2.34E+00    1.96E+00    1.88E+00    1.94E+00UR+SF  1
    2.00E+00    2.03E+00    1.94E+00    1.83E+00    1.77E+00    1.69E+00UR+SF  2
    1.64E+00    1.55E+00    1.50E+00    1.48E+00    1.48E+00    1.49E+00UR+SF  3
    1.52E+00    1.53E+00    1.53E+00    1.47E+00    1.46E+00    1.52E+00UR+SF  4
    1.61E+00    1.72E+00    1.82E+00    1.94E+00    2.07E+00    2.23E+00UR+SF  5
    2.38E+00    2.55E+00    2.72E+00    2.98E+00    3.33E+00    3.72E+00UR+SF  6
    4.15E+00    4.68E+00    5.89E+00    4.23E+00    7.38E+00    9.93E+00UR+SF  7
    6.51E+00    6.07E+00    2.84E+00    0.          0.          0.      UR+SF  8
    0.          0.          0.          0.       3                      UR+SF  9
RESONANCE CAPTURE CROSS SECTION FOR CA IN ZONE3
    0.          0.          0.          0.          0.          0.      RXSC   1
    0.          0.          0.          0.          0.          0.      RXSC   2
    0.          0.          0.          0.          0.          0.      RXSC   3
    0.          0.          0.          0.          0.          0.      RXSC   4
    0.          0.          0.          0.          0.          0.      RXSC   5
    0.          0.          0.          0.          0.          0.      RXSC   6
    0.          0.          0.          0.          0.          0.      RXSC   7
    0.          0.          0.          0.          0.          0.      RXSC   8
    0.          0.          0.          0.       3                      RXSC   9
RESONANCE FISSION CROSS SECTION FOR CA IN ZONE 3
    0.          0.          0.          0.          0.          0.      RXSF   1
    0.          0.          0.          0.          0.          0.      RXSF   2
    0.          0.          0.          0.          0.          0.      RXSF   3
    0.          0.          0.          0.          0.          0.      RXSF   4
    0.          0.          0.          0.          0.          0.      RXSF   5
    0.          0.          0.          0.          0.          0.      RXSF   6
    0.          0.          0.          0.          0.          0.      RXSF   7
    0.          0.          0.          0.          0.          0.      RXSF   8
    0.          0.          0.          0.       3                      RXSF   9
SMOOTH CAPTURE CROSS SECTION FOR CA IN ZONE3
    0.          0.          0.          0.          0.          0.      UR+SC  1
    0.          0.          0.          1.05E-04    1.54E-04    2.48E-04UR+SC  2
    3.42E-04    2.94E-04    2.88E-04    4.45E-04    6.09E-04    7.68E-04UR+SC  3
    8.81E-04    7.12E-04    2.29E-04    3.94E-04    1.83E-03    1.38E-03UR+SC  4
    2.17E-03    4.47E-04    4.94E-04    5.88E-04    7.45E-04    9.81E-04UR+SC  5
    1.34E-03    1.99E-03    4.94E-03    4.13E-02    1.82E-01    2.92E-02UR+SC  6
    1.19E-02    7.77E-03    6.38E-03    5.80E-03    5.56E-03    5.58E-03UR+SC  7
    5.86E-03    6.23E-03    6.83E-03    7.50E-03    8.23E-03    9.05E-03UR+SC  8
    1.02E-02    1.15E-02    1.30E-02    1.47E-023                       UR+SC  9
SMOOTH FISSION CROSS SECTION FOR CA IN ZONE  3
    0.          0.          0.          0.          0.          0.      UR+SF  1
    0.          0.          0.          0.          0.          0.      UR+SF  2
    0.          0.          0.          0.          0.          0.      UR+SF  3
    0.          0.          0.          0.          0.          0.      UR+SF  4
    0.          0.          0.          0.          0.          0.      UR+SF  5
    0.          0.          0.          0.          0.          0.      UR+SF  6
    0.          0.          0.          0.          0.          0.      UR+SF  7
    0.          0.          0.          0.          0.          0.      UR+SF  8
```

TABLE II (continued)

```
    0.          0.          0.          0.       3                        UR+SF  9
RESONANCE WEIGHTING FUNCTIONS FOR ZONE 3
    2.05E-02    1.06E-01    3.55E-01    8.53E-01    1.58E+00    2.42E+00RW     1
    3.28E+00    3.93E+00    4.47E+00    4.59E+00    4.66E+00    5.18E+00RW     2
    6.10E+00    7.07E+00    7.18E+00    7.16E+00    6.64E+00    6.13E+00RW     3
    5.33E+00    4.50E+00    3.67E+00    3.14E+00    2.60E+00    2.30E+00RW     4
    1.85E+00    1.61E+00    1.30E+00    8.79E-01    6.15E-01    4.38E-01RW     5
    3.26E-01    5.81E+01    3.16E+01    1.83E+01    1.33E+01    1.01E+01RW     6
    6.13E+00    2.89E+00    1.22E+00    5.17E-01    2.30E-01    9.48E-02RW     7
    3.27E-02    1.24E-02    3.68E-03    1.46E-03    5.89E-04    1.87E-04RW     8
    8.21E-05    2.23E-05    9.00E-06    3.51E-063                   RW     9
UNRESOLVED PLUS SMOOTH WEIGHTING FUNCTIONS FOR ZONE 3
    1.34E-02    6.79E-02    2.26E-01    5.48E-01    1.02E+00    1.55E+00SW     1
    2.26E+00    2.70E+00    3.01E+00    3.46E+00    4.24E+00    5.71E+00SW     2
    6.82E+00    8.94E+00    8.74E+00    9.08E+00    7.81E+00    6.70E+00SW     3
    5.77E+00    5.35E+00    4.20E+00    3.80E+00    2.54E+00    2.75E+00SW     4
    1.55E+00    1.31E+00    1.52E+00    9.42E-01    6.01E-01    3.66E-01SW     5
    2.23E-01    1.96E-01    1.08E-01    2.90E-02    1.12E-02    6.20E-03SW     6
    7.25E-02    4.34E-02    2.29E-02    1.37E-02    6.67E-03    3.19E-03SW     7
    1.63E-03    6.69E-04    2.67E-04    1.14E-04    6.73E-05    2.04E-05SW     8
    1.31E-05    3.19E-06    2.35E-06    8.25E-073                   SW     9
203 0.0         4.0         6.0     202 9.0         15.0    3                  R
103         1104        2102        33                                     MA
            7           8           93                                     MZ
102         7103        8104        93                                     MB
            0           1           0           2           3          0   1  MC
            4           5           63                                     2  MC
    0.0         0.06        0.0         0.05        0.04        0.0        1 XMD
    0.03        0.02        0.01        3                                  2 XMD
103 1.0     104 0.1     102 0.01    103 2.0     104 0.2     102 0.02       1 PHI
103 3.0     104 0.3     102 0.03    103 4.0     104 0.4     102 0.04       2 PHI
103 5.0     104 0.5     102 0.05    103 6.0     104 0.6     102 0.06       3 PHI
103 7.0     104 0.7     102 0.07    103 8.0     104 0.8     102 0.08       4 PHI
103 9.0     104 0.9     102 0.09    103 10.0    104 1.0     102 0.10       5 PHI
103 11.0    104 1.1     102 0.11    103 12.0    104 1.2     102 0.12       6 PHI
103 13.0    104 1.3     102 0.13    103 14.0    104 1.4     102 0.14       7 PHI
103 15.0    104 1.5     102 0.15    103 16.0    104 1.6     102 0.16       8 PHI
103 17.0    104 1.7     102 0.17    103 18.0    104 1.8     102 0.18       9 PHI
103 19.0    104 1.9     102 0.19    103 20.0    104 2.0     102 0.20      10 PHI
103 21.0    104 2.1     102 0.21    103 22.0    104 2.2     102 0.22      11 PHI
103 23.0    104 2.3     102 0.23    103 24.0    104 2.4     102 0.24      12 PHI
103 25.0    104 2.5     102 0.25    103 26.0    104 2.6     102 0.26      13 PHI
3                                                                         14 PHI
```

TABLE III

SAMPLE PROBLEM OUTPUT

```
ENDF/B TAPE I. D. = 1304        LIBRARY TAPE PREPARED FOR LAPH SAMPLE PROBLEM  ON 13JANUARY1970.


 LAPH PROBLEM ID= 71168 SAMPLE PROBL, 3 ZONE, 5 MAT, 9 INTERVAL, GAMMA SOURCE
INTEGER PARAMETERS          NGG      NFG      NBG      IZM      IM       MS       MCR      MM       NPM      IRES     IWO      IOO
                             11       52       26        3        9        9        6       18        9        1        0       21

RENORM CONST      1
  1.0000E+12

NO MATS/ZONE      3
          1         2         3
NUMBER OF NUCLIDES IN EACH ZONE
          ZONE  NUMBER OF NUCLIDES
            1         1
            2         2
            3         3

NNM ARRAY         12
          1      5001          2      5002          3      5004          4      5004          5      5005
          6      5006
NUCLIDE SEQUENCE NUMBER     NUCLIDE
            1---------------- 5001
            2---------------- 5002
            3---------------- 5004
            4---------------- 5004
            5---------------- 5005
            6---------------- 5006

MZT ARRAY         6
          1         1        13         1         1         1

MTN NUMBERS       18
        110       102         5         6         7         8         9        10        11        12
         13        14        51        52        53         0        -1        15
NUCLIDE SEQUENCE NUMBER      MT NUMBERS
                    1        110
                    2        102
                    3          5   6   7   8   9  10  11  12  13  14  51  52  53
                    4          0
                    5         -1
                    6         15

EGAMMA BAR        11
  8.5000E+06  6.0000E+06  4.5000E+06  3.5000E+06  2.8000E+06  2.4000E+06  2.0000E+06  1.6000E+06  1.1000E+06  7.0000E+04
  4.5000E+05

GAMMA BOUNDS      12
  1.0000E+07  7.0000E+06  5.0000E+06  4.0000E+06  3.0000E+06  2.6000E+06  2.2000E+06  1.8000E+06  1.3500E+06  9.0000E+05
  5.0000E+05  4.0000E+05

NEUTRON FINE      53
  1.5000E+07  1.1700E+07  9.1000E+06  7.0900E+06  5.5200E+06  4.3000E+06  3.3500E+06  2.6100E+06  2.0300E+06  1.5800E+06
  1.2300E+06  9.5900E+05  7.4700E+05  5.8200E+05  4.5300E+05  3.5300E+05  2.7500E+05  2.1400E+05  1.6700E+05  1.3000E+05
  1.0100E+05  7.8700E+04  6.1300E+04  4.7700E+04  3.7200E+04  2.9000E+04  2.2600E+04  1.7600E+04  1.3700E+04  1.0700E+04
  8.3000E+03  6.4600E+03  5.0300E+03  3.9200E+03  3.0500E+03  2.3800E+03  1.8500E+03  1.4400E+03  1.1200E+03  8.7400E+02
  6.8100E+02  5.3000E+02  4.1300E+02  3.2200E+02  2.5100E+02  1.9500E+02  1.5200E+02  1.1800E+02  9.2200E+01  7.1800E+01
  5.5900E+01  4.3500E+01  3.3900E+01

NEUTRON  BRD      27
  1.5000E+07  9.1000E+06  5.5200E+06  3.3500E+06  2.6100E+06  1.2300E+06  7.4700E+05  4.5300E+05  2.7500E+05  1.6700E+05
  1.0100E+05  6.1300E+04  3.7200E+04  2.2600E+04  1.3700E+04  8.3000E+03  5.0300E+03  3.0500E+03  1.8500E+03  1.1200E+03
  6.8100E+02  4.1300E+02  2.5100E+02  1.5200E+02  9.2200E+01  5.5900E+01  3.3900E+01
ERROR IN THE EFFECTIVE AVERAGE ENERGY INPUT FOR GROUP   10
THE VALUE EG(I)=  7.000000E+04 SHOULD LIE BETWEEN THE BOUNDARIES EMG(I)=  9.000000E+05 AND EMG(I+1)=  5.000000E+05
THE MIDPOINT OF THE ENERGY INTERVAL HAS BEEN USED, EG(I) HAS BEEN REPLACED BY  7.000000E+05

 RESONANCE CAPTURE CROSS SECTION FOR NA IN ZONE1

RXSC              52
  0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.

 RESONANCE FISSION CROSS SECTION FOR NA IN ZONE 1
```

TABLE III (continued)

```
RXSF            52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.
```

SMOOTH CAPTURE CROSS SECTION FOR NA IN ZONE 1

```
SXSC            52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          1.0500E-04
  1.5400E-04  2.4800E-04  3.4200E-04  2.9400E-04  2.8800E-04  4.4500E-04  6.0900E-04  7.6800E-04  8.8100E-04  7.1200E-04
  2.2900E-04  3.9400E-04  1.8300E-03  1.3800E-03  2.1700E-03  4.4700E-04  4.9400E-04  5.8800E-04  7.4500E-04  9.8100E-04
  1.3400E-03  1.9900E-03  4.9400E-03  4.1300E-02  1.8200E-01  2.9200E-02  1.1900E-02  7.7700E-03  6.3800E-03  5.8000E-03
  5.5600E-03  5.5800E-03  5.8600E-03  6.2300E-03  6.8300E-03  7.5000E-03  8.2300E-03  9.0500E-03  1.0200E-02  1.1500E-02
  1.3000E-02  1.4700E-02
```

SMOOTH FISSION CROSS SECTION FOR NA IN ZONE 1

```
SXSF            52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.
```

RESONANCE WEIGHTING FUNCTIONS FOR ZONE 1

```
RW              52
  2.0500E-02  1.0600E-01  3.5500E-01  8.5300E-01  1.5800E+00  2.4200E+00  3.2800E+00  3.9300E+00  4.4700E+00  4.5900E+00
  4.6600E+00  5.1800E+00  6.1000E+00  7.0700E+00  7.1800E+00  7.1600E+00  6.6400E+00  6.1300E+00  5.3300E+00  4.5600E+00
  3.6700E+00  3.1400E+00  2.6000E+00  2.3000E+00  1.8500E+00  1.6100E+00  1.3000E+00  8.7900E-01  6.1500E-01  4.3800E-01
  3.2600E-01  5.8100E+01  3.1600E+01  1.8300E+01  1.3300E+01  1.0100E+01  6.1300E+00  2.8900E+00  1.2200E+00  5.1700E-01
  2.3000E-01  9.4800E-02  3.2700E-02  1.2400E-02  3.6800E-03  1.4600E-03  5.8900E-04  1.8700E-04  8.2100E-05  2.2300E-05
  9.0000E-06  3.5100E-06
```

UNRESOLVED PLUS SMOOTH WEIGHTING FUNCTIONS FOR ZONE 1

```
SW              52
  1.3400E-02  6.7900E-02  2.2600E-01  5.4800E-01  1.0200E+00  1.5500E+00  2.2600E+00  2.7000E+00  3.0100E+00  3.4600E+00
  4.2400E+00  5.7100E+00  6.8200E+00  8.9400E+00  8.7400E+00  9.0800E+00  7.8100E+00  6.7000E+00  5.7700E+00  5.3500E+00
  4.2000E+00  3.8000E+00  2.5400E+00  2.7500E+00  1.5500E+00  1.3100E+00  1.5200E+00  9.4200E-01  6.0100E-01  3.6600E-01
  2.2300E-01  1.9600E-01  1.0800E-01  2.9000E-02  1.1200E-02  6.2000E-02  7.2500E-02  4.3400E-02  2.2900E-02  1.3700E-02
  6.6700E-03  3.1900E-03  1.6300E-03  6.6900E-04  2.6700E-04  1.1400E-04  6.7300E-05  2.6400E-05  1.3100E-05  3.1900E-06
  2.3500E-06  8.2500E-07
```

RESONANCE CAPTURE CROSS SECTION FOR MG IN ZONE2

```
RXSC            52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.
```

RESONANCE FISSION CROSS SECTION FOR MG IN ZONE 2

```
RXSF            52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.
```

SMOOTH CAPTURE CROSS SECTION FOR MG IN ZONE2

```
SXSC            52
  2.4800E-04  3.0200E-04  3.6800E-04  4.4700E-04  5.4500E-04  6.6300E-04  8.0800E-04  9.8300E-04  1.2900E-03  1.8700E-03
  2.7200E-03  3.6300E-03  4.3400E-03  4.9100E-03  5.2800E-03  5.4100E-03  5.4200E-03  5.3600E-03  5.2700E-03  5.3900E-03
  5.6500E-03  6.0600E-03  6.6000E-03  7.7200E-03  2.0200E-02  4.5900E-02  1.8800E-02  1.4400E-02  2.0200E-02  3.1900E-02
  7.6100E-02  4.6300E-02  1.7400E-02  1.4400E-02  7.8600E-03  7.6500E-03  1.9900E-02  2.3100E-01  3.8800E-02  1.7600E-02
  1.5800E-02  1.9400E-02  2.8400E-02  2.7200E-02  2.5400E-02  2.9600E-02  3.7800E-02  3.8100E-02  4.5300E-02  5.2900E-02
  6.5700E-02  6.7500E-02
```

SMOOTH FISSION CROSS SECTION FOR MG IN ZONE 2

```
SXSF            52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.
```

RESONANCE CAPTURE CROSS SECTION FOR CL IN ZONE2

```
RXSC            52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
```

TABLE III (continued)

```
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.
```

RESONANCE FISSION CROSS SECTION FOR CL IN ZONE 2

```
RXSF          52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.
```

SMOOTH CAPTURE CROSS SECTION FOR CL IN ZONE 2

```
SXSC          52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.
```

SMOOTH FISSION CROSS SECTION FOR CL IN ZONE 2

```
SXSF          52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.
```

RESONANCE WEIGHTING FUNCTIONS FOR ZONE 2

```
RW            52
 2.1300E-02  1.1000E-01  3.7000E-01  8.8800E-01  1.6400E+00  2.5200E+00  3.4200E+00  4.1000E+00  4.6600E+00  4.8000E+00
 4.8700E+00  5.4200E+00  6.4000E+00  7.4300E+00  7.5600E+00  7.5400E+00  7.0100E+00  6.4800E+00  5.6400E+00  4.7600E+00
 3.8900E+00  3.3300E+00  2.7700E+00  2.4400E+00  1.9700E+00  1.7100E+00  1.3800E+00  9.4100E-01  6.5900E-01  4.7000E-01
 3.5100E-01  6.0200E+01  3.2700E+01  1.9000E+01  1.3800E+01  1.0400E+01  6.3600E+00  3.0600E+00  1.3200E+00  5.6300E-01
 2.5300E-01  1.0400E-01  3.6100E-02  1.3800E-02  4.1200E-03  1.6400E-03  6.6200E-04  2.0600E-04  8.7000E-05  2.1700E-05
 7.5100E-06  2.6800E-06
```

UNRESOLVED PLUS SMOOTH WEIGHTING FUNCTIONS FOR ZONE 2

```
SW            52
 1.3600E-02  6.8500E-02  2.2800E-01  5.5300E-01  1.0300E+00  1.5600E+00  2.2800E+00  2.7300E+00  3.0500E+00  3.5100E+00
 4.3000E+00  5.8000E+00  6.9300E+00  9.1100E+00  9.9100E+00  9.2600E+00  7.9700E+00  6.8500E+00  5.9000E+00  5.4700E+00
 4.2900E+00  3.8900E+00  2.6100E+00  2.8300E+00  1.5900E+00  1.3500E+00  1.5700E+00  9.7400E-01  6.2300E-01  3.7900E-01
 2.3100E-01  2.0300E-01  1.1200E-01  3.0000E-02  1.1500E-02  6.4100E-02  7.6600E-02  4.6900E-02  2.4900E-02  1.5000E-02
 7.3300E-03  3.5100E-03  1.8100E-03  7.5400E-04  2.9900E-04  1.2900E-04  7.7400E-05  2.2500E-05  1.4200E-05  3.1200E-06
 1.9600E-06  6.4600E-07
```

RESONANCE CAPTURE CROSS SECTION FOR CL IN ZONE3

```
RXSC          52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          5.5800E-05  5.0500E-01  5.4400E-01  5.2800E-01  5.4800E-01  7.4200E-01  7.2700E-01  8.5900E-01
 8.5400E-01  7.3200E-01  8.4400E-01  9.2000E-01  1.0500E+00  1.1400E+00  4.2400E-01  2.6400E+00  1.3300E+00  2.6300E+00
 1.3500E-01  6.2500E+00
```

RESONANCE FISSION CROSS SECTION FOR CL IN ZONE 3

```
RXSF          52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.
```

SMOOTH CAPTURE CROSS SECTION FOR CL IN ZONE3

```
SXSC          52
 3.5700E-03  4.5500E-03  6.0800E-03  8.1400E-03  1.1400E-02  1.7400E-02  2.7400E-02  4.1600E-02  6.5100E-02  1.1200E-01
 1.4700E-01  1.5000E-01  1.4100E-01  1.3400E-01  1.3300E-01  1.3900E-01  1.4900E-01  1.6200E-01  1.7800E-01  1.9800E-01
 2.2900E-01  2.7400E-01  3.2500E-01  3.7600E-01  4.3100E-01  4.8800E-01  5.4500E-01  6.0000E-01  6.5200E-01  7.0000E-01
 7.4300E-01  7.8400E-01  8.2100E-01  3.6400E-01  3.3200E-01  3.0300E-01  2.7200E-01  2.4300E-01  2.1700E-01  1.3000E-01
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.
```

SMOOTH FISSION CROSS SECTION FOR CL IN ZONE 3

```
SXSF          52
 1.1000E+00  1.0100E+00  1.0200E+00  7.5000E-01  5.6800E-01  5.6300E-01  5.4300E-01  5.7200E-01  4.8100E-01  1.7700E-01
 2.6300E-02  7.8500E-03  1.2400E-03  4.0400E-04  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
```

TABLE III (continued)

```
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.

 RESONANCE CAPTURE CROSS SECTION FOR  K IN ZONE3

RXSC            52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          4.7100E-06
  1.2200E-05  4.6300E-05  1.2200E-03  4.0800E+00  6.7900E+00  4.7500E+00  9.2400E+00  4.3500E+00  6.0700E+00  8.7400E+00
  2.0400E+01  1.4000E+01

 RESONANCE FISSION CROSS SECTION FOR  K IN ZONE 3

RXSF            52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          7.6800E-04
  1.9900E-03  7.0200E-03  3.9500E-02  8.7800E+00  9.8900E+00  1.1400E+01  1.4600E+01  1.7100E+01  2.1500E+01  5.0100E+01
  1.5700E+01  3.2500E+00

 SMOOTH CAPTURE CROSS SECTION FOR  K IN ZONE3

SXSC            52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          1.9100E-02
  4.1800E-02  6.3500E-02  8.7300E-02  1.0700E-01  1.3300E-01  1.5600E-01  1.8000E-01  1.9400E-01  2.0900E-01  2.1600E-01
  2.1800E-01  2.2600E-01  2.7600E-01  3.7400E-01  4.8800E-01  6.0200E-01  7.1300E-01  8.2700E-01  9.4300E-01  1.0700E+00
  1.1800E+00  1.3100E+00  1.4700E+00  1.6800E+00  1.9400E+00  2.2100E+00  2.5200E+00  2.8800E+00  3.6600E+00  2.4900E+00
  4.6100E+00  6.2600E+00  3.7000E+00  1.9200E+00  3.6600E-01  0.          0.          0.          0.          0.
  0.          0.

 SMOOTH FISSION CROSS SECTION FOR  K IN ZONE  3

SXSF            52
  2.6100E+00  2.4600E+00  2.3400E+00  1.9600E+00  1.8800E+00  1.9400E+00  2.0000E+00  2.0300E+00  1.9400E+00  1.8300E+00
  1.7700E+00  1.6900E+00  1.6400E+00  1.5500E+00  1.5000E+00  1.4800E+00  1.4800E+00  1.4900E+00  1.5200E+00  1.5300E+00
  1.5300E+00  1.4700E+00  1.4600E+00  1.5200E+00  1.6100E+00  1.7200E+00  1.8200E+00  1.9400E+00  2.0700E+00  2.2300E+00
  2.3800E+00  2.5500E+00  2.7200E+00  2.9800E+00  3.3300E+00  3.7200E+00  4.1500E+00  4.6800E+00  5.8900E+00  4.2300E+00
  7.3800E+00  9.9300E+00  6.5100E+00  6.0700E+00  2.8400E+00  0.          0.          0.          0.          0.
  0.          0.

 RESONANCE CAPTURE CROSS SECTION FOR CA IN ZONE3

RXSC            52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.

 RESONANCE FISSION CROSS SECTION FOR CA IN ZONE 3

RXSF            52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.

 SMOOTH CAPTURE CROSS SECTION FOR CA IN ZONE3

SXSC            52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          1.0500E-04
  1.5400E-04  2.4800E-04  3.4200E-04  2.9400E-04  2.8800E-04  4.4500E-04  6.0900E-04  7.6800E-04  8.8100E-04  7.1200E-04
  2.2900E-04  3.9400E-04  1.8300E-03  1.3800E-03  2.1700E-03  4.4700E-04  4.9400E-04  5.8800E-04  7.4500E-04  9.8100E-04
  1.3400E-03  1.9900E-03  4.9400E-03  4.1300E-02  1.8200E-01  2.9200E-02  1.1900E-02  7.7700E-03  6.3800E-03  5.8000E-03
  5.5600E-03  5.5800E-03  5.8600E-03  6.2300E-03  6.8300E-03  7.5000E-03  8.2300E-03  9.0500E-03  1.0200E-02  1.1500E-02
  1.3000E-02  1.4700E-02

 SMOOTH FISSION CROSS SECTION FOR CA IN ZONE  3

SXSF            52
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
  0.          0.

 RESONANCE WEIGHTING FUNCTIONS FOR ZONE 3

RW              52
  2.0500E-02  1.0600E-01  3.5500E-01  8.5300E-01  1.5800E+00  2.4200E+00  3.2800E+00  3.9300E+00  4.4700E+00  4.5900E+00
  4.6600E+00  5.1800E+00  6.1000E+00  7.0700E+00  7.1800E+00  7.1600E+00  6.6400E+00  6.1300E+00  5.3300E+00  4.5000E+00
  3.6700E+00  3.1400E+00  2.6000E+00  2.3000E+00  1.8500E+00  1.6100E+00  1.3000E+00  8.7900E-01  6.1500E-01  4.3800E-01
  3.2600E-01  5.8100E+01  3.1600E+01  1.8300E+01  1.3300E+01  1.0100E+01  6.1300E+00  2.8900E+00  1.2200E+00  5.1700E-01
  2.3000E-01  9.4800E-02  3.2700E-02  1.2400E-02  3.6800E-03  1.4600E-03  5.8900E-04  1.8700E-04  8.2100E-05  2.2300E-05
  9.0000E-06  3.5100E-06
```

TABLE III (continued)

UNRESOLVED PLUS SMOOTH WEIGHTING FUNCTIONS FOR ZONE 3

```
SW          52
 1.3400E-02 6.7900E-02 2.2600E-01 5.4800E-01 1.0200E+00 1.5500E+00 2.2600E+00 2.7000E+00 3.0100E+00 3.4600E+00
 4.2400E+00 5.7100E+00 6.8200E+00 8.9400E+00 8.7400E+00 9.0800E+00 7.8100E+00 6.7000E+00 5.7700E+00 5.3500E+00
 4.2000E+00 3.8000E+00 2.5400E+00 2.7500E+00 1.5500E+00 1.3100E+00 1.5200E+00 9.4200E-01 6.0100E-01 3.6600E-01
 2.2300E-01 1.9600E-01 1.0800E-01 2.9000E-02 1.1200E-02 6.2000E-02 7.2500E-02 4.3400E-02 2.2900E-02 1.3700E-02
 6.6700E-03 3.1900E-03 1.6300E-03 6.6900E-04 2.6700E-04 1.1400E-04 6.7300E-05 2.0400E-05 1.3100E-05 3.1900E-06
 2.3500E-06 8.2500E-07

RADII       10
  0.        1.0000E+00 2.0000E+00 3.0000E+00 4.0000E+00 6.0000E+00 9.0000E+00 1.1000E+01 1.3000E+01 1.5000E+01

ZONE NUMBERS    9
           1           1           1           2           2           2           2           3           3

MIXTURE NOS     3
           7           8           9

MIX TABLE       9
           7           7           8           8           8           9           9           9           9

MIX COMMAND     9
           0           1           0           2           3           0           4           5           6

MIX DENSITY     9
  0.        6.0000E-02  0.          5.0000E-02  4.0000E-02  0.          3.0000E-02  2.0000E-02  1.0000E-02

NEUTRON FLUX  234
 1.0000E+00 1.0000E+00 1.0000E+00 1.0000E-01 1.0000E-01 1.0000E-01 1.0000E-01 1.0000E-02 1.0000E-02 2.0000E+00
 2.0000E+00 2.0000E+00 2.0000E-01 2.0000E-01 2.0000E-01 2.0000E-01 2.0000E-02 2.0000E-02 3.0000E+00 3.0000E+00
 3.0000E+00 3.0000E-01 3.0000E-01 3.0000E-01 3.0000E-01 3.0000E-02 3.0000E-02 4.0000E+00 4.0000E+00 4.0000E+00
 4.0000E-01 4.0000E-01 4.0000E-01 4.0000E-01 4.0000E-02 4.0000E-02 5.0000E+00 5.0000E+00 5.0000E+00 5.0000E-01
 5.0000E-01 5.0000E-01 5.0000E-01 5.0000E-02 5.0000E-02 6.0000E+00 6.0000E+00 6.0000E+00 6.0000E-01 6.0000E-01
 6.0000E-01 6.0000E-01 6.0000E-02 6.0000E-02 7.0000E+00 7.0000E+00 7.0000E+00 7.0000E-01 7.0000E-01 7.0000E-01
 7.0000E-01 7.0000E-02 7.0000E-02 8.0000E+00 8.0000E+00 8.0000E+00 8.0000E-01 8.0000E-01 8.0000E-01 8.0000E-01
 8.0000E-02 8.0000E-02 9.0000E+00 9.0000E+00 9.0000E+00 9.0000E-01 9.0000E-01 9.0000E-01 9.0000E-01 9.0000E-02
 9.0000E-02 1.0000E+01 1.0000E+01 1.0000E+01 1.0000E+00 1.0000E+00 1.0000E+00 1.0000E+00 1.0000E-01 1.0000E-01
 1.1000E+01 1.1000E+01 1.1000E+01 1.1000E+00 1.1000E+00 1.1000E+00 1.1000E+00 1.1000E-01 1.1000E-01 1.2000E+01
 1.2000E+01 1.2000E+01 1.2000E+01 1.2000E+00 1.2000E+00 1.2000E+00 1.2000E-01 1.2000E-01 1.3000E+01 1.3000E+01
 1.3000E+01 1.3000E+00 1.3000E+00 1.3000E+00 1.3000E+00 1.3000E-01 1.3000E-01 1.4000E+01 1.4000E+01 1.4000E+01
 1.4000E+00 1.4000E+00 1.4000E+00 1.4000E+00 1.4000E-01 1.4000E-01 1.5000E+01 1.5000E+01 1.5000E+01 1.5000E+00
 1.5000E+00 1.5000E+00 1.5000E+00 1.5000E-01 1.5000E-01 1.6000E+01 1.6000E+01 1.6000E+01 1.6000E+00 1.6000E+00
 1.6000E+00 1.6000E+00 1.6000E-01 1.6000E-01 1.7000E+01 1.7000E+01 1.7000E+01 1.7000E+00 1.7000E+00 1.7000E+00
 1.7000E+00 1.7000E-01 1.7000E-01 1.8000E+01 1.8000E+01 1.8000E+01 1.8000E+01 1.8000E+00 1.8000E+00 1.8000E+00
 1.8000E+01 1.8000E-01 1.9000E+01 1.9000E+01 1.9000E+01 1.9000E+00 1.9000E+00 1.9000E+00 1.9000E+00 1.9000E-01
 1.9000E-01 2.0000E+01 2.0000E+01 2.0000E+01 2.0000E+00 2.0000E+00 2.0000E+00 2.0000E+00 2.0000E-01 2.0000E-01
 2.1000E+01 2.1000E+01 2.1000E+01 2.1000E+00 2.1000E+00 2.1000E+00 2.1000E+00 2.1000E-01 2.1000E+01 2.2000E+01
 2.2000E+01 2.2000E+01 2.2000E+00 2.2000E+00 2.2000E+00 2.2000E+00 2.2000E-01 2.2000E-01 2.3000E+01 2.3000E+01
 2.3000E+01 2.3000E+00 2.3000E+00 2.3000E+00 2.3000E+00 2.3000E-01 2.3000E-01 2.4000E+01 2.4000E+01 2.4000E+01
 2.4000E+00 2.4000E+00 2.4000E+00 2.4000E+00 2.4000E-01 2.4000E-01 2.5000E+01 2.5000E-01 2.5000E+01 2.5000E+00
 2.5000E+00 2.5000E+00 2.5000E+00 2.5000E-01 2.5000E-01 2.6000E+01 2.6000E+01 2.6000E+01 2.6000E+00 2.6000E+00
 2.6000E+00 2.6000E+00 2.6000E-01 2.6000E-01
------ZONE   1   -----MATERIAL   1   ------
------ZONE   2   -----MATERIAL   1   ------
------ZONE   2   -----MATERIAL   2   ------
------ZONE   3   -----MATERIAL   1   ------
------ZONE   3   -----MATERIAL   2   ------
  UNDER THE OPTION PROVIDED WHEN INPUT MT=-1 IS USED, THERE WILL BE   22 REACTION TYPES USED AS FOLLOWS -
   MTNO(I)=   5   6   7   8   9  10  11  12  13  14  15  51  52  53  54  55  56  57 102 103

   MTNO(I)= 107 110
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OUTPUT FROM PR15

INDEX ILO	MT NUMBER	GAMMA ENERGY RANGE		NUMERATOR	DENOMINATOR	EMAT
1	15	.40000000E+06	.50000000E+06	.71956500E+04	.15642250E-01	.46001374E+06
23	15	.50000000E+06	.90000000E+06	.57921700E+05	.80912250E-01	.71585823E+06
45	15	.90000000E+06	.13500000E+07	.13033064E+06	.11495719E+00	.11337320E+07
67	15	.13500000E+07	.18000000E+07	.20214041E+06	.12810231E+00	.15779607E+07
89	15	.18000000E+07	.22000000E+07	.23460980E+06	.11727700E+00	.20004758E+07
111	15	.22000000E+07	.26000000E+07	.28072260E+06	.11701300E+00	.23990719E+07
133	15	.26000000E+07	.30000000E+07	.31364940E+06	.11215300E+00	.27966207E+07
155	15	.30000000E+07	.40000000E+07	.65685000E+06	.19283500E+00	.34062800E+07
177	15	.40000000E+07	.50000000E+07	.33776000E+06	.77684750E-01	.43478289E+07
199	15	.50000000E+07	.70000000E+07	.77647500E+05	.15529500E-01	.50000000E+07
243	15	.40000000E+06	.50000000E+06	.68521500E+04	.14895000E-01	.46003021E+06
255	15	.50000000E+06	.90000000E+06	.55177250E+05	.77077000E-01	.71587179E+06
267	15	.90000000E+06	.13500000E+07	.12413607E+06	.10949206E+00	.11337450E+07
279	15	.13500000E+07	.18000000E+07	.19255472E+06	.12202794E+00	.15779561E+07
291	15	.18000000E+07	.22000000E+07	.22395700E+06	.11195300E+00	.20004555E+07
303	15	.22000000E+07	.26000000E+07	.26736360E+06	.11144400E+00	.23990847E+07
315	15	.26000000E+07	.30000000E+07	.29870680E+06	.10681000E+00	.27966183E+07
327	15	.30000000E+07	.40000000E+07	.64069500E+06	.18751500E+00	.34167667E+07
339	15	.40000000E+07	.50000000E+07	.41782600E+06	.94886750E-01	.44034178E+07
351	15	.50000000E+07	.70000000E+07	.19452250E+06	.37352500E-01	.52077505E+07
375	15	.40000000E+06	.50000000E+06	.66207000E+04	.14391250E-01	.46005038E+06
381	15	.50000000E+06	.90000000E+06	.53313150E+05	.74475000E-01	.71585297E+06
387	15	.90000000E+06	.13500000E+07	.11995469E+06	.10580350E+00	.11337497E+07
393	15	.13500000E+07	.18000000E+07	.18806746E+06	.11791525E+00	.15779762E+07
399	15	.18000000E+07	.22000000E+07	.21591240E+06	.10793200E+00	.20004484E+07
405	15	.22000000E+07	.26000000E+07	.25833840E+06	.10768200E+00	.23990862E+07
411	15	.26000000E+07	.30000000E+07	.28861980E+06	.10320300E+00	.27966222E+07
417	15	.30000000E+07	.40000000E+07	.62642250E+06	.18310750E+00	.34210641E+07
423	15	.40000000E+07	.50000000E+07	.43409400E+06	.98260750E-01	.44177762E+07

TABLE III (continued)

429	15	.50000000E+07	.70000000E+07	.33518650E+06	.61566500E-01	.54443001E+07
435	15	.70000000E+07	.10000000E+08	.74115383E-09	.10587912E-15	.70000000E+07
441	15	.40000000E+06	.50000000E+06	.62988000E+04	.13691000E-01	.46006866E+06
446	15	.50000000E+06	.90000000E+06	.50726650E+05	.70862750E-01	.71584366E+06
451	15	.90000000E+06	.13500000E+07	.11410785E+06	.10064669E+00	.11337467E+07
456	15	.13500000E+07	.18000000E+07	.17700490E+06	.11217256E+00	.15779697E+07
461	15	.18000000E+07	.22000000E+07	.20540460E+06	.10267900E+00	.20004538E+07
466	15	.22000000E+07	.26000000E+07	.24575120E+06	.10243600E+00	.23990706E+07
471	15	.26000000E+07	.30000000E+07	.27453400E+06	.98166000E-01	.27966302E+07
476	15	.30000000E+07	.40000000E+07	.60261500E+06	.17593750E+00	.34251652E+07
481	15	.40000000E+07	.50000000E+07	.46293375E+06	.10435225E+00	.44362604E+07
486	15	.50000000E+07	.70000000E+07	.49334300E+06	.87542000E-01	.56355007E+07
491	15	.70000000E+07	.10000000E+08	.49703500E+05	.71005000E-02	.70000000E+07
496	15	.40000000E+06	.50000000E+06	.60465000E+04	.13143500E-01	.46003728E+06
499	15	.50000000E+06	.90000000E+06	.48697150E+05	.68024500E-01	.71587663E+06
502	15	.90000000E+06	.13500000E+07	.10955477E+06	.96630312E-01	.11337516E+07
505	15	.13500000E+07	.18000000E+07	.16995017E+06	.10770269E+00	.15779567E+07
508	15	.18000000E+07	.22000000E+07	.19692640E+06	.98452000E-01	.20002275E+07
511	15	.22000000E+07	.26000000E+07	.23513980E+06	.98003000E-01	.23993123E+07
514	15	.26000000E+07	.30000000E+07	.26361000E+06	.94260000E-01	.27966264E+07
517	15	.30000000E+07	.40000000E+07	.58627500E+06	.17091500E+00	.34302138E+07
520	15	.40000000E+07	.50000000E+07	.47496250E+06	.10687250E+00	.44441975E+07
523	15	.50000000E+07	.70000000E+07	.60786200E+06	.10613600E+00	.57271991E+07
526	15	.70000000E+07	.10000000E+08	.11832340E+06	.16421800E-01	.72052637E+07

------ZONE 3 ------MATERIAL 3 ------

OUTPUT FROM PR15

INDEX	ILOI	MT NUMBER	GAMMA ENERGY RANGE		NUMERATOR	DENOMINATOR	EHAT
1		15	.40000000E+06	.50000000E+06	.48782700E+04	.10464300E-01	.46618216E+06
5		15	.50000000E+06	.90000000E+06	.45350940E+05	.62620600E-01	.72421759E+06
9		15	.90000000E+06	.13500000E+07	.11353927E+06	.99762937E-01	.11380907E+07
13		15	.13500000E+07	.18000000E+07	.18616027E+06	.11782256E+00	.15800053E+07
17		15	.18000000E+07	.22000000E+07	.22288160E+06	.11138000E+00	.20010918E+07
21		15	.22000000E+07	.26000000E+07	.26158880E+06	.10913200E+00	.23969945E+07
25		15	.26000000E+07	.30000000E+07	.27935840E+06	.99998000E-01	.27936399E+07
29		15	.30000000E+07	.40000000E+07	.63512000E+06	.18461250E+00	.34402871E+07
33		15	.40000000E+07	.50000000E+07	.46916750E+06	.10819150E+00	.43364543E+07
37		15	.50000000E+07	.70000000E+07	.40756215E+06	.73310450E-01	.55594005E+07
41		15	.70000000E+07	.10000000E+08	.28706650E+05	.41009500E-02	.70000000E+07
45		15	.40000000E+06	.50000000E+06	.46803600E+04	.10040275E-01	.46615855E+06
51		15	.50000000E+06	.90000000E+06	.43514070E+05	.60082175E-01	.72424259E+06
57		15	.90000000E+06	.13500000E+07	.10895967E+06	.95738375E-01	.11380982E+07
63		15	.13500000E+07	.18000000E+07	.17866477E+06	.11307887E+00	.15800013E+07
69		15	.18000000E+07	.22000000E+07	.21393700E+06	.10690900E+00	.20011131E+07
75		15	.22000000E+07	.26000000E+07	.25105600E+06	.10473800E+00	.23969906E+07
81		15	.26000000E+07	.30000000E+07	.26811040E+06	.95972000E-01	.27936315E+07
87		15	.30000000E+07	.40000000E+07	.60939500E+06	.17713750E+00	.34402371E+07
93		15	.40000000E+07	.50000000E+07	.47472750E+06	.10872050E+00	.43664948E+07
99		15	.50000000E+07	.70000000E+07	.54658250E+06	.95935500E-01	.56973956E+07
105		15	.70000000E+07	.10000000E+08	.99525000E+05	.13792500E-01	.72158782E+07
111		15	.40000000E+06	.50000000E+06	.44811600E+04	.96125750E-02	.46617928E+06
116		15	.50000000E+06	.90000000E+06	.41661570E+05	.57525425E-01	.72422881E+06
121		15	.90000000E+06	.13500000E+07	.10433312E+06	.91673562E-01	.11380939E+07
126		15	.13500000E+07	.18000000E+07	.17103862E+06	.10825319E+00	.15799870E+07
131		15	.18000000E+07	.22000000E+07	.20479000E+06	.10233800E+00	.20011140E+07
136		15	.22000000E+07	.26000000E+07	.24032240E+06	.10026000E+00	.23969918E+07
141		15	.26000000E+07	.30000000E+07	.25669680E+06	.91886000E-01	.27936443E+07
146		15	.30000000E+07	.40000000E+07	.58348750E+06	.16960750E+00	.34402223E+07
151		15	.40000000E+07	.50000000E+07	.47092000E+06	.10737200E+00	.43858734E+07
156		15	.50000000E+07	.70000000E+07	.62029800E+06	.10785500E+00	.57512215E+07
161		15	.70000000E+07	.10000000E+08	.28721750E+06	.36521500E-01	.78643402E+07
166		15	.40000000E+06	.50000000E+06	.43689000E+04	.93717500E-02	.46617761E+06
169		15	.50000000E+06	.90000000E+06	.40624500E+05	.56092500E-01	.72424121E+06
172		15	.90000000E+06	.13500000E+07	.10171830E+06	.89376562E-01	.11380870E+07
175		15	.13500000E+07	.18000000E+07	.16676310E+06	.10554619E+00	.15800012E+07
178		15	.18000000E+07	.22000000E+07	.19967220E+06	.99781000E-01	.20011044E+07
181		15	.22000000E+07	.26000000E+07	.23456920E+06	.97852000E-01	.23971835E+07
184		15	.26000000E+07	.30000000E+07	.25022320E+06	.89582000E-01	.27932308E+07
187		15	.30000000E+07	.40000000E+07	.56828000E+06	.16515500E+00	.34408889E+07
190		15	.40000000E+07	.50000000E+07	.46858250E+06	.10657950E+00	.43965537E+07
193		15	.50000000E+07	.70000000E+07	.66979750E+06	.11576750E+00	.57857127E+07
196		15	.70000000E+07	.10000000E+08	.37118805E+06	.47317295E-01	.78446591E+07

PHOTON PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 1

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	0.	2.49268E-03	0.	0.	0.	0.	0.	0.
2	0.	8.71466E-04	0.	0.	0.	0.	0.	0.
3	0.	1.96759E-02	0.	0.	0.	0.	0.	0.
4	0.	5.03455E-02	0.	0.	0.	0.	0.	0.
5	0.	3.14871E-02	0.	0.	0.	0.	0.	0.
6	0.	4.01304E-02	0.	0.	0.	0.	0.	0.
7	0.	1.05218E-02	0.	0.	0.	0.	0.	0.
8	0.	7.10706E-02	0.	0.	0.	0.	0.	0.
9	0.	3.58987E-03	0.	0.	0.	0.	0.	0.
10	0.	1.01278E-02	0.	0.	0.	0.	0.	0.
11	5.40831E-01	1.66637E-01	0.	0.	0.	0.	0.	0.

TABLE III (continued)

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	0.	0.	
2	0.	0.	
3	0.	0.	
4	0.	0.	
5	0.	0.	
6	0.	0.	
7	0.	0.	
8	0.	0.	
9	0.	0.	
10	0.	0.	
11	0.	0.	

PHOTON PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 2

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	0.	0.	0.	0.	0.	2.25275E-04	4.64928E-04	5.32968E-04
2	0.	0.	0.	0.	0.	1.68578E-04	3.47915E-04	3.98830E-04
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	2.36876E-03	4.88871E-03	5.60416E-03
5	0.	0.	0.	0.	0.	1.15462E-03	2.38294E-03	2.73167E-03
6	0.	0.	0.	0.	0.	2.22744E-04	4.59704E-04	5.26980E-04
7	0.	0.	0.	0.	0.	2.13072E-04	4.39744E-04	5.04098E-04
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	5.03021E-04	1.03815E-03	1.19008E-03
10	0.	0.	0.	0.	0.	1.41912E-03	2.92883E-03	3.35745E-03
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	5.37555E-04	5.31121E-04	5.82686E-04	7.16038E-04	3.19018E-03	1.70624E-03	2.45491E-03	6.19686E-03
2	4.02263E-04	3.97449E-04	4.36035E-04	5.35825E-04	2.38728E-03	1.27681E-03	1.83706E-03	4.63723E-03
3	0.	0.	0.	0.	0.	0.	0.	0.
4	5.65239E-03	5.58474E-03	6.12694E-03	7.52914E-03	3.35447E-02	1.79411E-02	2.58134E-02	6.51600E-02
5	2.75518E-03	2.72220E-03	2.98649E-03	3.66997E-03	1.63509E-02	8.74512E-03	1.25824E-02	3.17613E-02
6	5.31516E-04	5.25154E-04	5.76139E-04	7.07994E-04	3.15434E-03	1.68707E-03	2.42733E-03	6.12724E-03
7	5.08437E-04	5.02352E-04	5.51123E-04	6.77252E-04	3.01738E-03	1.61381E-03	2.32193E-03	5.86119E-03
8	0.	0.	0.	0.	0.	0.	0.	0.
9	1.20032E-03	1.18595E-03	1.30109E-03	1.59886E-03	7.12343E-03	3.80989E-03	5.48162E-03	1.38371E-02
10	3.38634E-03	3.34581E-03	3.67064E-03	4.51070E-03	2.00966E-02	1.07485E-02	1.54648E-02	3.90373E-02
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	1.67142E-03	7.65813E-04	9.97565E-03	3.07345E-03	1.69131E-03	2.79602E-03	2.65832E-03	3.77502E-03
2	1.25076E-03	5.73073E-04	7.46498E-03	2.29992E-03	1.26564E-03	2.09231E-03	1.98928E-03	2.82492E-03
3	0.	0.	0.	0.	0.	0.	0.	0.
4	1.75750E-02	8.05252E-03	1.04894E-01	3.23173E-02	1.77841E-02	2.94001E-02	2.79523E-02	3.96943E-02
5	8.56669E-03	3.92509E-03	5.11291E-02	1.57526E-02	8.66862E-03	1.43307E-02	1.36249E-02	1.93484E-02
6	1.65264E-03	7.57209E-04	9.86358E-03	3.03892E-03	1.67231E-03	2.76460E-03	2.62846E-03	3.73261E-03
7	1.58088E-03	7.24331E-04	9.43529E-03	2.90697E-03	1.59969E-03	2.64456E-03	2.51433E-03	3.57053E-03
8	0.	0.	0.	0.	0.	0.	0.	0.
9	3.73216E-03	1.71000E-03	2.22749E-02	6.86277E-03	3.77656E-03	6.24329E-03	5.93583E-03	8.42932E-03
10	1.05292E-02	4.82426E-03	6.28419E-02	1.93613E-02	1.06544E-02	1.76136E-02	1.67462E-02	2.37808E-02
11	0.	0.	0.	0.	0.	0.	0.	0.

TABLE III (continued)

	GROUP 25	GROUP 26	GROUP
1	4.65244E-03	6.59411E-03	
2	3.48151E-03	4.93451E-03	
3	0.	0.	
4	4.89204E-02	6.93371E-02	
5	2.38456E-02	3.37974E-02	
6	4.60017E-03	6.52003E-03	
7	4.40043E-03	6.23693E-03	
8	0.	0.	
9	1.03885E-02	1.47241E-02	
10	2.93082E-02	4.15398E-02	
11	0.	0.	

PHOTON PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 3

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	8.37424E-15	0.	0.	0.	0.	0.
3	0.	0.	5.96705E-03	0.	0.	0.	0.	0.
4	0.	0.	8.57543E-02	1.13475E-02	0.	0.	0.	0.
5	0.	0.	1.35131E-01	7.30168E-02	0.	0.	0.	0.
6	0.	0.	1.84105E-03	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	2.25918E-01	2.82302E-01	8.90859E-02	0.	0.	0.
9	0.	0.	1.57589E-01	1.52537E-01	9.98537E-02	0.	0.	0.
10	0.	0.	1.50302E-03	6.19263E-11	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	0.	0.	
2	0.	0.	
3	0.	0.	
4	0.	0.	
5	0.	0.	
6	0.	0.	
7	0.	0.	
8	0.	0.	
9	0.	0.	
10	0.	0.	
11	0.	0.	

PHOTON PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 4

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

TABLE III (continued)

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	0.	0.	
2	0.	0.	
3	0.	0.	
4	0.	0.	
5	0.	0.	
6	0.	0.	
7	0.	0.	
8	0.	0.	
9	0.	0.	
10	0.	0.	
11	0.	0.	

PHOTON PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 5

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	4.79425E-03	0.	0.	0.	5.26094E-04	3.96047E-03	7.18867E-03	1.05645E-02
2	8.61033E-02	3.63571E-02	0.	0.	2.33499E-03	1.75780E-02	3.19059E-02	4.68891E-02
3	1.20051E-01	1.09488E-01	0.	0.	1.67197E-03	1.25867E-02	2.28462E-02	3.35749E-02
4	2.14624E-01	4.05126E-01	1.83639E-01	5.77015E-03	2.32058E-03	1.74695E-02	3.17089E-02	4.65997E-02
5	1.20451E-01	2.39808E-01	1.43481E-01	2.47068E-02	7.56710E-04	5.69656E-03	1.03399E-02	1.51955E-02
6	1.25647E-01	1.71660E-01	7.77110E-02	4.84230E-02	1.00895E-03	7.59562E-03	1.37865E-02	2.02607E-02
7	1.25982E-01	1.42053E-01	0.	0.	1.58549E-03	1.19357E-02	2.16645E-02	3.18383E-02
8	1.37627E-01	1.61149E-01	9.41182E-03	3.53499E-03	2.40035E-03	1.57334E-02	2.85577E-02	4.19686E-02
9	1.23488E-01	1.51896E-01	3.08341E-02	1.17747E-02	1.93846E-03	4.88277E-03	8.86275E-03	1.30247E-02
10	8.69303E-02	1.25011E-01	2.17163E-02	3.30837E-04	2.45030E-03	1.84460E-02	3.34815E-02	4.92046E-02
11	1.67972E-02	1.89212E-02	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	1.36119E-02	1.55028E-02	1.61914E-02	2.38670E-02	3.94358E-02	5.52331E-02	7.23480E-02	9.05792E-02
2	6.04145E-02	6.88072E-02	7.18632E-02	1.05930E-01	1.75030E-01	2.45144E-01	3.21106E-01	4.02023E-01
3	4.32598E-02	4.92693E-02	5.14576E-02	7.58513E-02	1.25330E-01	1.75535E-01	2.29928E-01	2.87868E-01
4	6.00416E-02	6.83824E-02	7.14196E-02	1.05276E-01	1.73950E-01	2.43631E-01	3.19124E-01	3.99541E-01
5	1.95788E-02	2.22986E-02	2.32890E-02	3.43292E-02	5.67228E-02	7.94449E-02	1.04062E-01	1.30285E-01
6	2.61050E-02	2.97315E-02	3.10520E-02	4.57723E-02	7.56303E-02	1.05927E-01	1.38750E-01	1.73714E-01
7	4.10222E-02	4.67209E-02	4.87960E-02	7.19279E-02	1.18848E-01	1.66456E-01	2.18035E-01	2.72979E-01
8	5.40747E-02	6.15867E-02	6.43220E-02	9.48141E-02	1.56663E-01	2.19419E-01	2.87410E-01	3.59835E-01
9	1.67818E-02	1.91131E-02	1.99620E-02	2.94251E-02	4.86195E-02	6.80956E-02	8.91961E-02	1.11673E-01
10	6.33979E-02	7.22051E-02	7.54120E-02	1.11161E-01	1.83674E-01	2.57250E-01	3.36963E-01	4.21876E-01
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	1.10555E-01	1.58314E-01	1.93801E-01	2.35210E-01	3.75501E-01	3.14242E-01	4.72093E-01	5.88498E-01
2	4.90683E-01	7.02655E-01	8.60157E-01	1.04394E+00	1.66661E+00	1.39472E+00	2.09532E+00	2.61196E+00
3	3.51353E-01	5.03136E-01	6.15915E-01	7.47516E-01	1.19337E+00	9.98687E-01	1.50035E+00	1.87029E+00
4	4.87654E-01	6.98318E-01	8.54847E-01	1.03750E+00	1.65632E+00	1.38611E+00	2.08238E+00	2.59584E+00
5	1.59018E-01	2.27712E-01	2.78755E-01	3.38315E-01	5.40104E-01	4.51992E-01	6.79034E-01	8.46469E-01
6	2.12023E-01	3.03616E-01	3.71673E-01	4.51087E-01	7.20138E-01	6.02656E-01	9.05385E-01	1.12863E+00
7	3.33180E-01	4.77111E-01	5.84057E-01	7.08851E-01	1.13165E+00	9.47031E-01	1.42275E+00	1.77355E+00
8	4.39191E-01	6.28920E-01	7.69894E-01	9.34395E-01	1.49172E+00	1.24836E+00	1.87544E+00	2.33787E+00
9	1.36301E-01	1.95182E-01	2.38933E-01	2.89985E-01	4.62946E-01	3.87422E-01	5.82033E-01	7.25545E-01
10	5.14914E-01	7.37354E-01	9.02634E-01	1.09550E+00	1.74891E+00	1.46359E+00	2.19879E+00	2.74095E+00
11	0.	0.	0.	0.	0.	0.	0.	0.

TABLE III (continued)

	GROUP 25	GROUP 26	GROUP
1	4.84743E-01	1.35812E+00	
2	2.15146E+00	6.02780E+00	
3	1.54055E+00	4.31620E+00	
4	2.13818E+00	5.99059E+00	
5	6.97233E-01	1.95345E+00	
6	9.29644E-01	2.60460E+00	
7	1.46087E+00	4.09295E+00	
8	1.92569E+00	5.39525E+00	
9	5.97628E-01	1.67439E+00	
10	2.25771E+00	6.32547E+00	
11	0.	0.	

PHOTON PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 6

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	2.59923E-02	7.33992E-05	0.	0.	0.	0.	0.	0.
2	1.11998E-01	1.19142E-03	0.	0.	0.	0.	0.	0.
3	1.22693E-01	1.73197E-03	0.	0.	0.	0.	0.	0.
4	1.98330E-01	2.94863E-03	0.	0.	0.	0.	0.	0.
5	1.07457E-01	1.59718E-03	0.	0.	0.	0.	0.	0.
6	1.17272E-01	1.74307E-03	0.	0.	0.	0.	0.	0.
7	1.19691E-01	1.77899E-03	0.	0.	0.	0.	0.	0.
8	1.26607E-01	1.88188E-03	0.	0.	0.	0.	0.	0.
9	1.07202E-01	1.59342E-03	0.	0.	0.	0.	0.	0.
10	6.72763E-02	1.00017E-03	0.	0.	0.	0.	0.	0.
11	1.12421E-02	1.67135E-04	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	0.	0.	
2	0.	0.	
3	0.	0.	
4	0.	0.	
5	0.	0.	
6	0.	0.	
7	0.	0.	
8	0.	0.	
9	0.	0.	
10	0.	0.	
11	0.	0.	

PHOTON PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 7

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	0.	1.49561E-04	0.	0.	0.	0.	0.	0.
2	0.	5.22879E-05	0.	0.	0.	0.	0.	0.
3	0.	1.18055E-03	0.	0.	0.	0.	0.	0.
4	0.	3.02073E-03	0.	0.	0.	0.	0.	0.
5	0.	1.88923E-03	0.	0.	0.	0.	0.	0.
6	0.	2.40782E-03	0.	0.	0.	0.	0.	0.
7	0.	6.31307E-04	0.	0.	0.	0.	0.	0.
8	0.	4.26424E-03	0.	0.	0.	0.	0.	0.
9	0.	2.15392E-04	0.	0.	0.	0.	0.	0.
10	0.	6.07667E-04	0.	0.	0.	0.	0.	0.
11	3.24499E-02	9.99820E-03	0.	0.	0.	0.	0.	0.

TABLE III (continued)

	GROUP 25	GROUP 26	GROUP
1	2.32622E-04	3.29706E-04	
2	1.74076E-04	2.46725E-04	
3	0.	0.	
4	2.44602E-03	3.46685E-03	
5	1.19228E-03	1.68987E-03	
6	2.30008E-04	3.26002E-04	
7	2.20021E-04	3.11846E-04	
8	0.	0.	
9	5.19427E-04	7.36207E-04	
10	1.46541E-03	2.07699E-03	
11	0.	0.	

PHOTON PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 9

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	3.55808E-04	7.33992E-07	0.	0.	1.05219E-05	7.92093E-05	1.43773E-04	2.11290E-04
2	2.84204E-03	7.39057E-04	0.	0.	4.66998E-05	3.51559E-04	6.38118E-04	9.37782E-04
3	3.62795E-03	2.20708E-03	0.	0.	3.34394E-05	2.51734E-04	4.56924E-04	6.71498E-04
4	6.27579E-03	8.13201E-03	3.67278E-03	1.15403E-04	4.64115E-05	3.49389E-04	6.34179E-04	9.31993E-04
5	3.48360E-03	4.81213E-03	2.86963E-03	4.94137E-04	1.51342E-05	1.13931E-04	2.06797E-04	3.03911E-04
6	3.68566E-03	3.45062E-03	1.55422E-03	9.68460E-04	2.01789E-05	1.51908E-04	2.75730E-04	4.05214E-04
7	3.71654E-03	2.85885E-03	0.	0.	3.17097E-05	2.38713E-04	4.33290E-04	6.36765E-04
8	4.01860E-03	3.24181E-03	1.88236E-04	7.06997E-05	4.80071E-05	3.14667E-04	5.71155E-04	8.39373E-04
9	3.54177E-03	3.05385E-03	6.16682E-04	2.35494E-04	3.87692E-05	9.76553E-05	1.77255E-04	2.60495E-04
10	2.41137E-03	2.51023E-03	4.34325E-04	6.61675E-06	4.90060E-05	3.68920E-04	6.69630E-04	9.84092E-04
11	4.48365E-04	3.80096E-04	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	2.72238E-04	3.10057E-04	3.23828E-04	4.77340E-04	7.88717E-04	1.10466E-03	1.44696E-03	1.81158E-03
2	1.20829E-03	1.37614E-03	1.43726E-03	2.11860E-03	3.50060E-03	4.90289E-03	6.42212E-03	8.04046E-03
3	8.65195E-04	9.85387E-04	1.02915E-03	1.51703E-03	2.50661E-03	3.51071E-03	4.59856E-03	5.75737E-03
4	1.20083E-03	1.36765E-03	1.42839E-03	2.10553E-03	3.47900E-03	4.87262E-03	6.38248E-03	7.99083E-03
5	3.91575E-04	4.45972E-04	4.65780E-04	6.86585E-04	1.13446E-03	1.58890E-03	2.08124E-03	2.60570E-03
6	5.22101E-04	5.94630E-04	6.21040E-04	9.15447E-04	1.51261E-03	2.11853E-03	2.77499E-03	3.47427E-03
7	8.20444E-04	9.34418E-04	9.75920E-04	1.43856E-03	2.37695E-03	3.32912E-03	4.36070E-03	5.45957E-03
8	1.08149E-03	1.23173E-03	1.28644E-03	1.89628E-03	3.13326E-03	4.38839E-03	5.74820E-03	7.19671E-03
9	3.35636E-04	3.82262E-04	3.99240E-04	5.88501E-04	9.72390E-04	1.36191E-03	1.78392E-03	2.23346E-03
10	1.26796E-03	1.44410E-03	1.50824E-03	2.22323E-03	3.67347E-03	5.14500E-03	6.73926E-03	8.43752E-03
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	2.21110E-03	3.16629E-03	3.87602E-03	4.70419E-03	7.51001E-03	6.28484E-03	9.44187E-03	1.17700E-02
2	9.81365E-03	1.40531E-02	1.72031E-02	2.08789E-02	3.33321E-02	2.78944E-02	4.19064E-02	5.22392E-02
3	7.02706E-03	1.00627E-02	1.23183E-02	1.49503E-02	2.38674E-02	1.99737E-02	3.00070E-02	3.74059E-02
4	9.75307E-03	1.39664E-02	1.70969E-02	2.07500E-02	3.31264E-02	2.77222E-02	4.16477E-02	5.19168E-02
5	3.18035E-03	4.55425E-03	5.57509E-03	6.76631E-03	1.08021E-02	9.03984E-03	1.35808E-02	1.69294E-02
6	4.24047E-03	6.07233E-03	7.43346E-03	9.02174E-03	1.44028E-02	1.20531E-02	1.81077E-02	2.25725E-02
7	6.66359E-03	9.54223E-03	1.16811E-02	1.41770E-02	2.26329E-02	1.89406E-02	2.84549E-02	3.54711E-02
8	8.78382E-03	1.25784E-02	1.53979E-02	1.86879E-02	2.98343E-02	2.49672E-02	3.75088E-02	4.67573E-02
9	2.72601E-03	3.90364E-03	4.77865E-03	5.79969E-03	9.25892E-03	7.74843E-03	1.16407E-02	1.45109E-02
10	1.02983E-02	1.47471E-02	1.80527E-02	2.19099E-02	3.49782E-02	2.92719E-02	4.39758E-02	5.48190E-02
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	9.69486E-03	2.71623E-02	
2	4.30292E-02	1.20556E-01	
3	3.08111E-02	8.63240E-02	
4	4.27636E-02	1.19812E-01	
5	1.39447E-02	3.90691E-02	
6	1.85929E-02	5.20921E-02	
7	2.92174E-02	8.18590E-02	
8	3.85138E-02	1.07905E-01	
9	1.19526E-02	3.34878E-02	
10	4.51541E-02	1.26509E-01	
11	0.	0.	

TABLE III (continued)

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	0.	0.	
2	0.	0.	
3	0.	0.	
4	0.	0.	
5	0.	0.	
6	0.	0.	
7	0.	0.	
8	0.	0.	
9	0.	0.	
10	0.	0.	
11	0.	0.	

PHOTON PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 8

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	0.	0.	0.	0.	0.	1.12637E-05	2.32464E-05	2.66484E-05
2	0.	0.	3.34970E-16	0.	0.	8.42888E-06	1.73957E-05	1.99415E-05
3	0.	0.	2.38682E-04	0.	0.	0.	0.	0.
4	0.	0.	3.43017E-03	4.53899E-04	0.	1.18438E-04	2.44436E-04	2.80208E-04
5	0.	0.	5.40523E-03	2.92067E-03	0.	5.77310E-05	1.19147E-04	1.36583E-04
6	0.	0.	7.36422E-05	0.	0.	1.11372E-05	2.29852E-05	2.63490E-05
7	0.	0.	0.	0.	0.	1.06536E-05	2.19872E-05	2.52049E-05
8	0.	0.	9.03674E-03	1.12921E-02	3.56344E-03	0.	0.	0.
9	0.	0.	6.30354E-03	6.10149E-03	3.99415E-03	2.51511E-05	5.19074E-05	5.95038E-05
10	0.	0.	6.01208E-05	2.47705E-12	0.	7.09562E-05	1.46441E-04	1.67872E-04
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	2.68778E-05	2.65561E-05	2.91343E-05	3.58019E-05	1.59509E-04	8.53118E-05	1.22746E-04	3.09843E-04
2	2.01132E-05	1.98724E-05	2.18018E-05	2.67913E-05	1.19364E-04	6.38405E-05	9.18529E-05	2.31862E-04
3	0.	0.	0.	0.	0.	0.	0.	0.
4	2.82620E-04	2.79237E-04	3.06347E-04	3.76457E-04	1.67724E-03	8.97053E-04	1.29067E-03	3.25800E-03
5	1.37759E-04	1.36110E-04	1.49325E-04	1.83499E-04	8.17546E-04	4.37256E-04	6.29119E-04	1.58807E-03
6	2.65758E-05	2.62577E-05	2.88070E-05	3.53997E-05	1.57717E-04	8.43533E-05	1.21367E-04	3.06362E-04
7	2.54218E-05	2.51176E-05	2.75561E-05	3.38626E-05	1.50869E-04	8.06906E-05	1.16097E-04	2.93059E-04
8	0.	0.	0.	0.	0.	0.	0.	0.
9	6.00159E-05	5.92976E-05	6.50546E-05	7.99429E-05	3.56171E-04	1.90494E-04	2.74081E-04	6.91855E-04
10	1.69317E-04	1.67291E-04	1.83532E-04	2.25535E-04	1.00483E-03	5.37424E-04	7.73239E-04	1.95186E-03
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	8.35711E-05	3.82907E-05	4.98783E-04	1.53673E-04	8.45654E-05	1.39801E-04	1.32914E-04	1.88751E-04
2	6.25379E-05	2.86537E-05	3.73249E-04	1.14996E-04	6.32820E-05	1.04616E-04	9.94638E-05	1.41246E-04
3	0.	0.	0.	0.	0.	0.	0.	0.
4	8.78750E-04	4.02626E-04	5.24470E-03	1.61587E-03	8.89205E-04	1.47001E-03	1.39761E-03	1.98471E-03
5	4.28334E-04	1.96254E-04	2.55645E-03	7.87631E-04	4.33431E-04	7.16534E-04	6.81247E-04	9.67422E-04
6	8.26322E-05	3.78605E-05	4.93179E-04	1.51946E-04	8.36154E-05	1.38230E-04	1.31423E-04	1.86630E-04
7	7.90442E-05	3.62165E-05	4.71765E-04	1.45348E-04	7.99847E-05	1.32228E-04	1.25716E-04	1.78527E-04
8	0.	0.	0.	0.	0.	0.	0.	0.
9	1.86608E-04	8.55000E-05	1.11374E-03	3.43139E-04	1.88828E-04	3.12164E-04	2.96791E-04	4.21466E-04
10	5.26459E-04	2.41213E-04	3.14210E-03	9.68064E-04	5.32722E-04	8.80679E-04	8.37309E-04	1.18904E-03
11	0.	0.	0.	0.	0.	0.	0.	0.

TABLE III (continued)

PHOTON PRODUCTION SOURCE VECTORS AT INDICATED MESH INTERVALS

```
   FOR MESH INTERVAL  1 BOUNDED BY RADII R=  0.          AND R=  1.0000E+00   THE VECTOR IS
2.99121185E+08  1.04575880E+08  2.36110834E+09  6.04145688E+09  3.77845681E+09  4.81564585E+09  1.26261364E+09  8.52847253E+09
4.30784467E+08  1.21533336E+09  5.24462832E+10
   FOR MESH INTERVAL  2 BOUNDED BY RADII R=  1.0000E+00  AND R=  2.0000E+00   THE VECTOR IS
2.99121185E+08  1.04575880E+08  2.36110834E+09  6.04145688E+09  3.77845681E+09  4.81564585E+09  1.26261364E+09  8.52847253E+09
4.30784467E+08  1.21533336E+09  5.24462832E+10
   FOR MESH INTERVAL  3 BOUNDED BY RADII R=  2.0000E+00  AND R=  3.0000E+00   THE VECTOR IS
2.99121185E+08  1.04575880E+08  2.36110834E+09  6.04145688E+09  3.77845681E+09  4.81564585E+09  1.26261364E+09  8.52847253E+09
4.30784467E+08  1.21533336E+09  5.24462832E+10
   FOR MESH INTERVAL  4 BOUNDED BY RADII R=  3.0000E+00  AND R=  4.0000E+00   THE VECTOR IS
5.32544491E+09  3.98513582E+09  7.16046338E+07  5.72076453E+10  3.00848123E+10  5.28770710E+09  5.03697663E+09  9.00957538E+09
1.82200358E+10  3.35658284E+10  0.
   FOR MESH INTERVAL  5 BOUNDED BY RADII R=  4.0000E+00  AND R=  6.0000E+00   THE VECTOR IS
5.32544491E+09  3.98513582E+09  7.16046338E+07  5.72076453E+10  3.00848123E+10  5.28770710E+09  5.03697663E+09  9.00957538E+09
1.82200358E+10  3.35658284E+10  0.
   FOR MESH INTERVAL  6 BOUNDED BY RADII R=  6.0000E+00  AND R=  9.0000E+00   THE VECTOR IS
5.32544491E+09  3.98513582E+09  7.16046338E+07  5.72076453E+10  3.00848123E+10  5.28770710E+09  5.03697663E+09  9.00957538E+09
1.82200358E+10  3.35658284E+10  0.
   FOR MESH INTERVAL  7 BOUNDED BY RADII R=  9.0000E+00  AND R=  1.1000E+01   THE VECTOR IS
5.32544491E+09  3.98513582E+09  7.16046338E+07  5.72076453E+10  3.00848123E+10  5.28770710E+09  5.03697663E+09  9.00957538E+09
1.82200358E+10  3.35658284E+10  0.
   FOR MESH INTERVAL  8 BOUNDED BY RADII R=  1.1000E+01  AND R=  1.3000E+01   THE VECTOR IS
2.10135116E+10  9.32927934E+10  6.68517337E+10  9.30141747E+10  3.04567080E+10  4.04842675E+10  6.34119664E+10  8.35779484E+10
2.60283692E+10  9.79421226E+10  1.20855669E+07
   FOR MESH INTERVAL  9 BOUNDED BY RADII R=  1.3000E+01  AND R=  1.5000E+01   THE VECTOR IS
2.10135116E+10  9.32927934E+10  6.68517337E+10  9.30141747E+10  3.04567080E+10  4.04842675E+10  6.34119664E+10  8.35779484E+10
2.60283692E+10  9.79421226E+10  1.20855669E+07
```

PHOTON ENERGY PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 1

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	0.	1.77229E+04	0.	0.	0.	0.	0.	0.
2	0.	5.81337E+03	0.	0.	0.	0.	0.	0.
3	0.	8.64877E+04	0.	0.	0.	0.	0.	0.
4	0.	1.85553E+05	0.	0.	0.	0.	0.	0.
5	0.	8.77429E+04	0.	0.	0.	0.	0.	0.
6	0.	9.45773E+04	0.	0.	0.	0.	0.	0.
7	0.	2.12524E+04	0.	0.	0.	0.	0.	0.
8	0.	1.18202E+05	0.	0.	0.	0.	0.	0.
9	0.	3.78220E+03	0.	0.	0.	0.	0.	0.
10	0.	6.32986E+03	0.	0.	0.	0.	0.	0.
11	2.37533E+05	7.31868E+04	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	0.	0.	
2	0.	0.	
3	0.	0.	
4	0.	0.	
5	0.	0.	
6	0.	0.	
7	0.	0.	
8	0.	0.	
9	0.	0.	
10	0.	0.	
11	0.	0.	

TABLE III (continued)

PHOTON ENERGY PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 2

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	0.	0.	0.	0.	0.	1.87575E+03	3.87122E+03	4.43775E+03
2	0.	0.	0.	0.	0.	1.06513E+03	2.19825E+03	2.51995E+03
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	8.70612E+03	1.79679E+04	2.05974E+04
5	0.	0.	0.	0.	0.	3.26626E+03	6.74100E+03	7.72751E+03
6	0.	0.	0.	0.	0.	5.63987E+02	1.16397E+03	1.33431E+03
7	0.	0.	0.	0.	0.	3.87844E+02	8.00443E+02	9.17584E+02
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	5.15557E+02	1.06402E+03	1.21973E+03
10	0.	0.	0.	0.	0.	8.28769E+02	1.71043E+03	1.96075E+03
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	4.47595E+03	4.42238E+03	4.85173E+03	5.96208E+03	2.65630E+04	1.42069E+04	2.04408E+04	5.15981E+04
2	2.54164E+03	2.51122E+03	2.75503E+03	3.38554E+03	1.50837E+04	8.06734E+03	1.16072E+04	2.92997E+04
3	0.	0.	0.	0.	0.	0.	0.	0.
4	2.07747E+04	2.05261E+04	2.25189E+04	2.76725E+04	1.23290E+05	6.59403E+04	9.48742E+04	2.39488E+05
5	7.79402E+03	7.70074E+03	8.44837E+03	1.03819E+04	4.62545E+04	2.47387E+04	3.55938E+04	8.98484E+04
6	1.34580E+03	1.32969E+03	1.45878E+03	1.79264E+03	7.98679E+03	4.27165E+03	6.14600E+03	1.55142E+04
7	9.25482E+02	9.14405E+02	1.00318E+03	1.23277E+03	5.49238E+03	2.93754E+03	4.22650E+03	1.06688E+04
8	0.	0.	0.	0.	0.	0.	0.	0.
9	1.23023E+03	1.21551E+03	1.33352E+03	1.63870E+03	7.30095E+03	3.90484E+03	5.61823E+03	1.41819E+04
10	1.97762E+03	1.95396E+03	2.14366E+03	2.63425E+03	1.17364E+04	6.27711E+03	9.03143E+03	2.27978E+04
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	1.39171E+04	6.37653E+03	8.30622E+04	2.55910E+04	1.40827E+04	2.32810E+04	2.21345E+04	3.14326E+04
2	7.90274E+03	3.62088E+03	4.71664E+04	1.45317E+04	7.99676E+03	1.32200E+04	1.25689E+04	1.78489E+04
3	0.	0.	0.	0.	0.	0.	0.	0.
4	6.45949E+04	2.95961E+04	3.85526E+05	1.18779E+05	6.53635E+04	1.08057E+05	1.02735E+05	1.45892E+05
5	2.42340E+04	1.11035E+04	1.44637E+05	4.45620E+04	2.45223E+04	4.05395E+04	3.85431E+04	5.47341E+04
6	4.18449E+03	1.91725E+03	2.49746E+04	7.69455E+03	4.23428E+03	6.99998E+03	6.65525E+03	9.45096E+03
7	2.87760E+03	1.31846E+03	1.71746E+04	5.29141E+03	2.91184E+03	4.81376E+03	4.57670E+03	6.49926E+03
8	0.	0.	0.	0.	0.	0.	0.	0.
9	3.82516E+03	1.75262E+03	2.28300E+04	7.03380E+03	3.87068E+03	6.39887E+03	6.08375E+03	8.63939E+03
10	6.14904E+03	2.81737E+03	3.66997E+04	1.13070E+04	6.22220E+03	1.02863E+04	9.77977E+03	1.38880E+04
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	3.87385E+04	5.49058E+04	
2	2.19974E+04	3.11780E+04	
3	0.	0.	
4	1.79801E+05	2.54841E+05	
5	6.74558E+04	9.56082E+04	
6	1.16476E+04	1.65087E+04	
7	8.00987E+03	1.13528E+04	
8	0.	0.	
9	1.06474E+04	1.50911E+04	
10	1.71160E+04	2.42593E+04	
11	0.	0.	

PHOTON ENERGY PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 3

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	4.29599E-08	0.	0.	0.	0.	0.
3	0.	0.	2.46929E+04	0.	0.	0.	0.	0.
4	0.	0.	2.59016E+05	3.41105E+04	0.	0.	0.	0.
5	0.	0.	3.64004E+05	1.94275E+05	0.	0.	0.	0.
6	0.	0.	4.22706E+03	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	3.81556E+05	4.87552E+05	1.56969E+05	0.	0.	0.
9	0.	0.	1.92258E+05	1.86095E+05	1.21822E+05	0.	0.	0.
10	0.	0.	7.78564E+02	3.20778E-05	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

TABLE III (continued)

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	0.	0.	
2	0.	0.	
3	0.	0.	
4	0.	0.	
5	0.	0.	
6	0.	0.	
7	0.	0.	
8	0.	0.	
9	0.	0.	
10	0.	0.	
11	0.	0.	

PHOTON ENERGY PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 4

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	0.	0.	
2	0.	0.	
3	0.	0.	
4	0.	0.	
5	0.	0.	
6	0.	0.	
7	0.	0.	
8	0.	0.	
9	0.	0.	
10	0.	0.	
11	0.	0.	

TABLE III (continued)

PHOTON ENERGY PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 5

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	4.07511E+04	0.	0.	0.	4.17587E+03	3.14362E+04	5.70602E+04	8.38559E+04
2	5.16620E+05	2.18143E+05	0.	0.	1.30065E+04	9.79135E+04	1.77724E+05	2.61184E+05
3	5.40230E+05	4.92696E+05	0.	0.	7.23340E+03	5.44535E+04	9.88390E+04	1.45254E+05
4	7.51186E+05	1.43178E+06	6.26886E+05	1.74316E+04	7.99213E+03	6.01652E+04	1.09208E+05	1.60490E+05
5	3.37264E+05	6.73233E+05	4.04187E+05	6.95991E+04	2.18559E+03	1.64533E+04	2.98645E+04	4.38891E+04
6	3.01553E+05	4.15776E+05	1.96298E+05	1.22316E+05	2.50406E+03	1.88507E+04	3.42161E+04	5.02842E+04
7	2.51963E+05	2.84106E+05	0.	0.	3.19490E+03	2.40514E+04	4.36559E+04	6.41570E+04
8	2.20203E+05	2.57346E+05	1.43060E+04	5.37318E+03	3.88737E+03	2.57127E+04	4.66712E+04	6.85883E+04
9	1.35836E+05	1.69265E+05	3.91593E+04	1.49539E+04	2.32333E+03	5.15837E+03	9.36300E+03	1.37599E+04
10	6.08512E+04	8.98942E+04	1.71124E+04	2.60700E+02	1.89163E+03	1.42403E+04	2.58477E+04	3.79860E+04
11	7.55875E+03	8.51455E+03	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	1.08045E+05	1.23054E+05	1.28519E+05	1.89444E+05	3.13022E+05	4.38413E+05	5.74263E+05	7.18973E+05
2	3.36523E+05	3.83272E+05	4.00295E+05	5.90057E+05	9.74961E+05	1.36551E+06	1.78864E+06	2.23936E+06
3	1.87154E+05	2.13153E+05	2.22620E+05	3.28154E+05	5.42213E+05	7.59415E+05	9.94731E+05	1.24540E+06
4	2.06785E+05	2.35511E+05	2.45971E+05	3.62574E+05	5.99087E+05	8.39071E+05	1.09907E+06	1.37603E+06
5	5.65491E+04	6.44048E+04	6.72653E+04	9.91527E+04	1.63832E+05	2.29460E+05	3.00561E+05	3.76301E+05
6	6.47890E+04	7.37893E+04	7.70666E+04	1.13600E+05	1.87704E+05	2.62895E+05	3.44357E+05	4.31132E+05
7	8.26634E+04	9.41469E+04	9.83284E+04	1.44941E+05	2.39489E+05	3.35424E+05	4.39369E+05	5.50077E+05
8	8.83730E+04	1.00650E+05	1.05120E+05	1.54952E+05	2.56030E+05	3.58592E+05	4.69707E+05	5.88070E+05
9	1.77290E+04	2.01919E+04	2.10887E+04	3.10859E+04	5.13638E+04	7.19393E+04	9.42308E+04	1.17976E+05
10	4.89432E+04	5.57423E+04	5.82181E+04	8.58166E+04	1.41796E+05	1.98597E+05	2.60136E+05	3.25688E+05
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	8.77531E+05	1.25662E+06	1.53830E+06	1.86698E+06	2.98054E+06	2.49430E+06	3.74724E+06	4.67120E+06
2	2.73322E+06	3.91396E+06	4.79128E+06	5.81502E+06	9.28340E+06	7.76892E+06	1.16714E+07	1.45493E+07
3	1.52005E+06	2.17670E+06	2.66462E+06	3.23396E+06	5.16286E+06	4.32060E+06	6.49094E+06	8.09141E+06
4	1.67949E+06	2.40502E+06	2.94412E+06	3.57318E+06	5.70440E+06	4.77379E+06	7.17178E+06	8.94013E+06
5	4.59288E+05	6.57698E+05	8.05123E+05	9.77151E+05	1.55997E+06	1.30548E+06	1.96126E+06	2.44484E+06
6	5.26212E+05	7.53533E+05	9.22439E+05	1.11953E+06	1.78728E+06	1.49571E+06	2.24704E+06	2.80109E+06
7	6.71387E+05	9.61423E+05	1.17693E+06	1.42840E+06	2.28037E+06	1.90835E+06	2.86697E+06	3.57387E+06
8	7.17760E+05	1.02783E+06	1.25822E+06	1.52706E+06	2.43787E+06	2.04016E+06	3.06499E+06	3.82072E+06
9	1.43994E+05	2.06199E+05	2.52419E+05	3.06353E+05	4.89077E+05	4.09289E+05	6.14885E+05	7.66498E+05
10	3.97514E+05	5.69237E+05	6.96833E+05	8.45724E+05	1.35016E+06	1.12989E+06	1.69747E+06	2.11601E+06
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	3.84765E+06	1.07800E+07	
2	1.19842E+07	3.35763E+07	
3	6.66486E+06	1.86731E+07	
4	7.36395E+06	2.06317E+07	
5	2.01381E+06	5.64213E+06	
6	2.30724E+06	6.46426E+06	
7	2.94378E+06	8.24767E+06	
8	3.14711E+06	8.81733E+06	
9	6.31361E+05	1.76890E+06	
10	1.74295E+06	4.88326E+06	
11	0.	0.	

PHOTON ENERGY PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 6

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	2.20935E+05	6.23893E+02	0.	0.	0.	0.	0.	0.
2	6.71988E+05	7.14853E+03	0.	0.	0.	0.	0.	0.
3	5.52118E+05	7.79385E+03	0.	0.	0.	0.	0.	0.
4	6.94156E+05	1.03202E+04	0.	0.	0.	0.	0.	0.
5	3.00879E+05	4.47212E+03	0.	0.	0.	0.	0.	0.
6	2.81452E+05	4.18338E+03	0.	0.	0.	0.	0.	0.
7	2.39382E+05	3.55798E+03	0.	0.	0.	0.	0.	0.
8	2.02571E+05	3.01101E+03	0.	0.	0.	0.	0.	0.
9	1.17922E+05	1.75277E+03	0.	0.	0.	0.	0.	0.
10	4.70934E+04	7.00121E+02	0.	0.	0.	0.	0.	0.
11	5.05895E+03	7.52109E+01	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

TABLE III (continued)

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	0.	0.	
2	0.	0.	
3	0.	0.	
4	0.	0.	
5	0.	0.	
6	0.	0.	
7	0.	0.	
8	0.	0.	
9	0.	0.	
10	0.	0.	
11	0.	0.	

PHOTON ENERGY PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 7

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	0.	1.06338E+03	0.	0.	0.	0.	0.	0.
2	0.	3.48802E+02	0.	0.	0.	0.	0.	0.
3	0.	5.18926E+03	0.	0.	0.	0.	0.	0.
4	0.	1.11332E+04	0.	0.	0.	0.	0.	0.
5	0.	5.26457E+03	0.	0.	0.	0.	0.	0.
6	0.	5.67464E+03	0.	0.	0.	0.	0.	0.
7	0.	1.27514E+03	0.	0.	0.	0.	0.	0.
8	0.	7.09211E+03	0.	0.	0.	0.	0.	0.
9	0.	2.26932E+02	0.	0.	0.	0.	0.	0.
10	0.	3.79792E+02	0.	0.	0.	0.	0.	0.
11	1.42520E+04	4.39121E+03	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	0.	0.	0.	0.	0.	0.	0.	0.
2	0.	0.	0.	0.	0.	0.	0.	0.
3	0.	0.	0.	0.	0.	0.	0.	0.
4	0.	0.	0.	0.	0.	0.	0.	0.
5	0.	0.	0.	0.	0.	0.	0.	0.
6	0.	0.	0.	0.	0.	0.	0.	0.
7	0.	0.	0.	0.	0.	0.	0.	0.
8	0.	0.	0.	0.	0.	0.	0.	0.
9	0.	0.	0.	0.	0.	0.	0.	0.
10	0.	0.	0.	0.	0.	0.	0.	0.
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	0.	0.	
2	0.	0.	
3	0.	0.	
4	0.	0.	
5	0.	0.	
6	0.	0.	
7	0.	0.	
8	0.	0.	
9	0.	0.	
10	0.	0.	
11	0.	0.	

TABLE III (continued)

PHOTON ENERGY PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 8

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	0.	0.	0.	0.	0.	9.37874E+01	1.93561E+02	2.21888E+02
2	0.	0.	1.71839E-09	0.	0.	5.32567E+01	1.09912E+02	1.25998E+02
3	0.	0.	9.87717E+02	0.	0.	0.	0.	0.
4	0.	0.	1.03606E+04	1.36442E+03	0.	4.35306E+02	8.98396E+02	1.02987E+03
5	0.	0.	1.45601E+04	7.77100E+03	0.	1.63313E+02	3.37050E+02	3.86376E+02
6	0.	0.	1.69082E+02	0.	0.	2.81994E+01	5.81986E+01	6.67157E+01
7	0.	0.	0.	0.	0.	1.93922E+01	4.00221E+01	4.58792E+01
8	0.	0.	1.52622E+04	1.95021E+04	6.27877E+03	0.	0.	0.
9	0.	0.	7.69032E+03	7.44381E+03	4.87286E+03	2.57778E+01	5.32009E+01	6.09867E+01
10	0.	0.	3.11426E+01	1.28311E-06	0.	4.14384E+01	8.55217E+01	9.80374E+01
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	2.23797E+02	2.21119E+02	2.42586E+02	2.98104E+02	1.32815E+03	7.10347E+02	1.02204E+03	2.57990E+03
2	1.27082E+02	1.25561E+02	1.37751E+02	1.69277E+02	7.54183E+02	4.03367E+02	5.80359E+02	1.46498E+03
3	0.	0.	0.	0.	0.	0.	0.	0.
4	1.03874E+03	1.02630E+03	1.12594E+03	1.38363E+03	6.16450E+03	3.29702E+03	4.74371E+03	1.19744E+04
5	3.89701E+02	3.85037E+02	4.22419E+02	5.19093E+02	2.31273E+03	1.23694E+03	1.77969E+03	4.49242E+03
6	6.72899E+01	6.64846E+01	7.29392E+01	8.96320E+01	3.99340E+02	2.13583E+02	3.07300E+02	7.75708E+02
7	4.62741E+01	4.57203E+01	5.01590E+01	6.16384E+01	2.74619E+02	1.46877E+02	2.11325E+02	5.33441E+02
8	0.	0.	0.	0.	0.	0.	0.	0.
9	6.15116E+01	6.07754E+01	6.66758E+01	8.19351E+01	3.65047E+02	1.95242E+02	2.80912E+02	7.09097E+02
10	9.88812E+01	9.76978E+01	1.07183E+02	1.31713E+02	5.86822E+02	3.13856E+02	4.51572E+02	1.13989E+03
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	6.95854E+02	3.18827E+02	4.15311E+03	1.27955E+03	7.04133E+02	1.16405E+03	1.10672E+03	1.57163E+03
2	3.95137E+02	1.81044E+02	2.35832E+03	7.26587E+02	3.99838E+02	6.60999E+02	6.28447E+02	8.92443E+02
3	0.	0.	0.	0.	0.	0.	0.	0.
4	3.22975E+03	1.47981E+03	1.92763E+04	5.93893E+03	3.26817E+03	5.40284E+03	5.13677E+03	7.29460E+03
5	1.21170E+03	5.55177E+02	7.23186E+03	2.22810E+03	1.22612E+03	2.02698E+03	1.92715E+03	2.73670E+03
6	2.09225E+02	9.58627E+01	1.24873E+03	3.84727E+02	2.11714E+02	3.49999E+02	3.32763E+02	4.72548E+02
7	1.43880E+02	6.59231E+01	8.58729E+02	2.64570E+02	1.45592E+02	2.40688E+02	2.28835E+02	3.24963E+02
8	0.	0.	0.	0.	0.	0.	0.	0.
9	1.91258E+02	8.76308E+01	1.14150E+03	3.51690E+02	1.93534E+02	3.19944E+02	3.04188E+02	4.31969E+02
10	3.07452E+02	1.40868E+02	1.83498E+03	5.65350E+02	3.11110E+02	5.14317E+02	4.88988E+02	6.94400E+02
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	1.93692E+03	2.74529E+03	
2	1.09987E+03	1.55890E+03	
3	0.	0.	
4	8.99007E+03	1.27420E+04	
5	3.37279E+03	4.78041E+03	
6	5.82381E+02	8.25436E+02	
7	4.00494E+02	5.67638E+02	
8	0.	0.	
9	5.32371E+02	7.54554E+02	
10	8.55798E+02	1.21296E+03	
11	0.	0.	

PHOTON ENERGY PRODUCTION MATRIX FOR MATERIAL (OR MIXTURE) 9

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8
1	3.02437E+03	6.23893E+00	0.	0.	8.35174E+01	6.28725E+02	1.14120E+03	1.67712E+03
2	1.70523E+04	4.43434E+03	0.	0.	2.60129E+02	1.95827E+03	3.55447E+03	5.22367E+03
3	1.63258E+04	9.93186E+03	0.	0.	1.44668E+02	1.08907E+03	1.96678E+03	2.90509E+03
4	2.19653E+04	2.87388E+04	1.25377E+04	3.48632E+02	1.59843E+02	1.20330E+03	2.18413E+03	3.20981E+03
5	9.75407E+03	1.35094E+04	8.08374E+03	1.39198E+03	4.37119E+01	3.29066E+02	5.97290E+02	8.77781E+02
6	8.84559E+03	8.35735E+03	3.92596E+03	2.44633E+03	5.00812E+01	3.77015E+02	6.84322E+02	1.00568E+03
7	7.43308E+03	5.71770E+03	0.	0.	6.38980E+01	4.81028E+02	8.73119E+02	1.28314E+03
8	6.42976E+03	5.17704E+03	2.86119E+02	1.07464E+02	7.77474E+01	5.14253E+02	9.33425E+02	1.37177E+03
9	3.89595E+03	3.40283E+03	7.83186E+02	2.99078E+02	4.64665E+01	1.03167E+02	1.87260E+02	2.75198E+02
10	1.68796E+03	1.80488E+03	3.42248E+02	5.21400E+00	3.78326E+01	2.84806E+02	5.16954E+02	7.59719E+02
11	2.01764E+02	1.71043E+02	0.	0.	0.	0.	0.	0.

	GROUP 9	GROUP 10	GROUP 11	GROUP 12	GROUP 13	GROUP 14	GROUP 15	GROUP 16
1	2.16089E+03	2.46108E+03	2.57039E+03	3.78889E+03	6.26044E+03	8.76827E+03	1.14853E+04	1.43795E+04
2	6.73047E+03	7.66545E+03	8.00591E+03	1.18011E+04	1.94992E+04	2.73103E+04	3.57728E+04	4.47873E+04
3	3.74307E+03	4.26305E+03	4.45240E+03	6.56307E+03	1.08443E+04	1.51883E+04	1.98946E+04	2.49079E+04
4	4.13569E+03	4.71022E+03	4.91942E+03	7.25149E+03	1.19817E+04	1.67814E+04	2.19814E+04	2.75206E+04
5	1.13098E+03	1.28810E+03	1.34531E+03	1.98305E+03	3.27663E+03	4.58919E+03	6.01123E+03	7.52602E+03
6	1.29578E+03	1.47579E+03	1.54133E+03	2.27201E+03	3.75407E+03	5.25789E+03	6.88713E+03	8.62265E+03
7	1.65327E+03	1.88294E+03	1.96657E+03	2.89883E+03	4.78978E+03	6.70848E+03	8.78721E+03	1.10015E+04
8	1.76746E+03	2.01299E+03	2.10240E+03	3.09905E+03	5.12061E+03	7.17183E+03	9.39414E+03	1.17614E+04
9	3.54581E+02	4.03839E+02	4.21775E+02	6.21719E+02	1.02728E+03	1.43879E+03	1.88462E+03	2.35953E+03
10	9.78864E+02	1.11485E+03	1.16436E+03	1.71633E+03	2.83592E+03	3.97194E+03	5.20271E+03	6.51376E+03
11	0.	0.	0.	0.	0.	0.	0.	0.

TABLE III (continued)

	GROUP 17	GROUP 18	GROUP 19	GROUP 20	GROUP 21	GROUP 22	GROUP 23	GROUP 24
1	1.75506E+04	2.51324E+04	3.07659E+04	3.73396E+04	5.96108E+04	4.98860E+04	7.49449E+04	9.34241E+04
2	5.46644E+04	7.82792E+04	9.58256E+04	1.16300E+05	1.85668E+05	1.55378E+05	2.33429E+05	2.90985E+05
3	3.04010E+04	4.35341E+04	5.32924E+04	6.46792E+04	1.03257E+05	8.64119E+04	1.29819E+05	1.61828E+05
4	3.35898E+04	4.81005E+04	5.88823E+04	7.14635E+04	1.14088E+05	9.54759E+04	1.43436E+05	1.78803E+05
5	9.18576E+03	1.31540E+04	1.61025E+04	1.95430E+04	3.11995E+04	2.61096E+04	3.92251E+04	4.88969E+04
6	1.05242E+04	1.50707E+04	1.84488E+04	2.23907E+04	3.57456E+04	2.99141E+04	4.49407E+04	5.60217E+04
7	1.34277E+04	1.92285E+04	2.35386E+04	2.85680E+04	4.56074E+04	3.81671E+04	5.73393E+04	7.14775E+04
8	1.43552E+04	2.05566E+04	2.51644E+04	3.05412E+04	4.87575E+04	4.08033E+04	6.12997E+04	7.64144E+04
9	2.87988E+03	4.12398E+03	5.04838E+03	6.12705E+03	9.78154E+03	8.18579E+03	1.22977E+04	1.53300E+04
10	7.95027E+03	1.13847E+04	1.39367E+04	1.69145E+04	2.70031E+04	2.25979E+04	3.39493E+04	4.23202E+04
11	0.	0.	0.	0.	0.	0.	0.	0.

	GROUP 25	GROUP 26	GROUP
1	7.69530E+04	2.15601E+05	
2	2.39683E+05	6.71526E+05	
3	1.33297E+05	3.73462E+05	
4	1.47279E+05	4.12635E+05	
5	4.02762E+04	1.12843E+05	
6	4.61449E+04	1.29285E+05	
7	5.88757E+04	1.64953E+05	
8	6.29422E+04	1.76347E+05	
9	1.26272E+04	3.53780E+04	
10	3.48590E+04	9.76652E+04	
11	0.	0.	

PHOTON ENERGY PRODUCTION SOURCE VECTORS AT INDICATED MESH INTERVALS

FOR MESH INTERVAL 1 BOUNDED BY RADII R= 0. AND R= 1.0000E+00 THE VECTOR IS
2.12675162E+15 6.97604782E+14 1.03785212E+16 2.22663777E+16 1.05291495E+16 1.13492814E+16 2.55028620E+15 1.41842297E+16
4.53863760E+14 7.59583350E+14 2.30344076E+16

FOR MESH INTERVAL 2 BOUNDED BY RADII R= 1.0000E+00 AND R= 2.0000E+00 THE VECTOR IS
2.12675162E+15 6.97604782E+14 1.03785212E+16 2.22663777E+16 1.05291495E+16 1.13492814E+16 2.55028620E+15 1.41842297E+16
4.53863760E+14 7.59583350E+14 2.30344076E+16

FOR MESH INTERVAL 3 BOUNDED BY RADII R= 2.0000E+00 AND R= 3.0000E+00 THE VECTOR IS
2.12675162E+15 6.97604782E+14 1.03785212E+16 2.22663777E+16 1.05291495E+16 1.13492814E+16 2.55028620E+15 1.41842297E+16
4.53863760E+14 7.59583350E+14 2.30344076E+16

FOR MESH INTERVAL 4 BOUNDED BY RADII R= 3.0000E+00 AND R= 4.0000E+00 THE VECTOR IS
4.43422585E+16 2.51795064E+16 2.96314993E+14 2.09464789E+17 8.46901758E+16 1.33832605E+16 9.16855284E+15 1.55188937E+16
1.99086971E+16 1.96012534E+16 0.

FOR MESH INTERVAL 5 BOUNDED BY RADII R= 4.0000E+00 AND R= 6.0000E+00 THE VECTOR IS
4.43422585E+16 2.51795064E+16 2.96314993E+14 2.09464789E+17 8.46901758E+16 1.33832605E+16 9.16855284E+15 1.55188937E+16
1.99086971E+16 1.96012534E+16 0.

FOR MESH INTERVAL 6 BOUNDED BY RADII R= 6.0000E+00 AND R= 9.0000E+00 THE VECTOR IS
4.43422585E+16 2.51795064E+16 2.96314993E+14 2.09464789E+17 8.46901758E+16 1.33832605E+16 9.16855284E+15 1.55188937E+16
1.99086971E+16 1.96012534E+16 0.

FOR MESH INTERVAL 7 BOUNDED BY RADII R= 9.0000E+00 AND R= 1.1000E+01 THE VECTOR IS
4.43422585E+16 2.51795064E+16 2.96314993E+14 2.09464789E+17 8.46901758E+16 1.33832605E+16 9.16855284E+15 1.55188937E+16
1.99086971E+16 1.96012534E+16 0.

FOR MESH INTERVAL 8 BOUNDED BY RADII R= 1.1000E+01 AND R= 1.3000E+01 THE VECTOR IS
1.66796902E+17 5.19681885E+17 2.89233013E+17 3.20355985E+17 8.79492646E+16 1.00472788E+17 1.27779453E+17 1.36584623E+17
2.75088387E+16 7.56071349E+16 5.43850510E+12

FOR MESH INTERVAL 9 BOUNDED BY RADII R= 1.3000E+01 AND R= 1.5000E+01 THE VECTOR IS
1.66796902E+17 5.19681885E+17 2.89233013E+17 3.20355985E+17 8.79492646E+16 1.00472788E+17 1.27779453E+17 1.36584623E+17
2.75088387E+16 7.56071349E+16 5.43850510E+12

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APPENDIX A

COMMENTS CONCERNING CODE OPERATION AND SUBROUTINES

As shown in Fig. A.1, the LAPH code has been divided into three main parts, each of which is a primary overlay. The main overlay, OVERLAY (0,0), is very short and serves principally to define unlabelled COMMON and labelled COMMON/TAPES/ and to call the three primary overlays, namely, OVERLAY (1,0), (2,0), and (3,0). In OVERLAY (1,0), the input is read in DTF-IV format and binary Tape 5 is prepared for use as input to OVERLAY's (2,0) and (3,0); in OVERLAY (2,0), the photon production and energy production matrices for each material in each zone are calculated and written onto binary Tape 18; in OVERLAY (3,0), the matrices on Tape 18 are combined appropriately, and the photon source and energy source vectors are calculated.

A brief description of each of the subroutines follows.

OVERLAY (0,0)

PROGRAM MAIN serves to define unlabelled COMMON and labelled COMMON/TAPES/ and to call the three primary overlays.

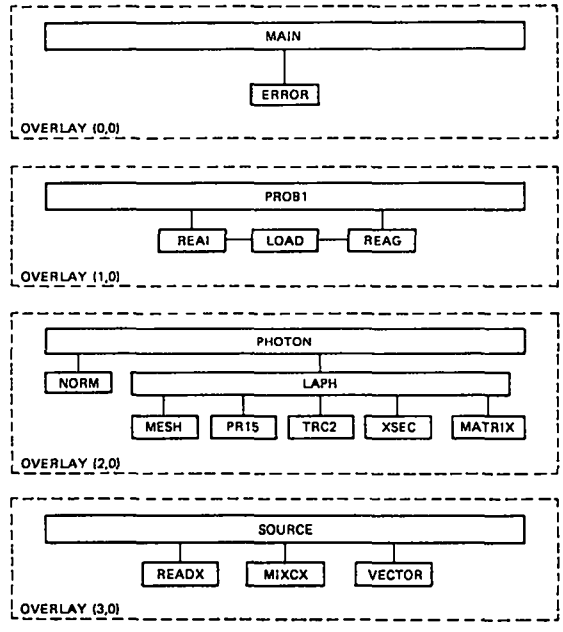

Fig. A.1. Arrangement of overlays and subroutines.

SUBROUTINE ERROR is called if there is an error in the input data or if any core storage allotments have been exceeded. An error stop number is printed, and execution is terminated. A complete catalog of the possible fatal error returns is included as a part of this subroutine. Other error messages are printed by the various subroutines when the error is nonfatal.

OVERLAY (1,0)

PROGRAM PROB1 reads all of the input data for the problem, does preliminary checking thereon, and arranges the data on binary Tape 5 in a form convenient for use in OVERLAY's (2,0) and (3,0).

SUBROUTINE REAI and SUBROUTINE REAG are DTF-IV routines. They are called by PROB1 to read integer and floating-point data, respectively, when these data are given in the DTF-IV format.

SUBROUTINE LOAD is another DTF-IV routine and is called by the two subroutines mentioned above. This routine interprets the DTF-IV control flags and fills out the integer and floating-point arrays accordingly.

OVERLAY (2,0)

PROGRAM PHOTON reads the input data from Tape 5 and supervises the calculations for each zone and each material within each zone.

SUBROUTINE INTG computes the integral of y(x) between two points x_1 and x_2, where values of y(x) are given at x_3 and x_4 such that $x_3 \leq x_1 < x_2 \leq x_4$. The dependence of y(x) on x between the two tabulated points (e.g., linear-linear or log-log) must be specified.

FUNCTION LOCT locates the mesh interval in which a given variable lies.

SUBROUTINE TERP1 interpolates between two specified points of y(x) vs x, assuming a dependence (e.g., linear-linear or log-log) which must be specified.

SUBROUTINE LAPH supervises the calculation of the photon production and energy production matrices for each material.

SUBROUTINE NORM normalizes the fine-group weighting functions over each broad group.

SUBROUTINE RSF3 reads tabulated arrays from the ENDF/B data tape.

SUBROUTINE MESH forms the energy mesh to be used in the numerical integration over neutron energy. The fine-group energy mesh is augmented with the energies at which the neutron cross sections are tabulated in File 3. Only those cross-section tables corresponding to reaction types specified in the input data are considered. This routine interprets the "MT = -1" command in the input specification and determines which MT numbers are to be used.

SUBROUTINE PR15 reads the photon production data from File 15 of the ENDF/B tape. For a continuous energy distribution under Option 1, the photon group yields, $Y_g(E)$ and $\tilde{Y}_g(E)$, are calculated on either Track 1 or 2 and written onto Tape 15. For distributions under Option 1 at discrete gamma energies, the yields are written directly onto Tape 17. The appropriate transition and conditional probabilities under Option 2 are read from the ENDF/B tape and are written onto Tape 16 for later use in SUBROUTINE TRC2.

SUBROUTINE TRC2 reconstructs the microscopic photon production cross sections from the transition arrays (read from Tape 16) and the appropriate cross sections (read from the ENDF/B tape File 3), integrates over the neutron fine groups, and writes the results on Tape 16.

SUBROUTINE MATRIX reads the microscopic fine-group photon and energy production matrix elements (τ's and ρ's) from Tape 16. It then performs the sum over fine groups which results in the photon production and energy production matrices for each reaction type. Finally, the sum over reaction types is taken to produce the G x N matrices which are written onto Tape 18.

OVERLAY (3,0)

PROGRAM SOURCE supervises the calculation of the photon source and energy source vectors.

SUBROUTINE READX reads either the photon production or the energy production microscopic matrices from Tape 18.

SUBROUTINE MIXCX multiplies the microscopic matrices by the specified number densities and prints the macroscopic matrices.

SUBROUTINE VECTOR multiplies the macroscopic matrices by the appropriate flux vectors and the scalar renormalization constant to give the source vectors.

SUBROUTINE PUNCR punches both integer and floating-point arrays in DTF-IV format.

APPENDIX B

INDEX'ed (CROSS REFERENCE) LISTING OF LAPH

```
I N D E X                                                                    PAGE   1
                                  OVERLAY(LAPH,0,0)

    1          OVERLAY(LAPH,0,0)                                                MAIN

I N D E X                                                                    PAGE   2
      PROGRAM MAIN (INPUT,OUTPUT,PUNCH,TAPE10=INPUT,TAPE9=OUTPUT,TAPE2,T

    1           PROGRAM MAIN (INPUT,OUTPUT,PUNCH,TAPE10=INPUT,TAPE9=OUTPUT,TAPE2,T MAIN
                1APE5,TAPE15,TAPE16,TAPE17,TAPE18,TAPE20)                        MAIN
                C                                                                MAIN
                C     PROGRAM MAIN SERVES TO DEFINE THE EXTENT OF UNLABELLED COMMON AND  MAIN
                C     TO CALL THE THREE PRIMARY OVERLAYS.                        MAIN
                C                                                                MAIN
    2           COMMON C,EG(50),EMG(50),EMNB(100),EMNF(100),GAMM(50),IM,IOO,IRES,I BLANK
                1WO,IZN,MA(100),MB(50),MC(50),MCR,MM,MS,MZ(10),NBG,NENB,NENF,NFG,NG BLANK
                2AM,NGG,NMAT(10),NNM(126),NPM,R(101),RW(100),RXSC(100),RXSF(100),SW BLANK
                3(100),SXSC(100),SXSF(100),XMD(50),AWRSAV                        BLANK
    3           COMMON /TAPES/ ISI,ISO,IEN                                       TAPES
    4           ISO=9                                                            MAIN
    5           ISI=10                                                           MAIN
    6           IEN=2                                                            MAIN
    7           REWIND 20                                                        MAIN
    8           REWIND 5                                                         MAIN
    9           REWIND 18                                                        MAIN
   10           CALL OVERLAY (4HLAPH,1,0)                                        MAIN
   11           CALL OVERLAY (4HLAPH,2,0)                                        MAIN
   12           CALL OVERLAY (4HLAPH,3,0)                                        MAIN
   13           CALL EXIT                                                        MAIN
                C                          TAPE USAGE                            MAIN
                C                                                                MAIN
                C     THE INPUT TAPE, TAPE10, IS REFERRED TO BY THE NAME ISI, ISI=10.  MAIN
                C                TAPE10 IS USED IN MAIN, PROB1, LOAD.            MAIN
                C                                                                MAIN
                C     THE OUTPUT TAPE, TAPE9, IS REFERRED TO BY THE NAME ISO, ISO=9.   MAIN
                C                TAPE9 IS USED IN MAIN, ERROR, LOAD, MESH, PR15,  MAIN
                C                              MIXCX, VECTOR, XSEC.              MAIN
                C                                                                MAIN
                C     THE PUNCH FILE IS USED IN PUNCR.                           MAIN
                C                                                                MAIN
                C     TAPE20 IS THE PHYSICAL TAPE ON WHICH IS WRITTEN THE ENDF/B DATA IN MAIN
                C            BCD CARD IMAGE FORMAT.  THIS TAPE IS USED IN MAIN, PROB1,  MAIN
                C            AND LAPH.                                           MAIN
                C                                                                MAIN
                C     TAPE2   (TAPE IEN WHERE IEN=2) IS THE TAPE ONTO WHICH THE ENDF/B  MAIN
                C            DATA FOR ONE SINGLE MAT NUMBER ARE WRITTEN.  THIS TAPE IS  MAIN
                C            PREPARED IN LAPH AND IS READ IN RSF3, MESH, PR15, TRC2,  MAIN
                C            AND XSEC.                                           MAIN
                C                                                                MAIN
                C     THE ABOVE TAPES ARE BCD TAPES. THERE ARE ALSO FIVE BINARY TAPES    MAIN
                C     USED AS INDICATED IN THE TABLE BELOW.                      MAIN
                C                                                                MAIN
                C              MAIN PROB1 PHOTON LAPH PR15 TRC2 XSEC MATRIX SOURCE READX MAIN
                C     TAPE 5     X    X       X                          X        MAIN
                C     TAPE15                        X    X         X              MAIN
                C     TAPE16                        X    X    X    X     X        MAIN
                C     TAPE17                        X    X         X              MAIN
                C     TAPE18     X                                    X      X   MAIN
```

```
C                                                                       MAIN
C                                                                       MAIN
C     TAPE 5 IS THE BINARY TAPE PREPARED FOR USE AS INPUT TO OVERLAY 2. MAIN
C     TAPE 15 CONTAINS BINARY OUTPUT FROM SUBROUTINE PR15 FOR ALL       MAIN
C     APPROPRIATE SECTIONS OF FILE 15 WITH LO=1, LF=1.  TAPE 15 IS INPUT MAIN
C     TO SUBROUTINE XSEC.                                               MAIN
C     TAPE 16 IS THE BINARY OUTPUT FROM TRC2 WHICH CONTAINS ALL THE     MAIN
C     ELEMENTS OF THE SIGMA(I,J) CALCULATED USING LO=2 INFORMATION FROM MAIN
C     FILE 15 AND CROSS SECTIONS FROM FILE 3.  ADDITIONAL OUTPUT FROM   MAIN
C     SUBROUTINE XSEC IS WRITTEN ON THIS TAPE FOR LO=1 SECTIONS OF FILE MAIN
C     15 AFTER THE APPROPRIATE CROSS SECTIONS FROM FILE 3 HAVE BEEN     MAIN
C     OBTAINED AND THE NECESSARY INTEGRATIONS OVER NEUTRON GROUPS       MAIN
C     PERFORMED.  TAPE 16 IS INPUT TO SUBROUTINE MATRIX.                MAIN
C     TAPE 17 CONTAINS BINARY OUTPUT FROM SUBROUTINE PR15 FOR ALL       MAIN
C     APPROPRIATE SECTIONS WITH LO=1, LF=2.  TAPE 17 IS INPUT TO        MAIN
C     SUBROUTINE XSEC.                                                  MAIN
C     TAPE 18 IS USED FOR STORING THE PHOTON PRODUCTION AND ENERGY      MAIN
C     PRODUCTION MATRICES FOR EACH MATERIAL IN ALL OF THE ZONES.  THIS  MAIN
C     TAPE IS INPUT TO SUBROUTINE READX IN OVERLAY 3.                   MAIN
C                                                                       MAIN
C                                                                       MAIN
C                                                                       MAIN
C                     LOCATIONS OF THE COMMON BLOCKS                    MAIN
C                                                                       MAIN
C     THE NAMES OF THE COMMON BLOCKS ARE LISTED HORIZONTALLY AND THE  C MAIN
C     ROUTINE NAMES ARE LISTED VERTICALLY.                              MAIN
C                                                                     O MAIN
C                                                                       MAIN
C                 BLANK TAPES TEST OVER1 READ BULK SAVE BOOK VEC      M MAIN
C                                                                       MAIN
C     (0.0)   MAIN      X      X                                        MAIN
C        ERROR                X                                       MAIN
C     (1.0)  PROB1      X      X      X                                 MAIN
C          REAI                      X                                MAIN
C          REAG                      X                              N MAIN
C          LOAD                 X                                    MAIN
C     (2.0) PHOTON      X      X             X                         MAIN
C          INTG                                                       MAIN
C          LOCT                                                     S MAIN
C          TERP1                                                      MAIN
C          LAPH                          X                        X T MAIN
C          NORM      X                                                MAIN
C          RSF3                 X                  X                O MAIN
C          MESH      X          X             X    X                  MAIN
C          PR15      X          X             X    X    X    X    X  R MAIN
C          TRC2      X          X             X    X    X    X    X    MAIN
C          XSEC      X          X             X    X    X    X    X  A MAIN
C        MATRIX      X                        X         X    X    X    MAIN
C     (3.0) SOURCE        X                                         X    MAIN
C        READX                                                          MAIN
```



```
C          MIXCX      X      X                                        E MAIN
C         VECTOR      X      X                                        MAIN
C          PUNCR             X                                        MAIN
C                                                                     MAIN
C     NOTE THAT COMMON/BULK/ IS DEFINED IN FOUR DIFFERENT WAYS AND    MAIN
C     COMMON/SAVE/ IS DEFINED IN TWO WAYS.                            MAIN
C                                                                     MAIN
   14       END                                                       MAIN
```

SYMBOL		REFERENCES
AMRSAV	-	200
C	-	200
EG	-	200
EMG	-	200
EMNB	-	200
EMNF	-	200
EXIT	-	13
GAMM	-	200
IEN	-	300 6=
IM	-	200
IOO	-	200
IRES	-	200
IST	-	300 5=
ISO	-	300 4=
IVO	-	200
IZM	-	200
MA	-	200
MH	-	200
MC	-	200
MCR	-	200
MM	-	200
MS	-	200
MZ	-	200
NAG	-	200
NENB	-	200
NENF	-	200
NEG	-	200
NGAM	-	200
NGG	-	200
NMAT	-	200
NNM	-	200
NPM	-	200
OVERLAY	-	10 11 12
R	-	200
RM	-	200
RXSC	-	200
RXSF	-	200
SM	-	200
SXSC	-	200
SXSF	-	200
TAPES	-	300
XMD	-	200

SUBROUTINE ERROR (N)

```
      1          SUBROUTINE ERROR (N)                                                ERROR
                 C     PRINTS ERROR MESSAGE                                          ERROR
                 C                                                                   ERROR
                 C                                                                   ERROR
                 C                     CATALOGUE OF FATAL ERROR RETURNS              ERROR
                 C                                                                   ERROR
                 C     ERROR RETURN          SUBROUTINE IN WHICH ERROR STOP OCCURRED ERROR
                 C        NUMBER                   AND SOURCE OF ERROR              ERROR
                 C                                                                   ERROR
                 C          100        PROB1     THE NEUTRON FINE AND BROAD GROUP ENERGY  ERROR
                 C                               BOUNDARIES MUST BE GIVEN IN ORDER OF     ERROR
                 C                               DECREASING MAGNITUDE.                    ERROR
                 C                                                                        ERROR
                 C          101        PROB1     THE MT NUMBERS FOR A GIVEN MATERIAL MUST ERROR
                 C                               BE GIVEN IN ASCENDING ORDER.             ERROR
                 C                                                                        ERROR
                 C          200        INTG      THE FLAG INDICATING DEPENDENCE OF Y(X) ON ERROR
                 C                               X MUST BE 1, 2, 3, 4, OR 5.              ERROR
                 C                                                                        ERROR
                 C          301        TERP1     IT IS INCORRECT TO INTERPOLATE BETWEEN TWO ERROR
                 C                               POINTS WHICH ARE AT THE SAME ABSCISSA.   ERROR
                 C                                                                        ERROR
                 C          302        TERP1     INTERPOLATION CODE FLAG MUST BE POSITIVE. ERROR
                 C                                                                        ERROR
                 C          303        TERP1     ARGUMENT OF LOG IS ZERO OR NEGATIVE.     ERROR
                 C                                                                        ERROR
                 C          400        MESH      THE AUGMENTED FINE GROUP ENERGY MESH MUST ERROR
                 C                               NOT HAVE MORE THAN 2000 POINTS.          ERROR
                 C                                                                        ERROR
                 C          500        PR15      THERE MUST NOT BE MORE THAN 100 ENTRIES IN ERROR
                 C                               THE LOLF12 ARRAY.                        ERROR
                 C                                                                        ERROR
                 C          501        PR15      AT THIS POINT IN THE CODE, THE NEUTRON   ERROR
                 C                               ENERGY SHOULD NOT LIE OUTSIDE THE RANGE OF ERROR
                 C                               ENERGIES FOR WHICH THE PHOTON YIELD IS   ERROR
                 C                               TABULATED FOR THIS LAW.                  ERROR
                 C                                                                        ERROR
                 C          502        PR15      ERROR IN DETERMINING INTERPOLATION CODE. ERROR
                 C                                                                        ERROR
                 C          503        PR15      THE LOLF11 ARRAY MUST NOT HAVE MORE THAN ERROR
                 C                               500 ENTRIES.                             ERROR
                 C                                                                        ERROR
                 C          600        TRC2      ERROR IN DETERMINING FROM WHICH LEVEL IN ERROR
                 C                               A CASCADE A TRANSITION OCCURS.           ERROR
                 C                                                                        ERROR
                 C          601        TRC2      LEVEL ENERGY SHOULD LIE WITHIN THIS ENERGY ERROR
                 C                               MESH.                                    ERROR
                 C                                                                        ERROR
                 C          602        TRC2      ENMAX MUST LIE WITHIN NEUTRON FINE GROUP ERROR
                 C                               ENERGY MESH.                             ERROR
```

SUBROUTINE ERROR (N)

```
C                                                                       ERROR
C          603      TRC2      ERROR IN DETERMINING INTERPOLATION CODE.  ERROR
C                                                                       ERROR
C          700      XSEC      WHEN INTEGRATING OVER THE NEUTRON FINE    ERROR
C                             GROUP, EVERY VALUE OF THE INTEGRAND MUST  ERROR
C                             BE FOR ONE PARTICULAR GAMMA GROUP.        ERROR
C                                                                       ERROR
C          701      XSEC      AT THIS POINT IN THE CODE, THERE SHOULD   ERROR
C                             BE AN INTERPOLATION CODE FOR THIS NEUTRON  ERROR
C                             ENERGY.                                   ERROR
C                                                                       ERROR
C          702      XSEC      CROSS SECTIONS IN FILE 3 CANNOT BE FOUND  ERROR
C                             CORRESPONDING TO THE MT NUMBER WRITTEN ON  ERROR
C                             TAPE 15 OR TAPE 17.                       ERROR
C                                                                       ERROR
C          800      SOURCE    THE TOTAL AMOUNT OF STORAGE REQUIRED FOR  ERROR
C                             THE PHOTON PRODUCTION MATRICES, THE       ERROR
C                             NEUTRON FLUXES, AND THE SOURCE VECTORS    ERROR
C                             MUST NOT EXCEED 30000 CORE LOCATIONS.     ERROR
C                                                                       ERROR
C          900      READX     IFLAG MUST BE EITHER 1 OR 2.              ERROR
C                                                                       ERROR
C                                                                       ERROR
      2          COMMON /TAPES/ ISI,ISO,IEN                            TAPES
      3     5    WRITE (ISO,10) N                                      ERROR
      4          CALL EXIT                                             ERROR
C                                                                       ERROR
      5     10   FORMAT (11H ERROR STOP,I6)                            ERROR
      6          END                                                   ERROR
```


SUBROUTINE ERROR (N)

SYMBOL = = = = = = = = = = = = = = = REFERENCES = = = = = = = = = = = = = = =

```
5        -     3*
10       -     3WR     5*
ERROR    -     1
EXIT     -     4
IEN      -     2C0
ISI      -     2C0
ISO      -     2C0     3WR
N        -     1AG     3WR
TAPES    -     2C0
```

I N D E X PAGE 10

PROGRAM PROB1

```
1           PROGRAM PROB1                                                    PROB1
      C                                                                      PROB1
      C     READS THE INPUT FOR THE PROBLEM IN DTF FORMAT AND PREPARES TAPE 5 PROB1
      C     IN BINARY FOR USE AS INPUT TO OVERLAY (LAPH,2,0) WHERE THE PHOTON PROB1
      C     AND ENERGY PRODUCTION MATRICES ARE CALCULATED.                   PROB1
      C                                                                      PROB1
2           COMMON C,EG(50),EMG(50),EMNB(100),EMNF(100),GAMM(50),IM,IOO,IRES,I BLANK
           1WO,IZM,MA(100),MR(50),MC(50),MCR,MM,MS,MZ(10),NBG,NENB,NENF,NFG,NG BLANK
           2AM,NGG,NMAT(10),NNM(126),NPM,R(101),RW(100),RXSC(100),RXSF(100),SW BLANK
           3(100),SXSC(100),SXSF(100),XMD(50),AWRSAV                       BLANK
3           COMMON /TAPES/ ISI,ISO,IEN                                       TAPES
4           COMMON /TEST/ IPRILD,IPRILT                                      TEST
5           DIMENSION MZT(126), MTN(126), PHI(5000), TITLE(12)               PROB1
6           IPRILD=0                                                         PROB1
7           IPRILT=0                                                         PROB1
      C     THESE INDICATORS ARE TESTED IN SUBROUTINE LOAD AND CONTROL EXTRA  PROB1
      C     OUTPUT WHICH IS PRINTED IN DTF FORMAT.                           PROB1
      C     IF IPRILD IS NON-ZERO, THE OP, CNT, AND NUMERIC FIELDS ON EACH   PROB1
      C     CARD WILL BE PRINTED AS EACH CARD IS READ.  IF IPRILD IS ZERO,   PROB1
      C     NO PRINTING WILL TAKE PLACE.                                     PROB1
      C     IF IPRILT IS ZERO, THE FULL ARRAY WILL BE PRINTED OUT.  IF IPRILT PROB1
      C     IS NON-ZERO, ONLY THE ARRAY NAME AND COUNT WILL BE PRINTED.      PROB1
8           READ (20,130) (TITLE(I),I=1,11),NTID                             PROB1
9           WRITE (ISO,135) NTID,(TITLE(I),I=1,11)                           PROB1
10          READ (ISI,125) ID,(TITLE(I),I=1,11)                              PROB1
11          WRITE (ISO,140) ID,(TITLE(I),I=1,11)                             PROB1
12          READ (ISI,145) NGG,NFG,NBG,IZM,IM,MS,MCR,MM,NPM,IRES,IWO,IOO     PROB1
13          WRITE (ISO,150) NGG,NFG,NBG,IZM,IM,MS,MCR,MM,NPM,IRES,IWO,IOO    PROB1
14          CALL REAG (C,1,6HRENORM,6H CONST)                                PROB1
15          CALL REAI (NMAT,IZM,6HNO MAT,6HS/ZONE)                           PROB1
16          WRITE (ISO,155) (I,NMAT(I),I=1,IZM)                              PROB1
17          I=2*MCR                                                          PROB1
18          CALL REAI (NNM,I,6HNNM AR,6HRAY   )                              PROB1
19          WRITE (ISO,160) (NNM(II),II=1,I)                                 PROB1
20          CALL REAI (MZT,MCR,6HMZT AR,6HRAY   )                            PROB1
21          CALL REAI (MTN,MM,6HMTN NU,6HMBERS )                             PROB1
22          WRITE (ISO,165)                                                  PROB1
23          K=1                                                              PROB1
24          KK=0                                                             PROB1
25          DO 5 I=1,MCR                                                     PROB1
26          KK=KK+MZT(I)                                                     PROB1
27          WRITE (ISO,170) I,(MTN(J),J=K,KK)                                PROB1
28     5    K=KK+1                                                           PROB1
29          IF (IWO.NE.0) GO TO 10                                           PROB1
30          CALL REAG (EG,NGG,6HEGAMMA,6H BAR  )                             PROB1
31     10   NGAM=NGG+1                                                       PROB1
32          NENF=NFG+1                                                       PROB1
33          NENB=NBG+1                                                       PROB1
34          CALL REAG (EMG,NGAM,6HGAMMA ,6HBOUNDS)                           PROB1
35          CALL REAG (EMNF,NENF,6HNEUTRO,6HN FINE)                          PROB1
```

PROGRAM PROB1

```
      CALL REAG (EMNB,NENB,6HNEUTRO,6HN   BRD)                          PROB1
      IF (IWO.NE.0) GO TO 20                                            PROB1
      DO 15 I=1,NGG                                                     PROB1
      IF (EG(I).LE.EMG(1).AND.EG(I).GE.EMG(I+1)) GO TO 15               PROB1
      EHOLD=EG(I)                                                       PROB1
      EG(I)=(EMG(I)+EMG(I+1))/2.0                                       PROB1
      WRITE (ISO,175) I,EHOLD,EMG(I),EMG(I+1),EG(I)                     PROB1
15    CONTINUE                                                          PROB1
20    DO 25 I=1,NGG                                                     PROB1
25    IF (EMG(I).LE.EMG(I+1)) GO TO 40                                  PROB1
      DO 30 I=1,NFG                                                     PROB1
30    IF (EMNF(I).LE.EMNF(I+1)) GO TO 40                                PROB1
      DO 35 I=1,NBG                                                     PROB1
35    IF (EMNB(I).LE.EMNB(I+1)) GO TO 40                                PROB1
      GO TO 45                                                          PROB1
40    CALL ERROR (100)                                                  PROB1
45    DO 50 I=1,NGAM                                                    PROB1
      K=NGAM+1-I                                                        PROB1
50    GAMM(K)=EMG(I)                                                    PROB1
      MATC=1                                                            PROB1
      IMIN=1                                                            PROB1
      IMAX=0                                                            PROB1
      IF (IRES.EQ.1) GO TO 60                                           PROB1
      DO 55 I=1,NFG                                                     PROB1
55    RW(I)=0.0                                                         PROB1
60    DO 115 II=1,IZM                                                   PROB1
      KNO=NMAT(II)                                                      PROB1
      K=0                                                               PROB1
      DO 85 J=1,KNO                                                     PROB1
      IF (IRES.NE.1) GO TO 85                                           PROB1
      READ (ISI,180) TITLE                                              PROB1
      WRITE (ISO,185) TITLE                                             PROB1
      CALL REAG (RXSC,NFG,6HRXSC  ,6H      )                            PROB1
      DO 65 I=1,NFG                                                     PROB1
      K=K+1                                                             PROB1
65    PHI(K)=RXSC(I)                                                    PROB1
      READ (ISI,180) TITLE                                              PROB1
      WRITE (ISO,185) TITLE                                             PROB1
      CALL REAG (RXSF,NFG,6HRXSF  ,6H      )                            PROB1
      DO 70 I=1,NFG                                                     PROB1
      K=K+1                                                             PROB1
70    PHI(K)=RXSF(I)                                                    PROB1
      READ (ISI,180) TITLE                                              PROB1
      WRITE (ISO,185) TITLE                                             PROB1
      CALL REAG (SXSC,NFG,6HSXSC  ,6H      )                            PROB1
      DO 75 I=1,NFG                                                     PROB1
      K=K+1                                                             PROB1
75    PHI(K)=SXSC(I)                                                    PROB1
      READ (ISI,180) TITLE                                              PROB1
      WRITE (ISO,185) TITLE                                             PROB1
```

```
      CALL REAG (SXSF,NFG,6HSXSF  ,6H      )                              PROB1
      DO 80 I=1,NFG                                                       PROB1
      K=K+1                                                               PROB1
   80 PHI(K)=SXSF(I)                                                      PROB1
   85 CONTINUE                                                            PROB1
      IF (IRES.NE.1) GO TO 90                                             PROB1
      READ (ISI,180) TITLE                                                PROB1
      WRITE (ISO,185) TITLE                                               PROB1
      CALL REAG (RW,NFG,6HRW    ,6H      )                                PROB1
   90 READ (ISI,180) TITLE                                                PROB1
      WRITE (ISO,185) TITLE                                               PROB1
      CALL REAG (SW,NFG,6HSW    ,6H      )                                PROB1
      IF (IRES.EQ.1) WRITE (5) (RW(I),I=1,NFG)                            PROB1
      WRITE (5) (SW(I),I=1,NFG)                                           PROB1
      KMIN=1                                                              PROB1
      KMAX=NFG                                                            PROB1
      DO 110 J=1,KNO                                                      PROB1
      IMAX=IMAX+MZT(MATC)                                                 PROB1
      MATC2=MATC+MATC                                                     PROB1
      MAT=NNM(MATC2)                                                      PROB1
      WRITE (5) MAT,MZT(MATC),(MTN(I),I=IMIN,IMAX)                        PROB1
      IF (IMIN.EQ.IMAX) GO TO 105                                         PROB1
      IMM1=IMAX-1                                                         PROB1
      DO 95 I=IMIN,IMM1                                                   PROB1
   95 IF (MTN(I+1).LE.MTN(I)) GO TO 100                                   PROB1
      GO TO 105                                                           PROB1
  100 CALL ERROR (101)                                                    PROB1
C     HERE WE ARE TESTING THAT THE MT NUMBERS FOR A GIVEN MATERIAL ARE    PROB1
C     IN ASCENDING ORDER.                                                 PROB1
  105 MATC=MATC+1                                                         PROB1
      IMIN=IMAX+1                                                         PROB1
      IF (IRES.NE.1) GO TO 110                                            PROB1
      WRITE (5) (PHI(K),K=KMIN,KMAX)                                      PROB1
      KMIN=KMAX+1                                                         PROB1
      KMAX=KMAX+NFG                                                       PROB1
      WRITE (5) (PHI(K),K=KMIN,KMAX)                                      PROB1
      KMIN=KMAX+1                                                         PROB1
      KMAX=KMAX+NFG                                                       PROB1
      WRITE (5) (PHI(K),K=KMIN,KMAX)                                      PROB1
      KMIN=KMAX+1                                                         PROB1
      KMAX=KMAX+NFG                                                       PROB1
      WRITE (5) (PHI(K),K=KMIN,KMAX)                                      PROB1
      KMIN=KMAX+1                                                         PROB1
      KMAX=KMAX+NFG                                                       PROB1
  110 CONTINUE                                                            PROB1
  115 CONTINUE                                                            PROB1
      I=IM+1                                                              PROB1
      CALL REAG (R,I,6HRADII ,6H      )                                   PROB1
      CALL REAI (MA,IM,6HZONE N,6HUMBERS)                                 PROB1
      CALL REAI (MZ,IZM,6HMIXTUR,6HE NOS )                                PROB1
```

PROGRAM PROB1

```
      CALL REAI (MB,MS,6HMIX TA,6HBLE   )                                PROB1
      CALL REAI (MC,MS,6HMIX CO,6HMMAND )                                PROB1
      CALL REAG (XMD,MS,6HMIX DE,6HNSITY )                               PROB1
      IF (I00.EQ.10*(I00/10)) RETURN                                     PROB1
C     FLUXES ARE NOT READ IN FOR I00=0, 10, OR 20.                       PROB1
      I=IM*NBG                                                           PROB1
      CALL REAG (PHI,I,6HNEUTRO,6HN FLUX)                                PROB1
      KMIN=1                                                             PROB1
      KMAX=IM                                                            PROB1
      DO 120 I=1,NBG                                                     PROB1
      WRITE (5) (PHI(K),K=KMIN,KMAX)                                     PROB1
      KMIN=KMAX+1                                                        PROB1
120   KMAX=KMAX+IM                                                       PROB1
      RETURN                                                             PROB1
C                                                                        PROB1
125   FORMAT (I6,11A6)                                                   PROB1
130   FORMAT (11A6,I4)                                                   PROB1
135   FORMAT (*1ENDF/B TAPE I. D. =*,I5,6X,11A6)                         PROB1
140   FORMAT (/////,*  LAPH PROBLEM ID=*,I6,11A6)                        PROB1
145   FORMAT (12I6)                                                      PROB1
150   FORMAT (* INTEGER PARAMETERS          NGG     NFG     NBG      IZM PROB1
     1     IM      MS      MCR     MM     NPM     IRES     IWO     I00*, PROB1
     2/,24X,12(2X,I6))                                                  PROB1
155   FORMAT (* NUMBER OF NUCLIDES IN EACH ZONE*,/,11X,*ZONE*,2X,*NUMBER PROB1
     1  OF NUCLIDES *,/,(10X,I5,5X,I5))                                 PROB1
160   FORMAT (* NUCLIDE SEQUENCE NUMBER     NUCLIDE*,/,(12XI2*---------- PROB1
     1------*,I5))                                                      PROB1
165   FORMAT (* NUCLIDE SEQUENCE NUMBER        MT NUMBERS*)              PROB1
170   FORMAT (15X,I5,15X,20I4)                                           PROB1
175   FORMAT (* ERROR IN THE EFFECTIVE AVERAGE ENERGY INPUT FOR GROUP*,I PROB1
     15,/,* THE VALUE EG(I)=*,1PE14.6,* SHOULD LIE BETWEEN THE BOUNDARIE PROB1
     2S EMG(I)=*,1PE14.6,* AND EMG(I+1)=*,1PE14.6,/,* THE MIDPOINT OF TH PROB1
     3E ENERGY INTERVAL HAS BEEN USED. EG(I) HAS BEEN REPLACED BY*,1PE14 PROB1
     4.6)                                                               PROB1
180   FORMAT (12A6)                                                      PROB1
185   FORMAT (/,2X,12A6)                                                 PROB1
      END                                                                PROB1
```

SYMBOL = = = = = = = = = = = = = = REFERENCES = = = = = = = = = = = = = =

5	-	25	28*								
10	-	29	31*								
15	-	36	39	43*							
20	-	37	44*								
25	-	44	45*								
30	-	46	47*								
35	-	48	49*								
40	-	45	47	49	51*						
45	-	50	52*								
50	-	52	54*								
55	-	59	60*								
60	-	58	61*								
65	-	69	71*								
70	-	75	77*								
75	-	81	83*								
80	-	87	89*								
85	-	64	65	90*							
90	-	91	95*								
95	-	109	110*								
100	-	110	112*								
105	-	107	111	113*							
110	-	102	115	128*							
115	-	61	129*								
120	-	142	145*								
125	-	10RD	147*								
130	-	8RD	148*								
135	-	9WR	149*								
140	-	11WR	150*								
145	-	12RD	151*								
150	-	13WR	152*								
155	-	16WR	153*								
160	-	19WR	154*								
165	-	22WR	155*								
170	-	27WR	156*								
175	-	42WR	157*								
180	-	66RD	72RD	78RD	84RD	92RD	95RD	158*			
185	-	67WR	73WR	79WR	85WR	93WR	96WR	159*			
ANSAV	-	2C0									
C	-	2C0	14AG								
EG	-	2C0	30AG	39	40	41=	42WR				
EHOLD	-	40=	42WR								
EOG	-	2C0	34AG	39	41	42WR	45	54			
EMNH	-	2C0	36AG	49							
EMNF	-	2C0	35AG	47							
ERROR	-	51	112								
GAMM	-	2C0	54=								
I	-	8RD	9WR	10RD	11WR	16WR	17=	18AG	19WR	25	26
		27WR	38	39	40	41	42WR	44	45	46	47

```
I N D E X                                                                                PAGE  17
                              SUBROUTINE REAI (IARRAY,NCOUNT,HOL1,HOL2)

     1          SUBROUTINE REAI (IARRAY,NCOUNT,HOL1,HOL2)                                REAI
     2          COMMON /TEST/ IPRILD,IPRILT                                              TEST
     3          DIMENSION IARRAY(1)                                                      REAI
     4          CALL LOAD (IARRAY,IARRAY,0,NCOUNT,HOL1,HOL2,IPRILD,IPRILT)               REAI
     5          RETURN                                                                   REAI
     6          END                                                                      REAI
```

```
I N D E X                                                                                PAGE  18
                              SUBROUTINE REAI (IARRAY,NCOUNT,HOL1,HOL2)

SYMBOL      = = = = = = = = = = = = = = =     REFERENCES     = = = = = = = = = = = = = = =

HOL1     -      1AG
HOL2     -      1AG
IARRAY   -      1AG      3DI      4AG
IPRILD   -      2CO
IPRILT   -      2CO
LOAD     -      4
NCOUNT   -      1AG
REAI     -      1
RETURN   -      5
TEST     -      2CO

-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
I N D E X                                                                                PAGE  19
                              SUBROUTINE REAG (ARRAY,NCOUNT,HOL1,HOL2)

     1          SUBROUTINE REAG (ARRAY,NCOUNT,HOL1,HOL2)                                 REAG
     2          COMMON /TEST/ IPRILD,IPRILT                                              TEST
     3          DIMENSION ARRAY(1)                                                       REAG
     4          CALL LOAD (ARRAY,ARRARY,1,NCOUNT,HOL1,HOL2,IPRILD,IPRILT)                REAG
     5          RETURN                                                                   REAG
     6          END                                                                      REAG
```

```
I N D E X                                                                                PAGE  20
                              SUBROUTINE REAG (ARRAY,NCOUNT,HOL1,HOL2)

SYMBOL      = = = = = = = = = = = = = = =     REFERENCES     = = = = = = = = = = = = = = =

ARRARY   -      4AG
ARRAY    -      1AG      3DI      4AG
HOL1     -      1AG      4AG
HOL2     -      1AG      4AG
IPRILD   -      2CO      4AG
IPRILT   -      2CO      4AG
LOAD     -      4
NCOUNT   -      1AG      4AG
REAG     -      1
RETURN   -      5
TEST     -      2CO

-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
1            SUBROUTINE LOAD (VECP,IVECP,ITYPIN,ICDES,HOL1,HOL2,IPRCRD,IPRCV)   LOAD
      C                                                                         LOAD
      C     THIS ROUTINE INTERPRETS THE DTF-IV CONTROL FLAGS AND FILLS OUT THE  LOAD
      C     INTEGER AND FLOATING POINT ARRAYS ACCORDINGLY.                      LOAD
      C                                                                         LOAD
2            COMMON /TAPES/ NINP,NOUT,IEN                                       LOAD
3            DIMENSION VECP(1), IVECP(1)                                        LOAD
4            DIMENSION IOP(6), ICOUNT(6), FL(6), IFX(6)                         LOAD
      C     THE PURPOSE OF THIS CODE IS TO READ BOTH                            LOAD
      C     THE STANDARD DTF FLOATING POINT FORMAT                              LOAD
      C     AND THE STANDARD DTF FIXED POINT FORMAT.                            LOAD
      C     CALLING SEQUENCE ENTRIES )                                          LOAD
      C     VECP IS THE FLOATING POINT VECTOR TO BE LOADED.                     LOAD
      C     IVECP IS THE FIXED POINT VECTOR TO BE LOADED.                       LOAD
      C     ICDES IS THE COUNT OF THE BLOCK.                                    LOAD
      C     ITYPIN IS THE TYPE OF BLOCK TO BE LOADED.                           LOAD
      C     IF THIS INDICATOR IS ZERO, THE CODE                                 LOAD
      C     ASSUMES THE BLOCK TO BE LOADED                                      LOAD
      C     IS FIXED POINT.                                                     LOAD
      C     IF THIS INDICATOR IS NON ZERO, THE CODE                             LOAD
      C     ASSUMES THE BLOCK TO BE LOADED IS FLOATING                          LOAD
      C     POINT.                                                              LOAD
      C     HOL1 IS A SET OF HOLLERITH CHARACTERS                               LOAD
      C     TO BE PRINTED AS A TITLE.                                           LOAD
      C     HOL2 IS A SECOND SET OF HOLLERITH CHARACTERS                        LOAD
      C     TO BE PRINTED AS A TITLE IMMEDIATELY                                LOAD
      C     FOLLOWING HOL1.  A SET OF HOLLERITH CHARACTERS                      LOAD
      C     CONSIST OF A WORD IN THE 1 A 6 FORMAT.                              LOAD
      C     IPRCRD IS THE PRINT INDIVIDUAL CARDS                                LOAD
      C     AS THEY ARE READ INDICATOR.  IF THIS INDICATOR                      LOAD
      C     IS NON ZERO, EACH INDIVIDUAL CARD WILL BE                           LOAD
      C     PRINTED AS IT IS READ.  IF THE INDICATOR IS ZERO,                   LOAD
      C     NO PRINTING WILL TAKE PLACE FOR AN INDIVIDUAL CARD.                 LOAD
      C     IPRCV IS THE CORRECT VECTOR PRINT INDICATOR.                        LOAD
      C     IF THIS INDICATOR IS ZERO, THE FULL VECTOR                          LOAD
      C     WILL BE PRINTED.  IF THIS INDICATOR IS                              LOAD
      C     NON ZERO, ONLY THE VECTOR NAME AND COUNT                            LOAD
      C     WILL BE PRINTED.                                                    LOAD
      C     COMMON PARAMTERS )                                                  LOAD
      C     NINP IS THE SYSTEM INPUT UNIT NUMBER.                               LOAD
      C     NOUT IS THE SYSTEM OUTPUT UNIT NUMBER.                              LOAD
      C     THE STANDARD DTF CARD IS COMPOSED OF SIX                            LOAD
      C     FIELDS OF LENGTH TWELVE.  EACH FIELD IS                             LOAD
      C     SUB DIVIDED INTO AN OPERATION FIELD, A                              LOAD
      C     COUNT FIELD AND A NUMERIC FIELD.                                    LOAD
      C     THE OPERATION FIELD HAS A LENGTH OF ONE.                            LOAD
      C     THE FOLLOWING NUMERIC VALUES ARE PERMITTED.                         LOAD
      C     A VALUE OF ZERO OR BLANK INDICATE JUST THE NUMBER IS TO             LOAD
      C     BE LOADED.  THE COUNT FIELD IS DISREGARDED.                         LOAD
      C     A VALUE OF ONE INDICATES REPEAT THE NUMBER IN THE                   LOAD
```

```
      SUBROUTINE LOAD (VECP,IVECP,ITYPIN,ICDES,HOL1,HOL2,IPRCRD,IPRCV)
C     NUMERIC FIELD.  THE NUMBER IN THE NUMERIC                        LOAD
C     FIELD WILL BE ENTERED INTO THE ARRARY A                          LOAD
C     TOTAL NUMBER OF TIMES AS INDICATED BY THE                        LOAD
C     COUNT FIELD.  THE COUNT FIELD MUST BE                            LOAD
C     POSITIVE NON ZERO.                                               LOAD
C     A VALUE OF TWO INDICATES THAT LINEAR INTERPOLATION               LOAD
C     IS DESIRED.  THE INTERPOLATION IS DONE BETWEEN                   LOAD
C     THIS VALUE AND THE SUCCESSIVE VALUE OF                           LOAD
C     THE NEXT ENTRY.  THIS SUCCESSIVE VALUE MAY                       LOAD
C     ALSO HAVE AN OPERATION.  THE NUMBER OF                           LOAD
C     LINEAR INTERPOLATANTS IS GIVEN BY THE                            LOAD
C     COUNT FIELD.  THIS MUST BE GREATER THAN                          LOAD
C     ZERO.  INTERPOLATION IS LIMITED TO                               LOAD
C     FLOATING POINT BLOCKS.                                           LOAD
C     A VALUE OF THREE INDICATES THE END OF THE                        LOAD
C     BLOCK.  THE COUNT FIELD AND NUMERIC FIELD ARE                    LOAD
C     DISREGARDED.  AT THIS POINT THE NUMBER OF                        LOAD
C     ENTRIES ARE CHECKED AGAINST THE DESIRED NUMBER.                  LOAD
C     A VALUE OF FOUR INDICATES AN OPERATION WHICH REPEATS             LOAD
C     THE NUMERIC FIELD TO THE END                                     LOAD
C     OF THE BLOCK.  THIS WILL BE DONE ONLY                            LOAD
C     IF ENTRIES ARE STILL TO BE FILLED.                               LOAD
C     THE COUNT FIELD IS DISREGARDED AND A                             LOAD
C     TERMINAL OPERATION MUST FOLLOW THIS OPERATION.                   LOAD
C     A VALUE OF 5 INDICATES THAT THE NUMBER                           LOAD
C     IN THE NUMERIC FIELD IS TO BE REPEARED                           LOAD
C     10 * THE NUMBER IN THE COUNT FIELD.                              LOAD
C     A VALUE OF NINE INDICATES THAT THE REMAINING                     LOAD
C     FIELDS OF THE CARD ARE TO BE DISREGARDED.                        LOAD
C     THE COUNT HAS A FIELD LENGTH OF TWO AND IS                       LOAD
C     DISREGARDED EXCEPT FOR THE REPEAT AND INTERPOLATION              LOAD
C     OPERATIONS.                                                      LOAD
C     THE NUMERIC FIELD HAS A LENGTH OF NINE AND                       LOAD
C     MUST BE FLOATING POINT OR FIXED POINT AS                         LOAD
C     THE DATA BEING READ INDICATES.                                   LOAD
C     TEMPORARY STORAGE )                                              LOAD
C     IERRT IS THE ERROR INDICATOR.                                    LOAD
C     ICNRD IS THE COUNT READ.                                         LOAD
C     ICNET IS THE COUNT ENTERED.                                      LOAD
C     ICNTS IS THE TEST COUNT.                                         LOAD
C     ITYRD IS THE TYPE READ INDICATOR.                                LOAD
C     INORD IS THE NUMBER OF COMPLETE FIELDS ON A CARD.                LOAD
C     IDX IS THE FIELD INDEX.                                          LOAD
C     IDY IS A STORE INDEX.                                            LOAD
C     INDIT IS THE INTERPOLATION INDICATOR.                            LOAD
C     IDZ IS A CURRENT INDEX.                                          LOAD
C     DEL IS THE DELTA FOR INTERPOLATION.                              LOAD
C     ICNIT IS THE COUNT FIELD OF THE INTERPOLATION                    LOAD
C     OPERATION.                                                       LOAD
C     IPERRT IS THE LIST INPUT CARD INDICATOR.                         LOAD
```

```
      SUBROUTINE LOAD (VECP,IVECP,ITYPIN,ICDES,HOL1,HOL2,IPRCRD,IPRCV)

C     IF THIS INDICATOR IS MINUS NON ZERO, NO                          LOAD
C     CARD INPUT WILL BE LISTED.  IF THIS INDICATOR                    LOAD
C     IS ZERO OR GREATER, THE INPUT CARDS WILL                         LOAD
C     BE LISTED AS THEY ARE READ.                                      LOAD
C     ICRDNW IS THE CURRENT CARD NUMBER PROCESSED.                     LOAD
C     TEMPORARY STORAGE BLOCKS ]                                       LOAD
C     IOP IS THE OPERATION BLOCK.                                      LOAD
C     ICOUNT IS THE COUNT BLOCK.                                       LOAD
C     IFX IS THE FIXED POINT NUMERIC BLOCK.                            LOAD
C     FL IS THE FLOATING POINT NUMERIC BLOCK.                          LOAD
C     SET LIST INDICATOR.                                              LOAD
 5          IPERRT=-1                                                 LOAD
 6          IF (IPRCRD.NE.0) IPERRT=0                                 LOAD
C     INITIAL INDICATORS.                                              LOAD
 7          IERRT=1                                                   LOAD
 8          ICNRD=0                                                   LOAD
 9          ICNET=0                                                   LOAD
10          ICNTS=ICDES                                               LOAD
11          ITYRD=ITYPIN                                              LOAD
12          INORD=6                                                   LOAD
13          INDIT=0                                                   LOAD
14          ICRDNW=0                                                  LOAD
15          IF (IPERRT.LT.0) GO TO 5                                  LOAD
16          WRITE (NOUT,265) HOL1,HOL2                                LOAD
C     READ A CARD.                                                     LOAD
17     5    CONTINUE                                                  LOAD
18          IF (ITYRD.EQ.0) GO TO 25                                  LOAD
C     READ FLOATING POINT.                                             LOAD
19          READ (NINP,200) (IOP(I),ICOUNT(I),FL(I),I=1,INORD)        LOAD
20          ICRDNW=ICRDNW+1                                           LOAD
21          IF (IPERRT) 20,10,15                                      LOAD
C     FIRST PASS TITLE.                                                LOAD
22     10   CONTINUE                                                  LOAD
23          WRITE (NOUT,270)                                          LOAD
24     15   CONTINUE                                                  LOAD
25          IPERRT=IPERRT+1                                           LOAD
26          WRITE (NOUT,275) IPERRT,(IOP(I),ICOUNT(I),FL(I),I=1,INORD) LOAD
27     20   CONTINUE                                                  LOAD
28          GO TO 45                                                  LOAD
C     READ FIXED POINT.                                                LOAD
29     25   CONTINUE                                                  LOAD
30          READ (NINP,205) (IOP(I),ICOUNT(I),IFX(I),I=1,INORD)       LOAD
31          ICRDNW=ICRDNW+1                                           LOAD
32          IF (IPERRT) 40,30,35                                      LOAD
C     FIRST PASS TITLE.                                                LOAD
33     30   CONTINUE                                                  LOAD
34          WRITE (NOUT,280)                                          LOAD
35     35   CONTINUE                                                  LOAD
36          IPERRT=IPERRT+1                                           LOAD
37          WRITE (NOUT,285) IPERRT,(IOP(I),ICOUNT(I),IFX(I),I=1,INORD) LOAD
```

SUBROUTINE LOAD (VECP,IVECP,ITYPIN,ICDES,HOL1,HOL2,IPRCRD,IPRCV)

```
38      40    CONTINUE                                                    LOAD
39      45    CONTINUE                                                    LOAD
40            DO 125 IDX=1,INORU                                          LOAD
              C     CHECK FOR END OF CARD.                                LOAD
41                  IF (IOP(IDX).EQ.9) GO TO 5                          LOAD
              C     RETURN ON PASS TWO OF INTERPOLATION.                  LOAD
42      50    CONTINUE                                                    LOAD
43            IDY=1                                                       LOAD
44            IF (INDIT.EQ.0) GO TO 55                                    LOAD
              C     INTERPOLATION PASS TWO.                               LOAD
45            INDIT=-1                                                    LOAD
              C     CHECK FOR TERMINAL OPERATION.                         LOAD
46            IF (IOP(IDX).EQ.3) GO TO 130                                LOAD
47            DEL=(FL(IDX)-VECP(ICNET))/DEL                               LOAD
48            IDY=ICNIT                                                   LOAD
49            GO TO 95                                                    LOAD
              C     CHECK FOR OPERATIONS.                                 LOAD
50      55    CONTINUE                                                    LOAD
51            IF (IOP(IDX).GT.0) GO TO 65                                 LOAD
              C     CHECK ZERO COUNT.                                     LOAD
52            IF (ICOUNT(IDX).EQ.0) GO TO 60                              LOAD
53            WRITE (NOUT,290)                                            LOAD
54            WRITE (NOUT,295)                                            LOAD
55            WRITE (NOUT,300) ICRDNW,IDX,HOL1,HOL2                       LOAD
56            WRITE (NOUT,290)                                            LOAD
              C     PROCESS BLANK OPERATION.                              LOAD
57      60    CONTINUE                                                    LOAD
58            GO TO 95                                                    LOAD
              C     OPERATION FIELD NOT BLANK.                            LOAD
59      65    CONTINUE                                                    LOAD
60            IF (IOP(IDX).GT.5) GO TO 170                                LOAD
61            IDZ=IOP(IDX)                                                LOAD
62            GO TO (85,75,130,70,80), IDZ                                LOAD
              C     REPEAT TO THE END OF THE BLOCK.                       LOAD
63      70    CONTINUE                                                    LOAD
64            IDY=ICNTS-ICNET                                             LOAD
65            IF (IDY) 125,125,95                                         LOAD
              C     INTERPOLATION PASS ONE.                               LOAD
66      75    CONTINUE                                                    LOAD
67            IF (ITYRD.EQ.0) GO TO 175                                   LOAD
68            IF (ICOUNT(IDX).LE.0) GO TO 180                             LOAD
69            ICNIT=ICOUNT(IDX)                                           LOAD
70            IDZ=ICNIT+1                                                 LOAD
71            DEL=FLOAT(IDZ)                                              LOAD
72            INDIT=1                                                     LOAD
73            GO TO 95                                                    LOAD
              C     NUMBER OF REPEATS TIMES TEN.  (IOP = 5 )              LOAD
74      80    CONTINUE                                                    LOAD
75            IDY=10                                                      LOAD
76            IDY=IDY*ICOUNT(IDX)                                         LOAD
```

SUBROUTINE LOAD (VECP,IVECP,ITYPIN,ICDES,HOL1,HOL2,IPRCRD,IPRCV)

```
 77            GO TO 90                                                  LOAD
       C       REPEAT.                                                   LOAD
 78    85      CONTINUE                                                  LOAD
 79            IDY=ICOUNT(IDX)                                           LOAD
 80    90      CONTINUE                                                  LOAD
 81            IF (IDY.LE.0) GO TO 190                                   LOAD
       C       ENTER ARRARY.                                             LOAD
 82    95      CONTINUE                                                  LOAD
 83            DO 115 IDZ=1,IDY                                          LOAD
 84            ICNRD=ICNRD+1                                             LOAD
 85            IF (ICNRD.GT.ICNTS) GO TO 115                             LOAD
 86            ICNET=ICNET+1                                             LOAD
 87            IF (ITYRD.EQ.0) GO TO 110                                 LOAD
       C       FLOATING POINT ENTRY.                                     LOAD
 88            IF (INDIT) 100,105,105                                    LOAD
 89    100     CONTINUE                                                  LOAD
 90            VECP(ICNET)=VECP(ICNET-1)+DEL                             LOAD
 91            GO TO 115                                                 LOAD
 92    105     CONTINUE                                                  LOAD
 93            VECP(ICNET)=FL(IDX)                                       LOAD
 94            GO TO 115                                                 LOAD
       C       FIXED POINT ENTRY.                                        LOAD
 95    110     CONTINUE                                                  LOAD
 96            IVECP(ICNET)=IFX(IDX)                                     LOAD
       C       END OF IDZ LOOP.                                          LOAD
 97    115     CONTINUE                                                  LOAD
       C       CHECK FOR INTERPOLATION PASS TWO.                         LOAD
 98            IF (INDIT) 120,125,125                                    LOAD
 99    120     CONTINUE                                                  LOAD
100            INDIT=0                                                   LOAD
101            GO TO 50                                                  LOAD
       C       END OF IDX LOOP.                                          LOAD
102    125     CONTINUE                                                  LOAD
103            GO TO 5                                                   LOAD
       C       TERMINAL OPERATION.                                       LOAD
104    130     CONTINUE                                                  LOAD
       C       CHECK FOR INTERPOLATION COMPLETED.                        LOAD
105            IF (INDIT.NE.0) GO TO 185                                 LOAD
       C       CHECK COUNT.                                              LOAD
106            IF (ICNRD-ICNTS) 165,135,155                              LOAD
       C       ENTERED BLOCK COUNT CORRECT.                              LOAD
107    135     CONTINUE                                                  LOAD
108            IERRT=0                                                   LOAD
109            IDZ=ICNTS                                                 LOAD
110            WRITE (NOUT,210) HOL1,HOL2,ICNTS                          LOAD
       C       TEST FOR TITLE PRINT ONLY.                                LOAD
111            IF (IPRCV.NE.0) GO TO 150                                 LOAD
       C       PRINT BLOCK.                                              LOAD
112    140     CONTINUE                                                  LOAD
113            IF (IDZ.LE.0) GO TO 150                                   LOAD
```

SUBROUTINE LOAD (VECP,IVECP,ITYPIN,ICDES,HOL1,HOL2,IPRCRD,IPRCV)

```
      114           IF (ITYRD.EQ.0) GO TO 145                                LOAD
      115           WRITE (NOUT,215) (VECP(I),I=1,IDZ)                       LOAD
      116           GO TO 150                                                LOAD
      117     145   CONTINUE                                                 LOAD
      118           WRITE (NOUT,220) (VECP(I),I=1,IDZ)                       LOAD
            C       RETURN.                                                  LOAD
      119     150   CONTINUE                                                 LOAD
      120           IF (IERRT.NE.0) GO TO 195                                LOAD
      121           RETURN                                                   LOAD
            C       TOO MANY ENTRIES IN THE BLOCK.                           LOAD
      122     155   CONTINUE                                                 LOAD
      123           WRITE (NOUT,225)                                         LOAD
      124     160   CONTINUE                                                 LOAD
      125           WRITE (NOUT,230) ICNRD,ICNTS,HOL1,HOL2                   LOAD
      126           IDZ=ICNET                                                LOAD
      127           GO TO 140                                                LOAD
            C       TOO FEW ENTRIES IN THE BLOCK.                            LOAD
      128     165   CONTINUE                                                 LOAD
      129           WRITE (NOUT,235)                                         LOAD
      130           GO TO 160                                                LOAD
            C       ILLEGAL OPERATION.                                       LOAD
      131     170   CONTINUE                                                 LOAD
      132           WRITE (NOUT,240)                                         LOAD
      133           GO TO 160                                                LOAD
            C       INTERPOLATION ON A FIXED POINT BLOCK.                    LOAD
      134     175   CONTINUE                                                 LOAD
      135           WRITE (NOUT,245)                                         LOAD
      136           GO TO 160                                                LOAD
            C       ZERO OR LESS ON COUNT FOR INTERPOLATION.                 LOAD
      137     180   CONTINUE                                                 LOAD
      138           WRITE (NOUT,250)                                         LOAD
      139           GO TO 160                                                LOAD
            C       INTERPOLATION OPERATION NOT COMPLETED.                   LOAD
      140     185   CONTINUE                                                 LOAD
      141           WRITE (NOUT,255)                                         LOAD
      142           GO TO 160                                                LOAD
            C       ZERO OR LESS COUNT ON REPEATS.                           LOAD
      143     190   CONTINUE                                                 LOAD
      144           WRITE (NOUT,260)                                         LOAD
      145           GO TO 160                                                LOAD
            C       OBTAIN NEXT CASE DUE TO AN ERROR.                        LOAD
      146     195   CONTINUE                                                 LOAD
      147           WRITE (NOUT,305)                                         LOAD
      148           CALL EXIT                                                LOAD
            C                                                                LOAD
      149     200   FORMAT (6(I1,I2,E9.4))                                   LOAD
      150     205   FORMAT (6(I1,I2,I9))                                     LOAD
      151     210   FORMAT (1H02A6,I6)                                       LOAD
      152     215   FORMAT (1H 1P10E12.4)                                    LOAD
      153     220   FORMAT (1H 10I12)                                        LOAD
```

```
      SUBROUTINE LOAD (VECP,IVECP,ITYPIN,ICDES,HOL1,HOL2,IPRCRD,IPRCV)
  154     225   FORMAT (73H0  COUNT READ     DESIRED    BLOCK NAME - ERROR TOO MAN LOAD
                1Y ENTRIES LOADED. )                                               LOAD
  155     230   FORMAT (1H 2I12,2X,2A6)                                            LOAD
  156     235   FORMAT (72H0  COUNT READ     DESIRED    BLOCK NAME - ERROR TOO FEW LOAD
                1 ENTRIES LOADED. )                                                LOAD
  157     240   FORMAT (73H0  COUNT READ     DESIRED    BLOCK NAME - ERROR ILLEGAL LOAD
                1 OPERATION FOUND. )                                               LOAD
  158     245   FORMAT (98H0  COUNT READ     DESIRED    BLOCK NAME - ERROR INTERPO LOAD
                1LATION OPERATION REQUEST IN A FIXED BLOCK. )                      LOAD
  159     250   FORMAT (96H0  COUNT READ     DESIRED    BLOCK NAME - ERROR ZERO OR LOAD
                1 LESS COUNT FOR INTERPOLATION OPERATION. )                        LOAD
  160     255   FORMAT (94H0  COUNT READ     DESIRED    BLOCK NAME - ERROR THE INT LOAD
                1ERPOLATION OPERATION IS NOT COMPLETED. )                          LOAD
  161     260   FORMAT (89H0  COUNT READ     DESIRED    BLOCK NAME - ERROR ZERO OR LOAD
                1 LESS COUNT FOR REPEAT OPERATION. )                               LOAD
  162     265   FORMAT (35H0 LOADING CARD READ OF BLOCK NAMED 2A6)                 LOAD
  163     270   FORMAT (119H0 CARD OP CNT   NUMERIC OP CNT   NUMERIC OP CNT   NUME LOAD
                1RIC OP CNT   NUMERIC OP CNT   NUMERIC OP CNT   NUMERIC FLOATING. ) LOAD
  164     275   FORMAT (1H I5,6(1X,I2,1X,I3,1X,1PE9.2))                            LOAD
  165     280   FORMAT (116H0 CARD OP CNT   NUMERIC OP CNT   NUMERIC OP CNT   NUME LOAD
                1RIC OP CNT   NUMERIC OP CNT   NUMERIC OP CNT   NUMERIC FIXED. )   LOAD
  166     285   FORMAT (1H I5,6(1X,I2,1X,I3,1X,I9))                                LOAD
  167     290   FORMAT (77H0**************************************************** LOAD
                1**********  )                                                    LOAD
  168     295   FORMAT (77H   CARD FIELD   NAMED BLOCK**BLANK OPERATION AND NON ZE LOAD
                1RO COUNT ENCOUNTERED. )                                           LOAD
  169     300   FORMAT (1H ,I6,I6,2X,2A6)                                          LOAD
  170     305   FORMAT (*      ERROR - - EXIT CALLED FROM SUBROUTINE LOAD DUE TO I LOAD
                1NPUT ERROR*)                                                      LOAD
  171           END                                                                LOAD
```

SUBROUTINE LOAD (VECP,IVECP,ITYPIN,ICDES,HOL1,HOL2,IPRCRD,IPRCV)

SYMBOL = = = = = = = = = = = = = = REFERENCES = = = = = = = = = = = = = =

I N D E X PAGE 32

PROGRAM PHOTON

```
    1           PROGRAM PHOTON                                                  PHOTON
                C                                                               PHOTON
                C   PHOTON READS THE INPUT DATA FROM TAPES AND SUPERVISES THE    PHOTON
                C   CALCULATIONS FOR EACH ZONE AND EACH MATERIAL WITHIN EACH ZONE. PHOTON
                C                                                               PHOTON
    2           COMMON C,EG(50),EMG(50),EMNB(100),EMNF(100),GAMM(50),IM,IOO,IRES,I BLANK
               1WO,IZM,MA(100),MB(50),MC(50),MCR,MM,MS,MZ(10),NRG,NENB,NENF,NFG,NG BLANK
               2AM,NGG,NMAT(10),NNM(126),NPM,R(101),RW(100),RXSC(100),RXSF(100),SW BLANK
               3(100),SXSC(100),SXSF(100),XMD(50),AWRSAV                        BLANK
    3           COMMON /TAPES/ ISI,ISO,IEN                                      TAPES
    4           COMMON /OVER1/ EAUG(2000),IAUG,ILO1,ILO2,IXDA,IXSD,MATX,MTNO(40),M OVER1
               1TSL                                                             OVER1
    5           REWIND 5                                                        PHOTON
    6           DO 20 IZON=1,IZM                                                PHOTON
                C   SET UP THE PARAMETERS FOR THIS ZONE                        PHOTON
    7           IF (IRES.EQ.1) READ (5) (RW(I),I=1,NFG)                         PHOTON
    8           READ (5) (SW(I),I=1,NFG)                                        PHOTON
    9           CALL NORM                                                       PHOTON
   10           KNO=NMAT(IZON)                                                  PHOTON
   11           DO 20 I=1,KNO                                                   PHOTON
                C   SET UP THE PARAMETERS FOR THE I-TH MATERIAL IN THIS ZONE.   PHOTON
   12           READ (5) MATX,MTSL,(MTNO(J),J=1,MTSL)                           PHOTON
   13           REWIND IEN                                                      PHOTON
   14           REWIND 20                                                       PHOTON
   15       5   READ (20,25) MAT                                                PHOTON
   16           IF (MAT.NE.MATX) GO TO 5                                        PHOTON
   17           BACKSPACE 20                                                    PHOTON
                C   RXSC IS USED AS TEMPORARY STORAGE HERE.                    PHOTON
   18       10  READ (20,30) (RXSC(J),J=1,11),MAT,MF,MT                        PHOTON
   19           WRITE (IEN,30) (RXSC(J),J=1,11),MAT,MF,MT                       PHOTON
   20           IF (MAT.NE.0) GO TO 10                                          PHOTON
   21           REWIND IEN                                                      PHOTON
   22           IF (IRES.NE.1) GO TO 15                                         PHOTON
   23           READ (5) (RXSC(J),J=1,NFG)                                      PHOTON
   24           READ (5) (RXSF(J),J=1,NFG)                                      PHOTON
   25           READ (5) (SXSC(J),J=1,NFG)                                      PHOTON
   26           READ (5) (SXSF(J),J=1,NFG)                                      PHOTON
   27       15  WRITE (ISO,35) IZON,I                                           PHOTON
                C   THIS WRITE STATEMENT IS INCLUDED SO THAT ANY ERROR STOPS CAN BE PHOTON
                C   MORE EASILY TRACED DOWN.                                   PHOTON
   28           CALL LAPH                                                       PHOTON
   29       20  CONTINUE                                                        PHOTON
   30           RETURN                                                          PHOTON
                C                                                               PHOTON
   31       25  FORMAT (66X,I4)                                                 PHOTON
   32       30  FORMAT (11A6,I4,I2,I3)                                          PHOTON
   33       35  FORMAT (*  ------ZONE*,I4,*    ------MATERIAL*,I4,*    ------*) PHOTON
   34           END                                                             PHOTON
```

SYMBOL	REFERENCES						
5	15*	16					
17	18*	20					
15	22	27*					
2C	6	11	29*				
25	15RD	31*					
3C	18RD	19WR	32*				
35	27WR	33*					
AWRSAV	2C0						
C	2C0						
EAUG	4C0						
EG	2C0						
EMG	2C0						
EMNB	2C0						
EMNF	2C0						
GAMM	2C0						
I	7RD	8RD	11	27WR			
IAUG	4C0						
IEN	3C0	13	19WR	21			
IL01	4C0						
IL02	4C0						
IM	2C0						
INO	2C0						
IRES	2C0	7	22				
ISI	3C0						
ISO	3C0	27WR					
IWO	2C0						
IYDA	4C0						
IXSD	4C0						
IZM	2C0	6					
IZON	6	19	27WR				
J	12RD	18RD	19WR	23RD	24RD	25RD	26RD
KNO	19=	11					
LAPH	28						
MA	2C0						
MAT	15RD	16	18RD	19WR	20		
MATX	4C0	12RD	16				
MB	2C0						
MC	2C0						
MCR	2C0						
MF	18RD	19WR					
MM	2C0						
MS	2C0						
MT	18RD	19WR					
MTNO	4C0	12RD					
MTSL	4C0	12RD					
MZ	2C0						
NRG	2C0						
NFNB	2C0						

SUBROUTINE INTG (X3,Y3,X4,Y4,X1,X2,I,ANS)

```
    1           SUBROUTINE INTG (X3,Y3,X4,Y4,X1,X2,I,ANS)                          INTG
                C   COMPUTE INTEGRAL OF Y(X) BETWEEN X1 AND X2 WITH INTERPOLATION CODE INTG
    2       5   ANS=0.0                                                           INTG
    3           IF (X4-X3) 85,85,10                                               INTG
    4       10  IP=I                                                             INTG
    5           IF (IP) 15,15,20                                                  INTG
    6       15  CALL ERROR (200)                                                 INTG
    7       20  IF (IP-5) 25,25,15                                               INTG
    8       25  GO TO (30,35,40,55,70), IP                                       INTG
                C   Y=CONSTANT                                                    INTG
    9       30  ANS=(X2-X1)*Y3                                                   INTG
   10           GO TO 85                                                         INTG
                C   Y LINEAR IN X                                                INTG
   11       35  B=(Y4-Y3)/(X4-X3)                                                INTG
   12           A=Y3-B*X3                                                        INTG
   13           ANS=(X2-X1)*(A+0.5*B*(X2+X1))                                    INTG
   14           GO TO 85                                                         INTG
                C   Y LINEAR IN LN(X)                                           INTG
   15       40  IF ((X3.LE.0.0).OR.(X4.LE.0.0)) GO TO 35                         INTG
   16           B=(Y4-Y3)/ALOG(X4/X3)                                            INTG
   17           Z=(X2-X1)/X1                                                     INTG
   18           IF (ABS(Z)-0.15) 45,45,50                                        INTG
   19       45  ANS=(X2-X1)*(Y3+B*ALOG(X1/X3))+(0.5*B*X1*Z*Z)*(1.0+Z*(-0.33333333+ INTG
               1Z*(0.16666667-0.1*Z)))                                          INTG
   20           GO TO 85                                                         INTG
   21       50  ANS=(X2-X1)*(Y3+B*ALOG(X1/X3))+B*X1*(1.0+(X2/X1)*(ALOG(X2/X1)-1.0) INTG
               1)                                                               INTG
   22           GO TO 85                                                         INTG
                C   LN(Y) LINEAR IN X                                           INTG
   23       55  IF ((Y3.LE.0.0).OR.(Y4.LE.0.0)) GO TO 35                         INTG
   24           B=ALOG(Y4/Y3)/(X4-X3)                                            INTG
   25           A=ALOG(Y3)-B*X3                                                  INTG
   26           Z=(X2-X1)*B                                                      INTG
   27           IF (ABS(Z)-.1) 60,60,65                                          INTG
   28       60  ANS=EXP(A+B*X1)*(X2-X1)*(1.0+Z*(.5+.16666667*Z))                 INTG
   29           GO TO 85                                                         INTG
   30       65  ANS=EXP(A+B*X1)*(EXP(Z)-1.0)/B                                   INTG
   31           GO TO 85                                                         INTG
                C   LN(Y) LINEAR IN LN(X)                                       INTG
   32       70  IF ((X3.LE.0.0).OR.(X4.LE.0.0)) GO TO 55                         INTG
   33           IF ((Y3.LE.0.0).OR.(Y4.LE.0.0)) GO TO 40                         INTG
   34           B=ALOG(Y4/Y3)/ALOG(X4/X3)                                        INTG
   35           Z=(B+1.0)*ALOG(X2/X1)                                            INTG
   36           IF (ABS(Z)-0.1) 75,75,80                                         INTG
   37       75  ANS=Y3*X1*((X1/X3)**B)*ALOG(X2/X1)*(1.0+Z*(.5+0.16666667*Z))     INTG
   38           GO TO 85                                                         INTG
   39       80  ANS=Y3*X1*((X1/X3)**B)*(((X2/X1)**(B+1.0))-1.0)/(B+1.0)          INTG
   40       85  CONTINUE                                                         INTG
   41           RETURN                                                           INTG
   42           END                                                              INTG
```

SUBROUTINE INTG (X3,Y3,X4,Y4,X1,X2,I,ANS)

SYMBOL	REFERENCES									
5	2*									
10	3	4*								
15	5	6*	7							
20	5	7*								
25	7	8*								
30	8	9*								
35	6	11*	15	23						
40	8	15*	33							
45	18	19*								
50	18	21*								
55	8	23*	32							
60	27	28*								
65	27	30*								
70	8	32*								
75	36	37*								
80	36	39*								
B5	3	10	14	20	22	29	31	38	40*	
A	12=	13	25=	28	30					
ABS	18	27	36							
ALOG	16	19	21	24	25	34	35	37		
ANS	TAG	2=	9=	13=	19=	21=	28=	30=	37=	39=
B	11=	12	13	16=	19	21	24=	25	26	28
	30	34=	35	37	39					
ERROR	6									
EXP	28	30								
I	TAG	4								
INTG	1									
IP	4=	5	7	8						
RETURN	41									
X1	TAG	9	13	17	19	21	26	28	30	35
	37	39								
X2	TAG	9	13	17	19	21	26	28	35	37
	39									
X3	TAG	3	11	12	15	16	19	21	24	25
	32	34	37	39						
X4	TAG	3	11	15	16	24	32	34		
Y3	TAG	9	11	12	16	19	21	23	24	25
	33	34	37	39						
Y4	TAG	11	16	23	24	33	34			
Z	17=	18	19	26=	27	28	30	35=	36	37

FUNCTION LOCT (E,EK,N)

```
    1            FUNCTION LOCT (E,EK,N)                                          LOCT
         C       BRACKETS EK IN E SO THAT EK.GE.E(LOCT) AND EK.LT.E(LOCT+1)      LOCT
         C       IF EK CANNOT BE BRACKETED, LOCT=-1                              LOCT
    2            DIMENSION E(1)                                                  LOCT
    3            M=N-1                                                           LOCT
    4            DO 5 I=1,M                                                      LOCT
    5       5    IF ((EK.GE.E(I)).AND.(EK.LT.E(I+1))) GO TO 15                   LOCT
    6            IF (E(N).NE.EK) GO TO 10                                        LOCT
    7            LOCT=M                                                          LOCT
    8            RETURN                                                          LOCT
    9       10   LOCT=-1                                                         LOCT
   10            RETURN                                                          LOCT
   11       15   LOCT=I                                                          LOCT
   12            RETURN                                                          LOCT
   13            END                                                             LOCT
```


FUNCTION LOCT (E,EK,N)

SYMBOL = = = = = = = = = = = = = = = REFERENCES = = = = = = = = = = = = = = =

```
5        -      4       5*
10       -      6       9*
15       -      5      11*
E        -     1AG     2DI      5        6
EK       -     1AG      5       6
I        -      4       5      11
LOCT     -      1       7=      9=      11=
M        -     3=       4       7
N        -     1AG      3       6
RETURN   -      8      10      12
```

SUBROUTINE TERP1 (X1,Y1,X2,Y2,X,Y,I)

```
    1           SUBROUTINE TERP1 (X1,Y1,X2,Y2,X,Y,I)                                  TERP1
                C     ====INTERPOLATE ONE PT.                                         TERP1
                C     (X1,Y1) AND (X2,Y2) ARE END PTS. OF THE LINE                    TERP1
                C     (X,Y) IS INTERPOLATED POINT                                     TERP1
                C     I=INTERPOLATION CODE                                            TERP1
                C     NOTE - IF A NEGATIVE OR ZERO ARGUMENT OF A LOG IS DETECTED, THE TERP1
                C            INTERPOLATION IS AUTOMATICALLY CHANGED FROM LOG TO LINEAR. TERP1
                C     ERROR STOPS - 301 (X1=X2,DISCONTINUITY)                         TERP1
                C                   302 (INTERPOLATION CODE IS OUT OF RANGE)          TERP1
                C                   303 (ZERO OR NEGATIVE ARGUMENT FOR INTERPOLATED PT.) TERP1
    2           5     XA=X1                                                         TERP1
    3                 YA=Y1                                                         TERP1
    4                 XB=X2                                                         TERP1
    5                 YB=Y2                                                         TERP1
    6                 XP=X                                                          TERP1
    7                 II=I                                                          TERP1
    8                 IF (XA.EQ.XB) CALL ERROR (301)                                TERP1
    9                 IF (II) 10,10,15                                              TERP1
   10          10     CALL ERROR (302)                                              TERP1
   11          15     IF (II-5) 20,20,10                                            TERP1
   12          20     GO TO (25,30,35,60,75), II                                    TERP1
   13          25     YP=YA                                                         TERP1
   14                 GO TO 105                                                     TERP1
   15          30     YP=YA+(XP-XA)*(YB-YA)/(XB-XA)                                 TERP1
   16                 GO TO 105                                                     TERP1
   17          35     IF (XA) 30,30,40                                              TERP1
   18          40     IF (XB) 30,30,45                                              TERP1
   19          45     IF (XP) 50,50,55                                              TERP1
   20          50     CALL ERROR (303)                                              TERP1
   21          55     YP=YA*ALOG(XP/XA)*(YB-YA)/ALOG(XB/XA)                         TERP1
   22                 GO TO 105                                                     TERP1
   23          60     IF (YA) 30,30,65                                              TERP1
   24          65     IF (YB) 30,30,70                                              TERP1
   25          70     YP=YA*EXP((XP-XA)*ALOG(YB/YA)/(XB-XA))                        TERP1
   26                 GO TO 105                                                     TERP1
   27          75     IF (YA) 35,35,80                                              TERP1
   28          80     IF (YB) 35,35,85                                              TERP1
   29          85     IF (XA) 70,70,90                                              TERP1
   30          90     IF (XB) 70,70,95                                              TERP1
   31          95     IF (XP) 50,50,100                                             TERP1
   32          100    YP=YA*EXP(ALOG(XP/XA)*ALOG(YB/YA)/ALOG(XB/XA))                TERP1
   33          105    Y=YP                                                          TERP1
   34                 RETURN                                                        TERP1
   35                 END                                                           TERP1
```

SUBROUTINE TERP1 (X1,Y1,X2,Y2,X,Y,I)

SYMBOL	REFERENCES
5	2*
10	9 10* 11
15	9 11*
20	11 12*
25	12 13*
30	12 15* 17 18 23 24
35	12 17* 27 28
40	17 18*
45	18 19*
50	19 20* 31
55	19 21*
60	12 23*
65	23 24*
70	24 25* 29 30
75	12 27*
80	27 28*
85	28 29*
90	29 30*
95	30 31*
100	31 32*
105	14 16 22 26 33*
ALOG	21 25 32
ERROR	8 10 20
EXP	25 32
I	1AG 7
II	7= 9 11 12
RETURN	34
TERP1	1
X	1AG 6
X1	1AG 2
X2	1AG 4
XA	2= 8 15 17 21 25 29 32
XB	4= 8 15 18 21 25 30 32
XP	6= 15 19 21 25 31 32
Y	1AG 33=
Y1	1AG 3
Y2	1AG 5
YA	3= 13 15 21 23 25 27 32
YB	5= 15 21 24 25 28 32
YP	13= 15= 21= 25= 32= 33

SUBROUTINE LAPH

```
    1          SUBROUTINE LAPH                                                    LAPH
           C                                                                      LAPH
           C   LAPH SUPERVISES THE CALCULATION OF THE PHOTON PRODUCTION AND       LAPH
           C   ENERGY PRODUCTION MATRICES FOR EACH MATERIAL.                      LAPH
           C                                                                      LAPH
    2          COMMON /OVER1/ EAUG(2000),IAUG,ILO1,ILO2,IXDA,IXSD,MATX,MTNO(40),M OVER1
              1TSL                                                                OVER1
    3          COMMON /BOOK/ LO1LF2,LOLF12(100),LO1LF1,LOLF11(500),NRI6,NROW(100) BOOK
    4          IXDA=0                                                             LAPH
    5          IXSD=0                                                             LAPH
    6          ILO1=0                                                             LAPH
    7          ILO2=0                                                             LAPH
           C   ILO2 IS THE NUMBER OF DISCRETE EXCITATION LEVELS BEING CONSIDERED  LAPH
           C   FOR THIS MATERIAL.  IN OTHER WORDS, THERE ARE ILO2 SECTIONS WITH   LAPH
           C   LO=2 READ FROM FILE 15.                                           LAPH
           C   ILO1 IS THE TOTAL NUMBER OF YIELDS FOR NEUTRON FINE GROUPS AND     LAPH
           C   GAMMA GROUPS AS CALCULATED USING THE LO=1, LF=1 DATA ON FILE 15.  LAPH
           C   IXSD IS THE TOTAL NUMBER OF YIELDS CALCULATED USING LO=1, LF=2    LAPH
           C   DATA ON FILE 15.                                                  LAPH
           C   IXDA IS THE TOTAL NUMBER OF CASCADE GAMMA RAYS RECONSTRUCTED FROM  LAPH
           C   THE FIXED NUMBER OF DISCRETE LEVELS.                             LAPH
           C   ILO1, ILO2, AND IXSD ARE INCREMENTED IN SUBROUTINE PR15 WHILE     LAPH
           C   IXDA IS INCREMENTED IN TRC2.                                      LAPH
    8          NR16=0                                                             LAPH
    9          LO1LF1=0                                                           LAPH
   10          LO1LF2=0                                                           LAPH
   11          REWIND 15                                                          LAPH
   12          REWIND 16                                                          LAPH
   13          REWIND 17                                                          LAPH
   14          IF (MTNO(1).EQ.0) GO TO 10                                         LAPH
   15          CALL MESH                                                          LAPH
   16          CALL PR15                                                          LAPH
   17          IF (ILO2.EQ.0) GO TO 5                                             LAPH
   18          CALL TRC2                                                          LAPH
   19        5 CALL XSEC                                                          LAPH
   20       10 CALL MATRIX                                                        LAPH
   21          RETURN                                                             LAPH
   22          END                                                                LAPH
```

SYMBOL	REFERENCES
5	17 19*
10	14 20*
BOOK	3C0
EAUG	2C0
IAUG	2C0
IL01	2C0 6*
IL02	2C0 7* 17
IXDA	2C0 4*
IXSD	2C0 5*
LAPH	1
L01LF1	3C0 9*
L01LF2	3C0 10*
L0LF11	3C0
L0LF12	3C0
MATRIX	20
MATX	2C0
MESH	15
MTN0	2C0 14
MTSL	2C0
Np16	3C0 8*
NROW	3C0
OVER1	2C0
PP15	16
RETURN	21
TPC2	18
XSEC	19

SUBROUTINE NORM

```
    1            SUBROUTINE NORM                                                    NORM
                 C                                                                  NORM
                 C     IN THIS ROUTINE THE FINE GROUP WEIGHTING FUNCTIONS ARE NORMALIZED NORM
                 C     OVER EACH BROAD GROUP.                                       NORM
                 C                                                                  NORM
    2            COMMON C,EG(50),EMG(50),EMNB(100),EMNF(100),GAMM(50),IM,IOO,IRES,I BLANK
                1WO,IZM,MA(100),MB(50),MC(50),MCR,MM,MS,MZ(10),NBG,NENB,NENF,NFG,NG BLANK
                2AM,NGG,NMAT(10),NNM(126),NPM,R(101),RW(100),RXSC(100),RXSF(100),SW BLANK
                3(100),SXSC(100),SXSF(100),XMD(50),AWRSAV                           BLANK
    3            DO 20 I=1,NBG                                                      NORM
    4            SUMR=0.0                                                           NORM
    5            SUMS=0.0                                                           NORM
    6            IFST=0                                                             NORM
    7            DO 10 J=2,NENF                                                     NORM
    8            IF ((EMNF(J).LT.EMNB(I)).AND.(EMNF(J).GE.EMNB(I+1))) GO TO 5       NORM
    9            GO TO 10                                                           NORM
   10      5     SUMS=SUMS+SW(J-1)                                                  NORM
   11            SUMR=SUMR+RW(J-1)                                                  NORM
   12            IF (IFST.EQ.0) IFST=J-1                                            NORM
   13            ILST=J-1                                                           NORM
   14      10    CONTINUE                                                           NORM
   15            DO 20 K=IFST,ILST                                                  NORM
   16            IF (SUMR.EQ.0.0) GO TO 15                                          NORM
   17            RW(K)=RW(K)/SUMR                                                   NORM
   18      15    CONTINUE                                                           NORM
   19            IF (SUMS.EQ.0.0) GO TO 20                                          NORM
   20            SW(K)=SW(K)/SUMS                                                   NORM
   21      20    CONTINUE                                                           NORM
   22            RETURN                                                             NORM
                 C                                                                  NORM
   23            END                                                                NORM
```

SYMBOL = = = = = = = = = = = = = = = REFERENCES = = = = = = = = = = = = = = =

5	-	8	10*				
10	-	7	9	14*			
15	-	16	18*				
20	-	3	15	19	21*		
AMRSAV	-	200					
C	-	200					
EG	-	200					
EMG	-	200					
EMNB	-	200	8				
EMNF	-	200	8				
GAMM	-	200					
I	-	3	8				
IFST	-	6=	12	15			
ILST	-	13=	15				
IM	-	200					
IMO	-	200					
IPES	-	200					
IRO	-	200					
IRM	-	200					
J	-	7	8	10	11	12	13
K	-	15	17	20			
MA	-	200					
MB	-	200					
MC	-	200					
MCR	-	200					
MM	-	200					
MS	-	200					
MZ	-	200					
NAG	-	200	3				
NFNB	-	200					
NFNF	-	200	7				
NFG	-	200					
NGAM	-	200					
NGG	-	200					
NMAT	-	200					
NNM	-	200					
NORM	-	1					
NPM	-	200					
R	-	200					
RETURN	-	22					
RW	-	200	11	17=			
RXSC	-	200					
RXSF	-	200					
SIMR	-	4=	11=	16	17		
SIMS	-	5=	10=	19	20		
SW	-	200	10	20=			
SXSC	-	200					
SXSF	-	200					

XMD	-	200	

SUBROUTINE RSF3

```
    1            SUBROUTINE RSF3                                                    RSF3
    2            COMMON /TAPES/ ISI,ISO,IEN                                         TAPES
    3            COMMON /READ/ NR,NP,MAT,MF,MT,NBT(20),INT(20),E(2000),X(2000)      READ
         C       NR=NO. OF INTERPOLATION BREAK PTS.                                 RSF3
         C       NP=NO. OF CROSS SECTION, NEUTRON ENERGY PAIRS                      RSF3
         C       NBT(I) CONTAINS THE INDEX OF THE LAST PT. CORRESPONDING TO THE IN- RSF3
         C       TERPOLATION CODE GIVEN IN INT(I)                                   RSF3
    4            READ (IEN,10) NR,NP,MAT,MF,MT,(NBT(N),INT(N),N=1,NR)               RSF3
    5            READ (IEN,15) (E(N),X(N),N=1,NP)                                   RSF3
    6            READ (IEN,5) MAT,MF,MT                                             RSF3
    7            READ (IEN,5) MAT,MF,MT                                             RSF3
    8            RETURN                                                             RSF3
         C                                                                          RSF3
    9       5    FORMAT (66X,I4,I2,I3)                                              RSF3
   10      10    FORMAT (44X,2I11,I4,I2,I3/(6I11))                                  RSF3
   11      15    FORMAT (6E11.4)                                                    RSF3
   12            END                                                                RSF3
```


SUBROUTINE RSF3

SYMBOL		REFERENCES				
5	-	6RD	7RD	9*		
10	-	4RD	10*			
15	-	5RD	11*			
E	-	3CO	5RD			
IEN	-	2CO	4RD	5RD	6RD	7RD
INT	-	3CO	4RD			
ISI	-	2CO				
ISO	-	2CO				
MAT	-	3CO	4RD	6RD	7RD	
MF	-	3CO	4RD	6RD	7RD	
MT	-	3CO	4RD	6RD	7RD	
N	-	4RD	5RD			
NBT	-	3CO	4RD			
NP	-	3CO	4RD	5RD		
NR	-	3CO	4RD			
READ	-	3CO				
RETURN	-	8				
RSF3	-	1				
TAPES	-	2CO				
X	-	3CO	5RD			

SUBROUTINE MESH

```
      1            SUBROUTINE MESH                                                    MESH
                   C                                                                  MESH
                   C    FORMS ENERGY MESH FOR INTEGRATION DETERMINED BY OVERLAYING THE MESH
                   C    NEUTRON FINE GROUP ENERGY MESH AND THE CROSS SECTION MESH IN FILE3 MESH
                   C    THIS ROUTINE ALSO PROVIDES FOR THE OPTION THAT ALL PHOTON      MESH
                   C    PRODUCTION DATA WHICH EXIST IN FILE 15 ARE USED WHEN MT=-1 IS  MESH
                   C    SPECIFIED. NOTE THAT ALL REACTION TYPES (MT NUMBERS) INCLUDED IN MESH
                   C    FILE 15 ARE INCLUDED IN FILE 3.                               MESH
                   C                                                                  MESH
      2            COMMON C,EG(50),EMG(50),EMNB(100),EMNF(100),GAMM(50),IM,IOO,IRES,I BLANK
                  1WO,IZM,MA(100),MB(50),MC(50),MCR,MM,MS,MZ(10),NBG,NENB,NENF,NFG,NG BLANK
                  2AM,NGG,NMAT(10),NNM(126),NPM,R(101),RW(100),RXSC(100),RXSF(100),SW BLANK
                  3(100),SXSC(100),SXSF(100),XMD(50),AWRSAV                          BLANK
      3            COMMON /TAPES/ ISI,ISO,IEN                                         TAPES
      4            COMMON /OVER1/ EAUG(2000),IAUG,IL01,IL02,IXDA,IXSD,MATX,MTNO(40),M OVER1
                  1TSL                                                               OVER1
      5            COMMON /READ/ NR,NP,MAT,MF,MT,NBT(20),INT(20),E(2000),X(2000)      READ
      6            DIMENSION MV(40)                                                   MESH
      7            ILEVEL=1                                                           MESH
      8            IAUG=NENF                                                          MESH
      9            DO 5 I=1,NENF                                                      MESH
     10            K=NENF+1-I                                                         MESH
     11      5     EAUG(I)=EMNF(K)                                                    MESH
     12            REWIND IEN                                                         MESH
     13            READ (IEN,150) AWRSAV                                              MESH
     14     10     READ (IEN,190) MAT,MF,MT                                           MESH
     15            IF (MF.NE.3) GO TO 10                                              MESH
     16     15     DO 35 I=1,MTSL                                                     MESH
     17            IF (MT.EQ.MTNO(I)) GO TO 60                                        MESH
     18            IF (MTNO(I).NE.-1) GO TO 35                                        MESH
                   C    THE FOLLOWING TEST IS VERY SIGNIFICANT.  IF PHOTON PRODUCTION DATA MESH
                   C    ARE GIVEN IN FILE 15 FOR MT=4, THESE DATA ARE USED WHEN MT=-1 ONLY MESH
                   C    IF DATA ARE NOT GIVEN FOR ANY MT SUCH THAT 5.LE.MT.LE.15 OR    MESH
                   C    51.LE.MT.LE.80.                                               MESH
     19            JMAX=ILEVEL-1                                                      MESH
     20            IF (JMAX.EQ.0) GO TO 60                                            MESH
     21            DO 20 J=1,JMAX                                                     MESH
     22     20     IF ((MT.GT.4.AND.MT.LE.15.AND.MV(J).EQ.4).OR.(MT.GE.51.AND.MT.LE.8 MESH
                  10.AND.MV(J).EQ.4)) GO TO 25                                       MESH
     23            GO TO 60                                                           MESH
     24     25     ILEVEL=ILEVEL-1                                                    MESH
     25            IF (J.EQ.ILEVEL) GO TO 60                                          MESH
     26            JJ=J                                                               MESH
     27            DO 30 J=JJ,ILEVEL                                                  MESH
     28     30     MV(J)=MV(J+1)                                                      MESH
     29            GO TO 60                                                           MESH
     30     35     CONTINUE                                                           MESH
     31            CALL RSF3                                                          MESH
     32            IF (MF.NE.0) GO TO 15                                              MESH
     33     40     IF (MTNO(1).EQ.-1) GO TO 50                                        MESH
```

SUBROUTINE MESH

```
 34      45    GO TO 75                                                          MESH
 35      50    MTSL=ILEVEL-1                                                     MESH
 36            DO 55 I=1,MTSL                                                    MESH
 37      55    MTNO(I)=MV(I)                                                     MESH
 38            WRITE (ISO,195) MTSL,(MTNO(I),I=1,MTSL)                           MESH
 39            GO TO 45                                                          MESH
 40      60    MV(ILEVEL)=MT                                                     MESH
 41            CALL RSF3                                                         MESH
 42            K=1                                                               MESH
 43            IMAX=IAUG-1                                                       MESH
 44            DO 65 I=1,IMAX                                                    MESH
 45            X(K)=EAUG(I)                                                      MESH
 46            K=K+1                                                             MESH
 47            DO 65 J=1,NP                                                      MESH
 48            IF (E(J).LE.EAUG(I).OR.E(J).GE.EAUG(I+1)) GO TO 65                MESH
 49            X(K)=E(J)                                                         MESH
 50            K=K+1                                                             MESH
 51      65    CONTINUE                                                          MESH
 52            X(K)=EAUG(IAUG)                                                   MESH
 53            DO 70 I=1,K                                                       MESH
 54      70    EAUG(I)=X(I)                                                      MESH
 55            IAUG=K                                                            MESH
 56            ILEVEL=ILEVEL+1                                                   MESH
 57            IF (MF.NE.0) GO TO 15                                             MESH
 58            GO TO 40                                                          MESH
       C       THIS PART OF THE SUBROUTINE ADDS TO THE UNION OF THE SETS THOSE   MESH
       C       ENERGIES AT WHICH THE YIELDS ARE TABULATED IN FILE 15 FOR LO=1,   MESH
       C       LF=1,2 FOR THOSE MT NUMBERS INCLUDED IN THE PROBLEM.              MESH
 59      75    READ (IEN,155) LO,MAT,MF,MT                                       MESH
 60            IF (MF.NE.15) GO TO 75                                            MESH
 61            GO TO 85                                                          MESH
 62      80    READ (IEN,160) LO,NK,MAT,MF,MT                                    MESH
 63            IF (MF.EQ.0) GO TO 145                                            MESH
 64      85    DO 90 I=1,MTSL                                                    MESH
 65      90    IF (MT.EQ.MTNO(I)) GO TO 100                                      MESH
 66      95    READ (IEN,190) MAT,MF,MT                                          MESH
 67            IF (MF.EQ.0) GO TO 145                                            MESH
 68            IF (MT.EQ.0) GO TO 80                                             MESH
 69            GO TO 95                                                          MESH
 70     100    IF (LO.EQ.2) GO TO 140                                            MESH
 71            ISTOR=0                                                           MESH
 72            READ (IEN,165) NR,NP                                              MESH
 73            READ (IEN,170) (NN,NN,I=1,NR)                                     MESH
 74            READ (IEN,175) (XX,XX,I=1,NP)                                     MESH
 75            DO 125 J=1,NK                                                     MESH
 76            READ (IEN,180) LF,NR,NP                                           MESH
 77            IF (LF.EQ.2) GO TO 110                                            MESH
 78            READ (IEN,170) (NN,NN,I=1,NR)                                     MESH
 79            READ (IEN,175) (XX,XX,I=1,NP)                                     MESH
 80            READ (IEN,165) NBRN,NTBS                                          MESH
```

```
   81            READ (IEN,170) (NN,NN,I=1,NBBN)                                  MESH
   82            DO 105 K=1,NTBS                                                  MESH
   83            ISTOR=ISTOR+1                                                    MESH
   84            READ (IEN,185) E(ISTOR),NBR2,NPR2                                MESH
   85            READ (IEN,170) (NN,NN,I=1,NBR2)                                  MESH
   86            READ (IEN,175) (XX,XX,I=1,NPR2)                                  MESH
   87      105   CONTINUE                                                         MESH
   88            GO TO 125                                                        MESH
   89      110   READ (IEN,170) (NN,NN,I=1,NR)                                    MESH
   90            READ (IEN,175) (E(I),XX,I=1,NP)                                  MESH
   91            K=1                                                              MESH
   92            IMAX=IAUG-1                                                      MESH
   93            DO 115 I=1,IMAX                                                  MESH
   94            X(K)=EAUG(I)                                                     MESH
   95            K=K+1                                                            MESH
   96            DO 115 JJ=1,NP                                                   MESH
   97            IF (E(JJ).LE.EAUG(I).OR.E(JJ).GE.EAUG(I+1)) GO TO 115            MESH
   98            X(K)=E(JJ)                                                       MESH
   99            K=K+1                                                            MESH
  100      115   CONTINUE                                                         MESH
  101            X(K)=EAUG(IAUG)                                                  MESH
  102            DO 120 I=1,K                                                     MESH
  103      120   EAUG(I)=X(I)                                                     MESH
  104            IAUG=K                                                           MESH
  105      125   CONTINUE                                                         MESH
  106            IF (ISTOR.EQ.0) GO TO 140                                        MESH
  107            K=1                                                              MESH
  108            IMAX=IAUG-1                                                      MESH
  109            DO 130 I=1,IMAX                                                  MESH
  110            X(K)=EAUG(I)                                                     MESH
  111            K=K+1                                                            MESH
  112            DO 130 J=1,ISTOR                                                 MESH
  113            IF (E(J).LE.EAUG(I).OR.E(J).GE.EAUG(I+1)) GO TO 130              MESH
  114            X(K)=E(J)                                                        MESH
  115            K=K+1                                                            MESH
  116      130   CONTINUE                                                         MESH
  117            X(K)=EAUG(IAUG)                                                  MESH
  118            DO 135 I=1,K                                                     MESH
  119      135   EAUG(I)=X(I)                                                     MESH
  120            IAUG=K                                                           MESH
  121      140   READ (IEN,190) MAT,MF,MT                                         MESH
  122            IF (MT.EQ.0) GO TO 80                                            MESH
  123            GO TO 140                                                        MESH
  124      145   IF (IAUG.GT.2000) CALL ERROR (400)                               MESH
  125            RETURN                                                           MESH
         C                                                                       MESH
  126      150   FORMAT (11X,E11.4)                                               MESH
  127      155   FORMAT (22X,I11,33X,I4,I2,I3)                                    MESH
  128      160   FORMAT (22X,I11,22X,I11,I4,I2,I3)                                MESH
  129      165   FORMAT (44X,2I11)                                                MESH
```



```
  130      170   FORMAT (6I11)                                                    MESH
  131      175   FORMAT (6E11.4)                                                  MESH
  132      180   FORMAT (33X,3I11)                                                MESH
  133      185   FORMAT (11X,E11.4,22X,2I11)                                      MESH
  134      190   FORMAT (66X,I4,I2,I3)                                            MESH
  135      195   FORMAT (*    UNDER THE OPTION PROVIDED WHEN INPUT MT=-1 IS USED, T MESH
                1HERE WILL BE *,I4,* REACTION TYPES USED AS FOLLOWS - *,/,(*     MT MESH
                2NO(I)=*,20I4,/))                                                MESH
  136            END                                                             MESH
```

SUBROUTINE MESH

SYMBOL	REFERENCES
5	9 11*
10	14* 15
15	16* 32 57
20	21 22*
25	22 24*
30	27 28*
35	16 18 30*
40	33* 58
45	34* 39
50	33 35*
55	36 37*
60	17 20 23 25 29 40*
65	44 47 48 51*
70	53 54*
75	34 59* 60
80	62* 68 122
85	61 64*
90	64 65*
95	66* 69
100	65 70*
105	82 87*
110	77 89*
115	93 96 97 100*
120	102 103*
125	75 88 105*
130	109 112 113 116*
135	118 119*
140	70 106 121* 123
145	63 67 124*
150	13RD 126*
155	59RD 127*
160	62RD 128*
165	72RD 80RD 129*
170	73RD 78RD 81RD 85RD 89RD 130*
175	74RD 79RD 86RD 90RD 131*
180	76RD 132*
185	84RD 133*
190	14RD 66RD 121RD 134*
195	38WR 135*
AWRSAV	2C0 13RD
C	2C0
E	5C0 48 49 84RD 90RD 97 98 113 114
EAUG	4C0 11= 45 48 52 54= 94 97 101 103= 110 113 117 119=
EG	2C0
EMG	2C0
EMNB	2C0
EMNF	2C0 11

SUBROUTINE PR15

```
      1          SUBROUTINE PR15                                                    PR15
                 C                                                                  PR15
                 C    THIS ROUTINE READS THE PHOTON PRODUCTION DATA FROM FILE 15 OF THE  PR15
                 C    ENDF/B TAPE. FOR A CONTINUOUS ENERGY DISTRIBUTION UNDER OPTION 1,  PR15
                 C    THE PHOTON GROUP YIELDS, Y AND YTILDA, ARE CALCULATED ON EITHER    PR15
                 C    TRACK 1 OR 2 AND WRITTEN ONTO TAPE 15.                         PR15
                 C                FOR DISTRIBUTIONS UNDER OPTION 1 AT DISCRETE GAMMA  PR15
                 C    ENERGIES, THE YIELDS ARE WRITTEN DIRECTLY ONTO TAPE 17.        PR15
                 C                FOR OPTION 2 THE TRANSITIONAL PROBABILITIES AND    PR15
                 C    CONDITIONAL PROBABILITIES ARE READ FROM THE ENDF/B TAPE AND    PR15
                 C    WRITTEN ONTO TAPE 16 FOR LATER USE IN SUBROUTINE TRC2.         PR15
                 C                                                                  PR15
      2          COMMON C,EG(50),EMG(50),EMNB(100),EMNF(100),GAMM(50),IM,IOO,IRES,I BLANK
                1WO,IZM,MA(100),MB(50),MC(50),MCR,MM,MS,MZ(10),NBG,NENB,NENF,NFG,NG BLANK
                2AM,NGG,NMAT(10),NNM(126),NPM,R(101),RW(100),RXSC(100),RXSF(100),SW BLANK
                3(100),SXSC(100),SXSF(100),XMD(50),AWRSAV                           BLANK
      3          COMMON /TAPES/ ISI,ISO,IEN                                         TAPES
      4          COMMON /OVER1/ EAUG(2000),IAUG,ILO1,ILO2,IXDA,IXSD,MATX,MTNO(40),M OVER1
                1TSL                                                                OVER1
      5          COMMON /READ/ NR,NP,MAT,MF,MT,NBT(20),INT(20),E(2000),X(2000)      READ
      6          COMMON /BULK/ Y1(2000),Y2(2000),YINT(2000),YNEW(2000),EG1(2000),EG BULK1
                12(2000),NBT1(20),IBT1(20),NBT2(20),IBT2(20)                        BULK1
      7          COMMON /SAVE/ SAVE(1000,4),ISAVE(1000)                             SAVE1
      8          COMMON /BOOK/ LO1LF2,LOLF12(100),LO1LF1,LOLF11(500),NR16,NROW(100) BOOK
      9          DIMENSION SAVEL(4000), NBTN(20), INTN(20)                          PR15
     10          EQUIVALENCE (SAVEL(1),SAVE(1,1))                                   PR15
     11          EXTERNAL LOCT                                                      PR15
     12          REWIND IEN                                                         PR15
     13     5    READ (IEN,250) MAT,MF,MT                                           PR15
     14          IF (MF.NE.3) GO TO 5                                               PR15
     15     10   READ (IEN,230) LO,LG,MAT,MF,MT                                     PR15
     16          IF (MF.NE.15) GO TO 10                                             PR15
     17          GO TO 20                                                           PR15
     18     15   READ (IEN,245) ZA,AWR,LO,LG,IT1,NK,MAT,MF,MT                       PR15
     19          IF (MF.EQ.0) GO TO 225                                             PR15
     20     20   CONTINUE                                                           PR15
     21          DO 25 I=1,MTSL                                                     PR15
     22     25   IF (MT.EQ.MTNO(I)) GO TO 35                                        PR15
                 C    IS THIS MT REQUIRED                                           PR15
                 C    SKIP TO NEXT SECTION IF MT NOT REQUIRED                       PR15
     23     30   READ (IEN,250) MAT,MF,MT                                           PR15
     24          IF (MF.EQ.0) GO TO 225                                             PR15
                 C    END OF FILE 15- RETURN                                        PR15
     25          IF (MT.EQ.0) GO TO 15                                              PR15
     26          GO TO 30                                                           PR15
     27     35   IF (LO.EQ.2) GO TO 205                                             PR15
                 C    READ TOTAL YIELD TABLE (FOR ALL LAWS)                         PR15
     28          READ (IEN,245) ZA,AWR,LO,LG,NR,NP                                  PR15
     29          READ (IEN,255) (NBT(I),INT(I),I=1,NR)                              PR15
     30          READ (IEN,260) (E(I),X(I),I=1,NP)                                  PR15
```

SUBROUTINE PR15

```
      C     NOW GET TOTAL YIELD FOR EACH ENERGY IN EAUG ARRAY.                    PR15
31          ILAW=0                                                              PR15
      C     LOOP ONCE FOR EACH LAW                                              PR15
32    40    READ (IEN,245) ZA,AWR,LO,LF,NR,NP                                   PR15
33          IF (LF.EQ.1) GO TO 70                                               PR15
      C     THIS SECTION OF THE CODE FOR LO=1, LF=2                             PR15
34          READ (IEN,255) (NBT(I),INT(I),I=1,NR)                               PR15
35          READ (IEN,260) (E(I),X(I),I=1,NP)                                   PR15
36          IF (AWR.GT.EMG(1).OR.AWR.LT.EMG(NGAM)) GO TO 65                     PR15
37          ISTOR=1                                                             PR15
38          IKX=0                                                               PR15
39          DO 55 I=1,IAUG                                                      PR15
40          ILO=LOCT(E,EAUG(I),NP)                                              PR15
41          IF (ILO.EQ.-1) GO TO 55                                             PR15
42          IHI=ILO+1                                                           PR15
43          DO 45 J=1,NR                                                        PR15
44    45    IF (IHI.LE.NBT(J)) GO TO 50                                         PR15
45    50    IXSD=IXSD+1                                                         PR15
46          CALL TERP1 (E(ILO),X(ILO),E(IHI),X(IHI),EAUG(I),SAVE(ISTOR,2),INT(  PR15
           1J))                                                                 PR15
      C     SAVE(ISTOR,2) NOW CONTAINS THE INTERPOLATED YIELD                   PR15
47          SAVE(ISTOR,1)=EAUG(I)                                               PR15
48          SAVE(ISTOR,3)=AWR*SAVE(ISTOR,2)                                     PR15
      C     AWR CONTAINS PHOTON ENERGY                                          PR15
49          ISTOR=ISTOR+1                                                       PR15
50          IF (ISTOR.LE.1000) GO TO 55                                         PR15
51          WRITE (17) ((SAVE(IX,J),J=1,3),IX=1,1000),MT,AWR                    PR15
52          IKX=IKX+1                                                           PR15
53          ISTOR=1                                                             PR15
54    55    CONTINUE                                                            PR15
55          IF (ISTOR.EQ.1.AND.IKX.EQ.0) GO TO 65                               PR15
56          ISTOR=ISTOR-1                                                       PR15
57          IF (ISTOR.EQ.0) GO TO 60                                            PR15
58          WRITE (17) ((SAVE(IX,J),J=1,3),IX=1,ISTOR),MT,AWR                   PR15
59    60    LO1LF2=LO1LF2+1                                                     PR15
60          IF (LO1LF2.GT.100) CALL ERROR (500)                                 PR15
61          LOLF12(LO1LF2)=ISTOR+IKX*1000                                       PR15
62          ISTOR=1                                                             PR15
63    65    ILAW=ILAW+1                                                         PR15
64          IF (ILAW.LT.NK) GO TO 40                                            PR15
65          GO TO 220                                                           PR15
      C                                                                         PR15
      C     FOR EACH GAMMA ENERGY THERE IS A SINGLE ENTRY IN THE LOLF12 ARRAY   PR15
      C     INDICATING THE TOTAL NUMBER OF VALUES OF THE PHOTON YIELD WHICH     PR15
      C     HAVE BEEN INTERPOLATED.  THERE ARE A TOTAL OF LO1LF2 ENTRIES IN     PR15
      C     THIS ARRAY.  THIS ARRAY IS NEEDED IN SUBROUTINE XSEC FOR READING    PR15
      C     TAPE 17.  THE SUM OF ALL THE LO1LF2 ELEMENTS IN THE LOLF12 ARRAY    PR15
      C     IS IXSD.                                                            PR15
      C                                                                         PR15
      C                                                                         PR15
```

SUBROUTINE PR15

```
      C     THIS SECTION OF THE CODE FOR LO=1, LF=1                          PR15
   66 70    READ (IEN,255) (NBT(I),INT(I),I=1,NR)                            PR15
   67       READ (IEN,260) (E(I),X(I),I=1,NP)                                PR15
      C     COMPUTE TOTAL YIELD FOR EACH ENERGY FOR THIS LAW                 PR15
   68       IFST=0                                                           PR15
   69       WRITE (ISO,265)                                                  PR15
   70       READ (IEN,245) ZA,AWR,LO,LG,NBRN,NTBS                            PR15
   71       READ (IEN,255) (NBTN(I),INTN(I),I=1,NBRN)                        PR15
   72       ITAB=1                                                           PR15
   73 75    CONTINUE                                                         PR15
   74       READ (IEN,245) ZA,EN2,LO,LG,NBR2,NPR2                            PR15
   75       READ (IEN,255) (NBT2(I),IBT2(I),I=1,NBR2)                        PR15
   76       READ (IEN,260) (EG2(I),Y2(I),I=1,NPR2)                           PR15
   77       IF (IFST.NE.0) GO TO 95                                          PR15
   78 80    EN1=EN2                                                          PR15
   79       NBR1=NBR2                                                        PR15
   80       NPR1=NPR2                                                        PR15
   81       DO 85 I=1,NBR2                                                   PR15
   82       NBT1(I)=NBT2(I)                                                  PR15
   83 85    IBT1(I)=IBT2(I)                                                  PR15
   84       DO 90 I=1,NPR2                                                   PR15
   85       EG1(I)=EG2(I)                                                    PR15
   86 90    Y1(I)=Y2(I)                                                      PR15
   87       IFST=1                                                           PR15
   88       GO TO 75                                                         PR15
   89 95    DO 115 I=1,NPR2                                                  PR15
   90       ILO=LOCT(EG1,EG2(I),NPR1)                                        PR15
   91       IF (ILO.NE.-1) GO TO 100                                         PR15
   92       YNEW(I)=0.0                                                      PR15
   93       GO TO 115                                                        PR15
   94 100   IHI=ILO+1                                                        PR15
   95       DO 105 J=1,NBR1                                                  PR15
   96 105   IF (IHI.LE.NBT1(J)) GO TO 110                                    PR15
   97 110   CALL TERP1 (EG1(ILO),Y1(ILO),EG1(IHI),Y1(IHI),EG2(I),YNEW(I),IBT1( PR15
           1J))                                                              PR15
   98 115   CONTINUE                                                         PR15
      C     WE NOW HAVE 2 COINCIDENT TABLES                                  PR15
   99       DO 200 II=1,NGG                                                  PR15
  100       KP=II+1                                                          PR15
  101       ISTOR=1                                                          PR15
  102       IKX=0                                                            PR15
  103       IPRINT=1                                                         PR15
  104       DO 190 IQWE=1,IAUG                                               PR15
  105       EN=EAUG(IQWE)                                                    PR15
  106       IF ((EN.LT.EN1).OR.(EN.GT.EN2)) GO TO 190                        PR15
  107       DO 120 J=1,NBRN                                                  PR15
  108 120   IF (ITAB.LT.NBTN(J)) GO TO 125                                   PR15
  109 125   DO 130 IQ=1,NPR2                                                 PR15
  110 130   CALL TERP1 (EN1,YNEW(IQ),EN2,Y2(IQ),EN,YINT(IQ),INTN(J))         PR15
      C     TABLE FOR EN IS NOW IN YINT(1.....,NPR2)                         PR15
```

```
111             ILO1=ILO1+1                                                     PR15
112             ANS=0.0                                                         PR15
113             ANS1=0.0                                                        PR15
114             ILO=LOCT(EG2,GAMM(II),NPR2)                                     PR15
115             IHI=LOCT(EG2,GAMM(KP),NPR2)                                     PR15
116             XLOLIM=GAMM(II)                                                 PR15
117             XUPLIM=GAMM(KP)                                                 PR15
118             IF (ILO.NE.-1) GO TO 135                                        PR15
119             IF ((GAMM(II).LT.EG2(1)).AND.(GAMM(KP).LT.EG2(1))) GO TO 160    PR15
120             ILO=1                                                           PR15
121             XLOLIM=EG2(1)                                                   PR15
122     135     IF (IHI.NE.-1) GO TO 140                                        PR15
123             IF ((GAMM(II).GT.EG2(NPR2)).AND.(GAMM(KP).GT.EG2(NPR2))) GO TO 160 PR15
124             IHI=NPR2                                                        PR15
125             XUPLIM=EG2(NPR2)                                                PR15
126     140     IF (IHI.NE.ILO) GO TO 145                                       PR15
127             YL=EG2(ILO)*YINT(ILO)                                           PR15
128             YH=EG2(ILO+1)*YINT(ILO+1)                                       PR15
129             CALL INTG (EG2(ILO),YL,EG2(ILO+1),YH,XLOLIM,XUPLIM,2,ANS)       PR15
130             CALL INTG (EG2(ILO),YINT(ILO),EG2(ILO+1),YINT(ILO+1),XLOLIM,XUPLIM PR15
               1,2,ANS1)                                                        PR15
131             GO TO 160                                                       PR15
132     145     IHI=IHI+1                                                       PR15
133             IMP=IHI-2                                                       PR15
134             JK=ILO+1                                                        PR15
        C       FIRST PARTIAL INTEGRAL                                          PR15
        C       USE GAMMA ENERGIES AS WEIGHTS                                   PR15
135             YL=EG2(ILO)*YINT(ILO)                                           PR15
136             YH=EG2(JK)*YINT(JK)                                             PR15
137             CALL INTG (EG2(ILO),YL,EG2(JK),YH,XLOLIM,EG2(JK),2,ANS)         PR15
138             CALL INTG (EG2(ILO),YINT(ILO),EG2(JK),YINT(JK),XLOLIM,EG2(JK),2,AN PR15
               1S1)                                                             PR15
139             IF (IMP.LT.JK) GO TO 155                                        PR15
140             DO 150 I=JK,IMP                                                 PR15
141             IL=I+1                                                          PR15
        C       MIDDLE INTEGRALS BETWEEN TABULATED POINTS                       PR15
142             YL=YINT(I)*EG2(I)                                               PR15
143             YH=YINT(IL)*EG2(IL)                                             PR15
144             CALL INTG (EG2(I),YL,EG2(IL),YH,EG2(I),EG2(IL),2,A)             PR15
145             ANS=ANS+A                                                       PR15
146             CALL INTG (EG2(I),YINT(I),EG2(IL),YINT(IL),EG2(I),EG2(IL),2,A)  PR15
147             ANS1=ANS1+A                                                     PR15
148     150     CONTINUE                                                        PR15
149     155     CONTINUE                                                        PR15
        C       FINAL PARTIAL INTEGRAL                                          PR15
150             I=IHI-1                                                         PR15
151             YL=YINT(I)*EG2(I)                                               PR15
152             YH=YINT(IHI)*EG2(IHI)                                           PR15
153             CALL INTG (EG2(I),YL,EG2(IHI),YH,EG2(I),XUPLIM,2,A)             PR15
154             ANS=ANS+A                                                       PR15
```

SUBROUTINE PR15

```
155           CALL INTG (EG2(I),YINT(I),EG2(IHI),YINT(IHI),EG2(I),XUPLIM,P,A)      PR15
156           ANS1=ANS1+A                                                          PR15
157     160   IF (ANS.EQ.0.0) GO TO 190                                            PR15
158           EHAT=ANS/ANS1                                                        PR15
159           IF (IWO.EQ.1) GO TO 165                                              PR15
160           KLZ=NGAM-II                                                          PR15
161           SAVE(ISTOR,2)=ANS1                                                   PR15
162           SAVE(ISTOR,3)=ANS1*EG(KLZ)                                           PR15
163           GO TO 170                                                            PR15
164     165   SAVE(ISTOR,2)=ANS/((GAMM(II)+GAMM(KP))/2.0)                          PR15
165           SAVE(ISTOR,3)=ANS                                                    PR15
166     170   IF (IPRINT.EQ.0) GO TO 175                                           PR15
167           WRITE (ISO,270) ILO1,MT,GAMM(II),GAMM(KP),ANS,ANS1,EHAT              PR15
168           IPRINT=0                                                             PR15
169     175   ILO=LOCT(E,EN,NP)                                                    PR15
170           IF (ILO.EQ.-1) CALL ERROR (501)                                      PR15
171           IHI=ILO+1                                                            PR15
172           DO 180 J=1,NR                                                        PR15
173     180   IF (IHI.LE.NBT(J)) GO TO 185                                         PR15
174           CALL ERROR (502)                                                     PR15
175     185   CALL TERP1 (E(ILO),X(ILO),E(IHI),X(IHI),EN,XINT,INT(J))              PR15
176           SAVE(ISTOR,2)=SAVE(ISTOR,2)*XINT                                     PR15
        C     SAVE(ISTOR,2) HAS THE INTEGRAL OF THE PHOTON GROUP YIELD FROM EG     PR15
        C     TO EG+1                                                              PR15
177           SAVE(ISTOR,3)=SAVE(ISTOR,3)*XINT                                     PR15
        C     SAVE(ISTOR,3) HAS THE INTEGRAL OF THE PHOTON GROUP ENERGY YIELD      PR15
        C     FROM EG TO EG+1                                                      PR15
178           SAVE(ISTOR,1)=EN                                                     PR15
        C     SAVE(ISTOR,1) HAS THE NEUTRON ENERGY                                 PR15
        C     GAMM(KP) HAS THE UPPER LIMIT OF THE GAMMA ENERGY INTERVAL.           PR15
179           ISAVE(ISTOR)=MT                                                      PR15
180           ISTOR=ISTOR+1                                                        PR15
181           IF (ISTOR.LE.1000) GO TO 190                                         PR15
182           WRITE (15) ((SAVE(IX,J),J=1,3),IX=1,1000),MT,GAMM(KP)                PR15
183           IKX=IKX+1                                                            PR15
184           ISTOR=1                                                              PR15
185     190   CONTINUE                                                             PR15
186           IF (ISTOR.EQ.1.AND.IKX.EQ.0) GO TO 200                               PR15
187           ISTOR=ISTOR-1                                                        PR15
188           IF (ISTOR.EQ.0) GO TO 195                                            PR15
189           WRITE (15) ((SAVE(IX,J),J=1,3),IX=1,ISTOR),MT,GAMM(KP)               PR15
190     195   LO1LF1=LO1LF1+1                                                      PR15
191           IF (LO1LF1.GT.500) CALL ERROR (503)                                  PR15
192           LOLF11(LO1LF1)=ISTOR+IKX*1000                                        PR15
193     200   CONTINUE                                                             PR15
        C                                                                          PR15
        C     FOR EACH GAMMA GROUP THERE IS AN ENTRY IN THE LOLF11 ARRAY           PR15
        C     INDICATING THE NUMBER OF NEUTRON FINE GROUPS OVER WHICH IT HAS       PR15
        C     BEEN POSSIBLE TO INTEGRATE.  THIS ARRAY HAS LO1LF1 ELEMENTS WHICH    PR15
        C     ARE USED IN SUBROUTINE XSEC WHILE READING TAPE 15.  THE SUM OF       PR15
```

SUBROUTINE PR15

```
      C     ALL THE LO1LF1 ELEMENTS IN THE LOLF11 ARRAY IS ILO1.                PR15
      C                                                                         PR15
      C     HAVE ALL TABLES FOR THIS LAW BEEN CHECKED                           PR15
  194       ITAB=ITAB+1                                                       PR15
  195       IF (ITAB.LT.NTBS) GO TO 80                                        PR15
  196       ILAW=ILAW+1                                                       PR15
  197       IF (ILAW.GE.NK) GO TO 220                                         PR15
  198       GO TO 40                                                          PR15
      C     READS IN A SECTION FOR LO=2                                       PR15
      C     THIS SECTION OF THE CODE FOR TRANSITION PROBABILITY ARRAYS        PR15
  199 205   ILO2=ILO2+1                                                       PR15
  200       READ (IEN,235) SAVEL(1),NTM2                                      PR15
      C     READS NO. OF TRANSITION PAIRS AND STATE ENERGY                    PR15
  201       IF (LG.EQ.2) GO TO 210                                            PR15
  202       NTM2=2*NTM2+1                                                     PR15
  203       GO TO 215                                                         PR15
  204 210   NTM2=3*NTM2+1                                                     PR15
  205 215   READ (IEN,240) (SAVEL(I),I=2,NTM2)                               PR15
  206       WRITE (16) SAVEL(1),MT,LG,NTM2,(SAVEL(I),I=2,NTM2)                PR15
      C     PROCESS LO=2 SECTION                                              PR15
  207 220   CONTINUE                                                          PR15
  208       READ (IEN,245) ZA,AWR,LO,LG,IT1,NK,MAT,MF,MT                      PR15
      C     READ SEND RECORD AND CHECK FOR EOF                                PR15
  209       IF (MF.NE.0) GO TO 15                                             PR15
  210 225   RETURN                                                            PR15
      C                                                                       PR15
      C                                                                       PR15
      C                                                                       PR15
  211 230   FORMAT (30X,I3,8X,I3,22X,I4,I2,I3)                                PR15
  212 235   FORMAT (E11.4,44X,I11)                                            PR15
  213 240   FORMAT (6E11.4)                                                   PR15
  214 245   FORMAT (2E11.4,4I11,I4,I2,I3)                                     PR15
  215 250   FORMAT (66X,I4,I2,I3)                                             PR15
  216 255   FORMAT (6I11)                                                     PR15
  217 260   FORMAT (6E11.4)                                                   PR15
  218 265   FORMAT (60X,*OUTPUT FROM PR15*,/,*   INDEX ILO1  MT NUMBER       PR15
     1  GAMMA ENERGY RANGE                  NUMERATOR        DENOMINATOR     PR15
     2        EHAT*)                                                         PR15
  219 270   FORMAT (2I10,5X,2E18.8,3E18.8)                                    PR15
  220       END                                                               PR15
```

SYMBOL = = = = = = = = = = = = = = REFERENCES = = = = = = = = = = = = = =

5	-	13*	14				
10	-	15*	16				
15	-	18*	25	209			
20	-	17	20*				
25	-	21	22*				
30	-	23*	26				
35	-	22	27*				
40	-	32*	64	198			
45	-	43	44*				
50	-	44	45*				
55	-	39	41	50	54*		
60	-	57	59*				
65	-	36	55	63*			
70	-	33	66*				
75	-	73*	88				
80	-	78*	195				
85	-	81	83*				
90	-	84	86*				
95	-	77	89*				
100	-	91	94*				
105	-	95	96*				
110	-	96	97*				
115	-	89	93	98*			
120	-	107	108*				
125	-	108	109*				
130	-	109	110*				
135	-	118	122*				
140	-	122	126*				
145	-	126	132*				
150	-	141	148*				
155	-	139	149*				
160	-	119	123	131	157*		
165	-	159	164*				
170	-	163	166*				
175	-	166	169*				
180	-	172	173*				
185	-	173	175*				
190	-	104	106	157	181	185*	
195	-	188	190*				
200	-	99	186	193*			
205	-	27	199*				
210	-	201	204*				
215	-	203	205*				
220	-	65	197	207*			
225	-	19	24	210*			
230	-	15RD	211*				
235	-	200RD	212*				
240	-	205RD	213*				

SUBROUTINE TRC2

```
      SUBROUTINE TRC2                                                    TRC2
C                                                                        TRC2
C      THIS SUBROUTINE PROCESSES LO=2, FILE 15 INFORMATION.              TRC2
C     IT RECONSTRUCTS THE MICROSCOPIC PHOTON PRODUCTION CROSS SECTIONS   TRC2
C     FROM THE TRANSITION ARRAYS AS READ FROM TAPE 16 AND THE            TRC2
C     APPROPRIATE CROSS SECTIONS AS READ FROM THE ENDF/B TAPE,           TRC2
C     INTEGRATES OVER THE NEUTRON FINE GROUPS, MULTIPLIES BY THE         TRC2
C     NORMALIZED FINE GROUP WEIGHTING FUNCTIONS, AND WRITES THE RESULTS  TRC2
C     ON TAPE 16.                                                        TRC2
C                                                                        TRC2
      COMMON C,EG(50),EMG(50),EMNB(100),EMNF(100),GAMM(50),IM,IOO,IRES,I BLANK
     1WO,IZM,MA(100),MB(50),MC(50),MCR,MM,MS,MZ(10),NBG,NENB,NENF,NFG,NG BLANK
     2AM,NGG,NMAT(10),NNM(126),NPM,R(101),RW(100),RXSC(100),RXSF(100),SW BLANK
     3(100),SXSC(100),SXSF(100),XMD(50),AWRSAV                          BLANK
      COMMON /TAPES/ ISI,ISO,IEN                                         TAPES
      COMMON /OVER1/ EAUG(2000),IAUG,IL01,IL02,IXDA,IXSD,MATX,MTNO(40),M OVER1
     1TSL                                                                OVER1
      COMMON /READ/ NR,NP,MAT,MF,MT,NBT(20),INT(20),E(2000),X(2000)      READ
      COMMON /BULK/ XL02(40,50),L01(40),L02(40),L03(40),EE1(50),EE2(50), BULK2
     1TP1(50),TP2(50),XDAT(1952,4),LEVL(1952)                            BULK2
      COMMON /SAVE/ SAVE(1000,4),ISAVE(1000)                             SAVE1
      COMMON /BOOK/ L01LF2,L0LF12(100),L01LF1,L0LF11(500),NR16,NROW(100) BOOK
      DIMENSION CSEC(2000)                                               TRC2
      EQUIVALENCE (CSEC(1),XL02(1,1))                                    TRC2
C     IEE IS THE INDEX FOR THE STORAGE IN EITHER THE EE1 OR EE2 ARRAYS   TRC2
C     WHICHEVER ARRAY IS CURRENT.                                        TRC2
C     ITP=INDEX OF CURRENT TRANSITION PAIR                               TRC2
C     IECR=INDEX FOR ORTAINING ENERGIES IN EE(INPUT)                     TRC2
C     NL02=INDE OF ROW IN XL02,L02                                       TRC2
C     IL02=NO. ROWS IN XL02,L02                                          TRC2
C     IXDA=ROW FOR STORAGE IN XDAT                                       TRC2
C     NOEE=SWITCH TO DETERMINE CURRENT EE ARRAY, TAKES VALUE +1 OR -1.   TRC2
C     TAPE 16 WAS WRITTEN IN PR15.                                       TRC2
      REWIND 16                                                          TRC2
      DO 5 I=1,IL02                                                      TRC2
      READ (16) XL02(I,1),L01(I),L02(I),II,(XL02(I,J),J=2,II)            TRC2
    5 L03(I)=II                                                          TRC2
C     THE L01 ARRAY HAS THE MT NUMBER, L02 THE LG, L03 THE NUMBER OF     TRC2
C     ENTRIES.                                                           TRC2
C     BEGINNING OF THE PORTION OF TRC2 IN WHICH THE CASCADES ARE         TRC2
C     RECONSTRUCTED.                                                     TRC2
      IXDA=0                                                             TRC2
      DO 45 IRPR=1,IL02                                                  TRC2
      NL02=IRPR                                                          TRC2
      NOEE=1                                                             TRC2
      NEN=1                                                              TRC2
      TP=1.0                                                             TRC2
      IECR=1                                                             TRC2
      IEE=0                                                              TRC2
      ESR=XL02(NL02,1)                                                   TRC2
```

SUBROUTINE TRC2

```
      GO TO 20                                                          TRC2
   10 CONTINUE                                                          TRC2
      DO 15 NLO2=1,ILO2                                                 TRC2
   15 IF (ESR.EQ.XLO2(NLO2,1)) GO TO 20                                 TRC2
      CALL ERROR (600)                                                  TRC2
   20 NT=LO3(NLO2)                                                      TRC2
      NTT=2                                                             TRC2
      IF (LO2(NLO2).EQ.2) NTT=3                                         TRC2
      DO 30 ITP=2,NT,NTT                                                TRC2
      IXDA=IXDA+1                                                       TRC2
      K=ITP+1                                                           TRC2
      KK=ITP+2                                                          TRC2
      XDAT(IXDA,1)=XLO2(IRPR,1)                                         TRC2
C     INITIAL (HIGHEST) ENERGY ASSOCIATED WITH THIS CASCADE.            TRC2
      XDAT(IXDA,2)=XLO2(NLO2,1)                                         TRC2
C     ENERGY LEVEL FROM WHICH THIS TRANSITION OCCURS.                   TRC2
      XDAT(IXDA,3)=XLO2(NLO2,K)*TP                                      TRC2
      IF (LO2(NLO2).EQ.2) XDAT(IXDA,3)=XDAT(IXDA,3)*XLO2(NLO2,KK)       TRC2
C     PROBABILITY FOR GAMMA EMISSION DURING DECAY TO ASSOCIATED LEVEL.  TRC2
      XDAT(IXDA,4)=XDAT(IXDA,2)-XLO2(NLO2,ITP)                          TRC2
C     ENERGY OF THE EMITTED PHOTON                                      TRC2
      LEVL(IXDA)=LO1(IRPR)                                              TRC2
C     THIS IS THE MT NUMBER CORRESPONDING TO THE ENERGY LEVEL FROM WHICH TRC2
C     THE CASCADE ORIGINATES.                                           TRC2
      IF (XLO2(NLO2,ITP).EQ.0.0) GO TO 30                               TRC2
      IEE=IEE+1                                                         TRC2
      IF (NOEE.GT.0) GO TO 25                                           TRC2
      TP1(IEE)=XLO2(NLO2,K)*TP                                          TRC2
      EE1(IEE)=XLO2(NLO2,ITP)                                           TRC2
      GO TO 30                                                          TRC2
   25 EE2(IEE)=XLO2(NLO2,ITP)                                           TRC2
      TP2(IEE)=XLO2(NLO2,K)*TP                                          TRC2
   30 CONTINUE                                                          TRC2
      IECR=IECR+1                                                       TRC2
      IF (IECR.LE.NEN) GO TO 35                                         TRC2
      NOEE=-NOEE                                                        TRC2
      NEN=IEE                                                           TRC2
      IF (NEN.EQ.0) GO TO 45                                            TRC2
      IECR=1                                                            TRC2
      IEE=0                                                             TRC2
   35 IF (NOEE.LT.0) GO TO 40                                           TRC2
      ESR=EE1(IECR)                                                     TRC2
      TP=TP1(IECR)                                                      TRC2
      GO TO 10                                                          TRC2
   40 ESR=EE2(IECR)                                                     TRC2
      TP=TP2(IECR)                                                      TRC2
      GO TO 10                                                          TRC2
   45 CONTINUE                                                          TRC2
C     END OF CASCADE RECONSTRUCTION.                                    TRC2
C     NOW MUST INTRODUCE THE CROSS SECTIONS FROM FILE 3.                TRC2
```

SUBROUTINE TRC2

```
      66            ENMAX=XLO2(ILO2,1)*(AWRSAV+1.0)/AWRSAV                    TRC2
      67            XDAT(IXDA+1,1)=999.347                                    TRC2
      68            REWIND IEN                                                TRC2
      69            REWIND 16                                                 TRC2
      70      50    READ (IEN,140) MAT,MF,MT                                  TRC2
      71            IF (MF.NE.3) GO TO 50                                     TRC2
      72            III=0                                                     TRC2
      73      55    III=III+1                                                 TRC2
      74            IF (III.GT.IXDA) RETURN                                   TRC2
      75      60    IF (MT.EQ.LEVL(III)) GO TO 65                             TRC2
      76            CALL RSF3                                                 TRC2
      77            IF (MF.NE.0) GO TO 60                                     TRC2
      78      65    CALL RSF3                                                 TRC2
      79            DO 70 I=1,IAUG                                            TRC2
      80      70    CSEC(I)=0.0                                               TRC2
      81            I1=LOCT(EAUG,XDAT(III,1),IAUG)                            TRC2
      82            IF (I1.EQ.-1) CALL ERROR (601)                            TRC2
      83            I2=LOCT(EAUG,ENMAX,IAUG)                                  TRC2
      84            IF (I2.EQ.-1) CALL ERROR (602)                            TRC2
            C       GETS THE CROSS SECTIONS FOR A PARTICULAR MT AND STORES THEM AWAY.  TRC2
      85            DO 85 I=1,IAUG                                            TRC2
      86            EN=EAUG(I)                                                TRC2
      87            ILO=LOCT(E,EN,NP)                                         TRC2
      88            IF (ILO.EQ.-1) GO TO 85                                   TRC2
      89            IHI=ILO+1                                                 TRC2
      90            DO 75 J=1,NR                                              TRC2
      91      75    IF (IHI.LE.NBT(J)) GO TO 80                               TRC2
      92            CALL ERROR (603)                                          TRC2
      93      80    CALL TERP1 (E(ILO),X(ILO),E(IHI),X(IHI),EN,CSEC(I),INT(J))  TRC2
      94      85    CONTINUE                                                  TRC2
            C       NOW PROCEED TO INTEGRATE OVER THE FINE GROUPS.            TRC2
            C       THE NEUTRON INTEGRALS ARE DONE USING ORDINATES ONLY AT THOSE  TRC2
            C       ENERGIES INCLUDED IN THE UNION OF THE SETS OF NEUTRON ENERGIES  TRC2
            C       IN FILE 3 AND THE NEUTRON FINE GROUP ENERGY MESH.         TRC2
      95            DO 120 II=1,NFG                                           TRC2
      96            IF (EMNF(II+1).GT.ENMAX) GO TO 120                        TRC2
      97            IF (EMNF(II).LT.XDAT(III,1)) GO TO 120                    TRC2
      98            KP=II+1                                                   TRC2
      99            ANS=0.0                                                   TRC2
     100            ILO=LOCT(EAUG,EMNF(KP),IAUG)                              TRC2
     101            IHI=LOCT(EAUG,EMNF(II),IAUG)                              TRC2
     102            XLOLIM=EMNF(KP)                                           TRC2
     103            XUPLIM=EMNF(II)                                           TRC2
     104            IF (ILO.GT.I1) GO TO 90                                   TRC2
     105            ILO=I1                                                    TRC2
     106            XLOLIM=XDAT(III,1)                                        TRC2
     107      90    IF (IHI.LE.I2) GO TO 95                                   TRC2
     108            IHI=I2                                                    TRC2
     109            XUPLIM=ENMAX                                              TRC2
     110      95    IF (IHI.NE.ILO) GO TO 100                                 TRC2
```

```
111           CALL INTG (EAUG(ILO),CSEC(ILO),EAUG(ILO+1),CSEC(ILO+1),XLOLIM,XUPL  TRC2
             1IM,2,ANS)                                                          TRC2
112           GO TO 115                                                          TRC2
113     100   IHI=IHI+1                                                          TRC2
114           IMP=IHI-2                                                          TRC2
115           JK=ILO+1                                                           TRC2
        C     FIRST PARTIAL INTEGRAL                                             TRC2
116           CALL INTG (EAUG(ILO),CSEC(ILO),EAUG(JK),CSEC(JK),XLOLIM,EAUG(JK),2 TRC2
             1,ANS)                                                              TRC2
117           IF (IMP.LT.JK) GO TO 110                                           TRC2
118           DO 105 I=JK,IMP                                                    TRC2
119           IL=I+1                                                             TRC2
        C     MIDDLE INTEGRALS BETWEEN THE TABULATED FINE GROUP BOUNDARIES.      TRC2
120           CALL INTG (EAUG(I),CSEC(I),EAUG(IL),CSEC(IL),EAUG(I),EAUG(IL),2,A) TRC2
121           ANS=ANS+A                                                          TRC2
122     105   CONTINUE                                                           TRC2
123     110   CONTINUE                                                           TRC2
        C     FINAL PARTIAL INTEGRAL                                             TRC2
124           I=IHI-1                                                            TRC2
125           CALL INTG (EAUG(I),CSEC(I),EAUG(IHI),CSEC(IHI),EAUG(J),XUPLIM,2,A) TRC2
126           ANS=ANS+A                                                          TRC2
127     115   CONTINUE                                                           TRC2
        C     ANS NOW CONTAINS THE INTEGRAL OVER ONE FINE GROUP OF SIGMA(E)      TRC2
        C     FOR THIS MT NUMBER.                                                TRC2
128           EE1(II)=(ANS/(EMNF(II)-EMNF(KP)))*SW(II)                           TRC2
129     120   CONTINUE                                                           TRC2
130           ISTOR=1                                                            TRC2
131     125   DO 130 I=1,NFG                                                     TRC2
132           IF (EMNF(I+1).GT.ENMAX) GO TO 130                                  TRC2
133           IF (EMNF(I).LT.XDAT(III,1)) GO TO 130                              TRC2
134           SAVE(ISTOR,1)=EMNF(I)                                              TRC2
135           SAVE(ISTOR,2)=XDAT(III,3)*EE1(I)                                   TRC2
136           SAVE(ISTOR,3)=SAVE(ISTOR,2)*XDAT(III,4)                            TRC2
137           SAVE(ISTOR,4)=XDAT(III,4)                                          TRC2
138           ISTOR=ISTOR+1                                                      TRC2
139     130   CONTINUE                                                           TRC2
140           IF (XDAT(III,1).EQ.XDAT(III+1,1)) GO TO 135                        TRC2
141           NR16=NR16+1                                                        TRC2
142           ISTOR=ISTOR-1                                                      TRC2
143           NROW(NR16)=ISTOR                                                   TRC2
144           WRITE (16) ((SAVE(IX,J),J=1,4),IX=1,ISTOR)                         TRC2
145           GO TO 55                                                           TRC2
146     135   III=III+1                                                          TRC2
147           GO TO 125                                                          TRC2
        C                                                                        TRC2
148     140   FORMAT (66X,I4,I2,I3)                                              TRC2
149           END                                                                TRC2
```

SUBROUTINE XSEC

```
    1           SUBROUTINE XSEC                                                   XSEC
                C                                                                 XSEC
                C   THIS SUBROUTINE OBTAINS THE APPROPRIATE CROSS SECTIONS FROM FILE 3 XSEC
                C   AND MULTIPLIES THEM BY THE YIELDS WHICH ARE READ FROM TAPES 15 AND XSEC
                C   17.  THE INTEGRATION OVER NEUTRON ENERGY USING EITHER TRACK A OR B XSEC
                C   IS CARRIED OUT AND THE RESULTS ARE MULTIPLIED BY THE NORMALIZED   XSEC
                C   FINE GROUP WEIGHTING FUNCTIONS.  FINALLY, THE RESULTS ARE WRITTEN XSEC
                C   ONTO TAPE 16.                                                  XSEC
                C                                                                 XSEC
    2           COMMON C,EG(50),EMG(50),EMNB(100),EMNF(100),GAMM(50),IM,IOO,IRES,I BLANK
               1WO,IZM,MA(100),MB(50),MC(50),MCR,MM,MS,MZ(10),NBG,NENB,NENF,NFG,NG BLANK
               2AM,NGG,NMAT(10),NNM(126),NPM,R(101),RW(100),RXSC(100),RXSF(100),SW BLANK
               3(100),SXSC(100),SXSF(100),XMD(50),AWRSAV                          BLANK
    3           COMMON /TAPES/ IS1,ISO,IEN                                        TAPES
    4           COMMON /OVER1/ EAUG(2000),IAUG,IL01,IL02,IXDA,IXSD,MATX,MTNO(40),M OVER1
               1TSL                                                               OVER1
    5           COMMON /READ/ NR,NP,MAT,MF,MT,NBT(20),INT(20),E(2000),X(200*)     READ
    6           COMMON /BULK/ XDAT(3020,3),EX(3020)                               XSEC
    7           COMMON /SAVE/ SAVE(1000,4),ISAVE(1000)                            SAVE1
    8           COMMON /BOOK/ LO1LF2,LOLF12(100),LO1LF1,LOLF11(500),NR16,NROW(100) BOOK
    9           EXTERNAL LOCT                                                     XSEC
   10           IF (IXSD.EQ.0.AND.IL01.EQ.0) RETURN                               XSEC
                C    THESE TAPES WERE WRITTEN IN PR15.   TAPE 15 HAS LO=1, LF=1   XSEC
                C   INFORMATION WHILE TAPE 17 HAS LO=1, LF=2 INFORMATION.        XSEC
   11           REWIND 15                                                         XSEC
   12           REWIND 17                                                         XSEC
   13           ICOUNT=0                                                          XSEC
   14           IFLOW=1                                                           XSEC
   15           ISTOR=1                                                           XSEC
   16      5    REWIND IEN                                                        XSEC
   17     10    READ (IEN,175) MAT,MF,MT                                          XSEC
   18           IF (MF.NE.3) GO TO 10                                             XSEC
   19           MTX=MT                                                            XSEC
   20           CALL RSF3                                                         XSEC
   21     15    GO TO (20,40,170), IFLOW                                          XSEC
   22     20    IF (IXSD.NE.0) GO TO 25                                           XSEC
   23           IFLOW=2                                                           XSEC
   24           GO TO 15                                                          XSEC
   25     25    ICOUNT=ICOUNT+1                                                   XSEC
   26           IMIN=1                                                            XSEC
   27           NPTS=LOLF12(ICOUNT)                                               XSEC
   28           N=NPTS/1000                                                       XSEC
   29           IF (N.EQ.0) GO TO 35                                              XSEC
   30           IMAX=1000                                                         XSEC
   31           DO 30 II=1,N                                                      XSEC
   32           READ (17) ((XDAT(I,J),J=1,3),I=IMIN,IMAX),LLEVL,XDAT4             XSEC
   33           IMIN=IMIN+1000                                                    XSEC
   34           IMAX=IMAX+1000                                                    XSEC
   35     30    CONTINUE                                                          XSEC
   36     35    IF (IMIN.EQ.NPTS) GO TO 60                                        XSEC
```

SUBROUTINE XSEC

```
37          READ (17) ((XDAT(I,J),J=1,3),I=IMIN,NPTS),LLEVL,XDAT4                    XSEC
38          GO TO 60                                                                 XSEC
      C     ILO1 IS THE NUMBER OF ENTRIES FOR LO=1, LF=1.                            XSEC
39    40    IF (ILO1.NE.0) GO TO 45                                                  XSEC
40          IFLOW=3                                                                  XSEC
41          GO TO 15                                                                 XSEC
42    45    ICOUNT=ICOUNT+1                                                          XSEC
43          IMIN=1                                                                   XSEC
44          NPTS=LOLF11(ICOUNT)                                                      XSEC
45          N=NPTS/1000                                                              XSEC
46          IF (N.EQ.0) GO TO 55                                                     XSEC
47          IMAX=1000                                                                XSEC
48          DO 50 II=1,N                                                             XSEC
49          READ (15) ((XDAT(I,J),J=1,3),I=IMIN,IMAX),LLEVL,XDAT4                    XSEC
50          IMIN=IMIN+1000                                                           XSEC
51          IMAX=IMAX+1000                                                           XSEC
52    50    CONTINUE                                                                 XSEC
53    55    IF (IMIN.EQ.NPTS) GO TO 60                                               XSEC
54          READ (15) ((XDAT(I,J),J=1,3),I=IMIN,NPTS),LLEVL,XDAT4                    XSEC
55    60    CONTINUE                                                                 XSEC
      C     THE XDAT ARRAY FOR A PARTICULAR MT NUMBER HAS NOW BEEN READ IN           XSEC
      C     COMPLETELY FROM TAPE FILES.                                              XSEC
56    65    IF (MTX.EQ.LLEVL) GO TO 70                                               XSEC
57          IF (MF.EQ.0) CALL ERROR (702)                                            XSEC
58          MTX=MT                                                                   XSEC
59          CALL RSF3                                                                XSEC
60          GO TO 65                                                                 XSEC
61    70    CONTINUE                                                                 XSEC
      C     TRACK A (IRES=0) AND TRACK B (IRES=1) TESTS.                             XSEC
62          IF (IRES.EQ.0) GO TO 75                                                  XSEC
      C     FOR TRACK A  GO AT ONCE TO STATEMENT 71.                                 XSEC
      C     FOR TRACK B TRANSFER TO STMT 71 EXCEPT FOR FISSION AND CAPTURE.          XSEC
63          IF (MTX.EQ.18.OR.MTX.EQ.102) GO TO 105                                   XSEC
      C     THIS TRANSFER ELIMINATES LOOKING UP THE CROSS SECTIONS FROM              XSEC
      C     FILE 3.  FOR THESE MATERIALS UNDER TRACK B, USE THE INPUT VALUES.        XSEC
64    75    DO 100 I=1,NPTS                                                          XSEC
65          EN=XDAT(I,1)                                                             XSEC
66          ILO=LOCT(E,EN,NP)                                                        XSEC
67          IF (ILO.NE.-1) GO TO 80                                                  XSEC
68          CSEC=0.0                                                                 XSEC
69          GO TO 95                                                                 XSEC
70    80    IHI=ILO+1                                                                XSEC
71          DO 85 J=1,NR                                                             XSEC
72    85    IF (IHI.LE.NBT(J)) GO TO 90                                              XSEC
73          WRITE (ISO,180) MAT,MF,MT                                                XSEC
74          CALL ERROR (701)                                                         XSEC
75    90    CALL TERP1 (E(ILO),X(ILO),E(IHI),X(IHI),EN,CSEC,INT(J))                  XSEC
76    95    XDAT(I,2)=XDAT(I,2)*CSEC                                                 XSEC
77          XDAT(I,3)=XDAT(I,3)*CSEC                                                 XSEC
78    100   CONTINUE                                                                 XSEC
```

SUBROUTINE XSEC

```
 79     105  CONTINUE                                                          XSEC
        C    NOW PROCEED TO INTEGRATE OVER THE NEUTRON FINE GROUPS.            XSEC
        C    STORE THE RESULTS IN THE ORDER E(L+1), PLANE Y INTEGRAL, TILDA Y  XSEC
        C    INTEGRAL, GAMMA RAY ENERGY OR ELSE THE UPPER LIMIT OF THE GAMMA   XSEC
        C    RANGE.                                                            XSEC
 80          DO 110 J=1,NPTS                                                   XSEC
 81     110  EX(J)=XDAT(J,1)                                                   XSEC
 82          DO 155 II=1,NFG                                                   XSEC
 83          KP=II+1                                                           XSEC
 84          ANS=0.0                                                           XSEC
 85          ANS1=0.0                                                          XSEC
 86          ILO=LOCT(EX,EMNF(KP),NPTS)                                        XSEC
 87          IHI=LOCT(EX,EMNF(II),NPTS)                                        XSEC
 88          XLOLIM=EMNF(KP)                                                   XSEC
 89          XUPLIM=EMNF(II)                                                   XSEC
 90          IF (ILO.NE.-1) GO TO 115                                          XSEC
 91          IF ((EMNF(KP).LT.EX(1)).AND.(EMNF(II).LT.EX(1))) GO TO 140        XSEC
 92          ILO=1                                                             XSEC
 93          XLOLIM=EX(1)                                                      XSEC
 94     115  IF (IHI.NE.-1) GO TO 120                                          XSEC
 95          IF ((EMNF(KP).GT.EX(NPTS)).AND.(EMNF(II).GT.EX(NPTS))) GO TO 140  XSEC
 96          IHI=NPTS-1                                                        XSEC
 97          XUPLIM=EX(NPTS)                                                   XSEC
 98     120  IF (IHI.NE.ILO) GO TO 125                                         XSEC
 99          CALL INTG (EX(ILO),XDAT(ILO,2),EX(ILO+1),XDAT(ILO+1,2),XLOLIM,XUPL XSEC
            1IM,2,ANS1)                                                       XSEC
100          CALL INTG (EX(ILO),XDAT(ILO,3),EX(ILO+1),XDAT(ILO+1,3),XLOLIM,XUPL XSEC
            1IM,2,ANS)                                                        XSEC
101          GO TO 140                                                        XSEC
102     125  IHI=IHI+1                                                        XSEC
103          IMP=IHI-2                                                        XSEC
104          JK=ILO+1                                                         XSEC
        C    FIRST PARTIAL INTEGRAL                                           XSEC
105          CALL INTG (EX(ILO),XDAT(ILO,2),EX(JK),XDAT(JK,2),XLOLIM,EX(JK),2,A XSEC
            1NS1)                                                             XSEC
106          CALL INTG (EX(ILO),XDAT(ILO,3),EX(JK),XDAT(JK,3),XLOLIM,EX(JK),2,A XSEC
            1NS)                                                              XSEC
107          IF (IMP.LT.JK) GO TO 135                                         XSEC
108          DO 130 I=JK,IMP                                                  XSEC
109          IL=I+1                                                           XSEC
        C    MIDDLE INTEGRALS BETWEEN THE TABULATED FINE GROUP BOUNDARIES.    XSEC
110          CALL INTG (EX(I),XDAT(I,2),EX(IL),XDAT(IL,2),EX(I),EX(IL),2,A)   XSEC
111          ANS1=ANS1+A                                                      XSEC
112          CALL INTG (EX(I),XDAT(I,3),EX(IL),XDAT(IL,3),EX(I),EX(IL),2,A)   XSEC
113          ANS=ANS+A                                                        XSEC
114     130  CONTINUE                                                         XSEC
115     135  CONTINUE                                                         XSEC
        C    FINAL PARTIAL INTEGRAL                                           XSEC
116          I=IHI-1                                                          XSEC
117          CALL INTG (EX(I),XDAT(I,2),EX(IHI),XDAT(IHI,2),EX(I),XUPLIM,2,A)  XSEC
```

SUBROUTINE XSEC

```
118             ANS1=ANS1+A                                                     XSEC
119             CALL INTG (EX(I),XDAT(I,3),EX(IHI),XDAT(IHI,3),EX(I),XUPLIM,2,A)XSEC
120             ANS=ANS+A                                                       XSEC
121       140   CONTINUE                                                        XSEC
122             IF (ANS.EQ.0.0.AND.ANS1.EQ.0.0) GO TO 155                       XSEC
          C     ANS NOW CONTAINS THE INTEGRAL OF SIGMA(E)*YTILDA(E)             XSEC
          C     ANS1 CONTAINS THE INTEGRAL OF SIGMA(E)*Y(E)                     XSEC
          C     THAT IS TRUE EXCEPT FOR MT=18 AND 102 ON TRACK B.               XSEC
123             ANS=ANS/(EMNF(II)-EMNF(KP))                                     XSEC
124             ANS1=ANS1/(EMNF(II)-EMNF(KP))                                   XSEC
125             SAVE(ISTOR,1)=EMNF(II)                                          XSEC
          C     TRACK A (IRES=0) AND TRACK B (IRES=1) TESTS                     XSEC
126             IF (IRES.EQ.0) GO TO 145                                        XSEC
127             IF (MTX.NE.18.AND.MTX.NE.102) GO TO 145                         XSEC
          C     MT = 18 FOR FISSION         MT=102 FOR CAPTURE                  XSEC
128             IF (MTX.EQ.18) FAC=SXSF(II)*SW(II)+RXSF(II)*RW(II)              XSEC
129             IF (MTX.EQ.102) FAC=SXSC(II)*SW(II)+RXSC(II)*RW(II)             XSEC
130             SAVE(ISTOR,2)=ANS1*FAC                                          XSEC
131             SAVE(ISTOR,3)=ANS*FAC                                           XSEC
132             GO TO 150                                                       XSEC
133       145   SAVE(ISTOR,2)=ANS1*SW(II)                                       XSEC
134             SAVE(ISTOR,3)=ANS*SW(II)                                        XSEC
135       150   SAVE(ISTOR,4)=XDAT4                                             XSEC
136             ISTOR=ISTOR+1                                                   XSEC
137             IF (ISTOR.LE.1000) GO TO 155                                    XSEC
138             NR16=NR16+1                                                     XSEC
139             NROW(NR16)=1000                                                 XSEC
140             WRITE (16) ((SAVE(I,J),J=1,4),I=1,1000)                         XSEC
141             ISTOR=1                                                         XSEC
142       155   CONTINUE                                                        XSEC
143             GO TO (160,165), IFLOW                                          XSEC
144       160   IF (ICOUNT.LT.LOILF2) GO TO 15                                  XSEC
145             ICOUNT=0                                                        XSEC
146             IFLOW=2                                                         XSEC
147             GO TO 5                                                         XSEC
148       165   IF (ICOUNT.LT.LOILF1) GO TO 15                                  XSEC
149       170   IF (ISTOR.EQ.1) RETURN                                          XSEC
150             ISTOR=ISTOR-1                                                   XSEC
151             NR16=NR16+1                                                     XSEC
152             NROW(NR16)=ISTOR                                                XSEC
153             WRITE (16) ((SAVE(I,J),J=1,4),I=1,ISTOR)                        XSEC
154             RETURN                                                          XSEC
          C                                                                     XSEC
155       175   FORMAT (66X,I4,I2,I3)                                           XSEC
156       180   FORMAT (*   NO INTERPOLATION CODE FOUND IN FILE 3    MAT=*,I4,* XSEC
               1   MF=*,I4,*       MT=*,I4)                                     XSEC
157             END                                                             XSEC
```

SUBROUTINE XSEC

SYMBOL	REFERENCES
5	16* 147
10	17* 18
15	21* 24 41 144 148
20	21 22*
25	22 25*
30	31 35*
35	29 36*
40	21 39*
45	39 42*
50	48 52*
55	46 53*
60	36 38 53 55*
65	56* 60
70	56 61*
75	62 64*
80	67 70*
85	71 72*
90	72 75*
95	69 76*
100	64 78*
105	63 79*
110	80 81*
115	90 94*
120	94 98*
125	98 102*
130	108 114*
135	107 115*
140	91 95 101 121*
145	126 127 133*
150	132 135*
155	82 122 137 142*
160	143 144*
165	143 148*
170	21 149*
175	17RD 155*
180	73WR 156*
A	110AG 111 112AG 113 117AG 118 119AG 120
ANS	84= 100AG 106AG 113= 120= 122 123= 131 134
ANS1	85= 99AG 105AG 111= 118= 122 124= 130 133
ARSAV	2C0
BOOK	8C0
BULK	6C0
C	2C0
CSEC	68= 75AG 76 77
E	5C0 66 75AG
EAUG	4C0
EG	2C0
EMG	2C0

SUBROUTINE XSEC

SUBROUTINE MATRIX

```
      1            SUBROUTINE MATRIX                                                  MATRIX
                   C                                                                  MATRIX
                   C     MATRIX READS THE MICROSCOPIC FINE GROUP PHOTON AND ENERGY PRODUCT- MATRIX
                   C     ION MATRIX ELEMENTS MULTIPLIED BY THE WEIGHTING FUNCTIONS AND  MATRIX
                   C     PERFORMS THE SUM OVER FINE GROUPS TO PRODUCE THE  G X N MATRICES MATRIX
                   C     WHICH ARE WRITTEN ONTO TAPE 18.                              MATRIX
                   C                                                                  MATRIX
      2            COMMON C,EG(50),EMG(50),EMNB(100),EMNF(100),GAMM(50),IM,IOO,IRES,I BLANK
                  1WO,IZM,MA(100),MR(50),MC(50),MCR,MM,MS,MZ(10),NBG,NENB,NENF,NFG,NG BLANK
                  2AM,NGG,NMAT(10),NNM(126),NPM,R(101),RW(100),RXSC(100),RXSF(100),SW BLANK
                  3(100),SXSC(100),SXSF(100),XMD(50),AWRSAV                         BLANK
      3            COMMON /OVER1/ EAUG(2000),IAUG,ILO1,ILO2,IXDA,IXSD,MATX,MTNO(40),M OVER1
                  1TSL                                                               OVER1
      4            COMMON /BULK/ XDAT(3020,4)                                        MATRIX
      5            COMMON /SAVE/ XMAT(50,50),XEMAT(50,50)                            SAVE2
      6            COMMON /BOOK/ LO1LF2,LOLF12(100),LO1LF1,LOLF11(500),NR16,NROW(100) BOOK
      7            REWIND 16                                                         MATRIX
      8            DO 5 I=1,NGAM                                                     MATRIX
      9            DO 5 J=1,NENB                                                     MATRIX
     10            XEMAT(I,J)=0.0                                                    MATRIX
     11      5     XMAT(I,J)=0.0                                                     MATRIX
     12            IF (MTNO(1).EQ.0) GO TO 20                                        MATRIX
     13            DO 15 J=1,NR16                                                    MATRIX
     14            IMAX=NROW(J)                                                      MATRIX
     15            READ (16) ((XDAT(I,K),K=1,4),I=1,IMAX)                            MATRIX
     16            DO 10 IB=1,NBG                                                    MATRIX
     17            DO 10 IG=1,NGG                                                    MATRIX
     18            DO 10 I=1,IMAX                                                    MATRIX
     19            IF ((XDAT(I,4).GT.EMG(IG)).OR.(XDAT(I,4).LE.EMG(IG+1))) GO TO 10  MATRIX
     20            IF ((XDAT(I,1).GT.EMNB(IB)).OR.(XDAT(I,1).LE.EMNB(IB+1))) GO TO 10 MATRIX
     21            XMAT(IG,IB)=XMAT(IG,IB)+XDAT(I,2)                                 MATRIX
     22            XEMAT(IG,IB)=XEMAT(IG,IB)+XDAT(I,3)                               MATRIX
     23      10    CONTINUE                                                          MATRIX
     24      15    CONTINUE                                                          MATRIX
     25      20    WRITE (18) ((XMAT(IG,IB),IB=1,NBG),IG=1,NGG),((XEMAT(IG,IB),IB=1,N MATRIX
                  1BG),IG=1,NGG)                                                     MATRIX
     26            RETURN                                                            MATRIX
     27            END                                                               MATRIX
```

SUBROUTINE MATRIX

SYMBOL	REFERENCES
S	8 9 11*
1n	16 17 18 19 20 23*
1F	13 24*
2n	12 25*
AWRSAV	2C0
BOOK	6C0
BULK	4C0
C	2C0
EAUG	3C0
EG	2C0
EMG	2C0 19
EMNB	2C0 20
EMNF	2C0
GAMM	2C0
I	8 10 11 15RD 18 19 20 21 22
IAUG	3C0
IB	16 20 21 22 25WR
IG	17 19 21 22 25WR
IL01	3C0
IL02	3C0
IM	2C0
IMAX	14= 15RD 18
INO	2C0
IPES	2C0
IWO	2C0
IXDA	3C0
IXSD	3C0
IZM	2C0
J	9 10 11 13 14
K	15RD
LO1LF1	6C0
LO1LF2	6C0
LOLF11	6C0
LOLF12	6C0
MA	2C0
MATRIX	1
MATX	3C0
MB	2C0
MC	2C0
MCB	2C0
MD	2C0
MS	2C0
MTNO	3C0 12
MTSL	3C0
MZ	2C0
NAG	2C0 16 25WR
NENB	2C0 9
NENF	2C0

OVERLAY(LAPH,3,0)

PROGRAM SOURCE

```
      1            PROGRAM SOURCE                                                    SOURCE
                 C                                                                  SOURCE
                 C    SOURCE SUPERVISES THE CALCULATION OF THE PHOTON SOURCE AND ENERGY  SOURCE
                 C    SOURCE VECTORS.                                               SOURCE
                 C                                                                  SOURCE
      2            COMMON C,EG(50),EMG(50),EMNB(100),EMNF(100),GAMM(50),IM,IOO,IRES,I BLANK
                 1WO,IZM,MA(100),MB(50),MC(50),MCR,MM,MS,MZ(10),NBG,NENB,NENF,NFG,NG BLANK
                 2AM,NGG,NMAT(10),NNM(126),NPM,R(101),RW(100),RXSC(100),RXSF(100),SW BLANK
                 3(100),SXSC(100),SXSF(100),XMD(50),AWRSAV                          BLANK
      3            COMMON /VEC/ A(30000)                                             VEC
      4            IP=NGG*NBG*NPM+1                                                  SOURCE
                 C    (IP-1) IS THE LENGTH OF THE ARRAY USED FOR STORING THE PHOTON  SOURCE
                 C    PRODUCTION OR ENERGY PRODUCTION MATRICES.  THEREFORE, A(IP) IS SOURCE
                 C    THE FIRST ELEMENT OF THE FLUX ARRAY.                          SOURCE
      5            IQ=IP+NBG*IM                                                      SOURCE
                 C    IQ IS THE FIRST LOCATION OF THE SOURCE VECTOR ARRAY.          SOURCE
      6            IR=IP-1+IQ+NGG*IM                                                 SOURCE
                 C    IR IS THE AMOUNT OF STORAGE REQUIRED FOR THE PHOTON PRODUCTION SOURCE
                 C    MATRIX, THE NEUTRON FLUXES, AND THE SOURCE VECTOR ARRAY.      SOURCE
      7            IF (IR.GT.30000) CALL ERROR (800)                                 SOURCE
      8            IF (IOO.EQ.10*(IOO/10)) GO TO 10                                  SOURCE
      9            JMIN=IP                                                           SOURCE
     10            JMAX=IP+IM-1                                                      SOURCE
     11            DO 5 I=1,NBG                                                      SOURCE
     12            READ (5) (A(J),J=JMIN,JMAX)                                       SOURCE
     13            JMIN=JMAX+1                                                       SOURCE
     14        5   JMAX=JMAX+IM                                                      SOURCE
     15       10   IF (IOO.GE.10.AND.IOO.LT.20) GO TO 15                             SOURCE
     16            CALL READX (A,NGG,NBG,NPM,MCR,1)                                  SOURCE
     17            CALL MIXCX (A,NGG,NBG,NPM,0)                                      SOURCE
     18            CALL VECTOR (A(1),A(IP),A(IQ),NGG,NBG,NPM,IM,0)                   SOURCE
     19            IF (IOO.LT.20) RETURN                                             SOURCE
     20       15   CALL READX (A,NGG,NBG,NPM,MCR,2)                                  SOURCE
     21            CALL MIXCX (A,NGG,NBG,NPM,1)                                      SOURCE
     22            CALL VECTOR (A(1),A(IP),A(IQ),NGG,NBG,NPM,IM,1)                   SOURCE
     23            RETURN                                                            SOURCE
     24            END                                                               SOURCE
```

```
    1           SUBROUTINE READX (X,NGG,NBG,NPM,MCR,IFLAG)                      READX
                C                                                               READX
                C     THIS SUBROUTINE READS EITHER THE PHOTON PRODUCTION OR ENERGY READX
                C     PRODUCTION MICROSCOPIC MATRICES FROM TAPE 18.             READX
                C                                                               READX
    2           DIMENSION X(NGG,NBG,NPM)                                        READX
    3           REWIND 18                                                       READX
    4           IF (IFLAG.EQ.2) GO TO 10                                        READX
    5           IF (IFLAG.NE.1) CALL ERROR (900)                                READX
    6           DO 5 I=1,MCR                                                    READX
    7      5    READ (18) ((X(IG,IB,I),IB=1,NBG),IG=1,NGG)                      READX
    8           RETURN                                                          READX
    9      10   DO 15 I=1,MCR                                                   READX
   10      15   READ (18) ((X(IG,IB,I),IB=1,NBG),IG=1,NGG),((X(IG,IB,I),IB=1,NBG), READX
               1IG=1,NGG)                                                       READX
   11           RETURN                                                          READX
   12           END                                                             READX
```


SYMBOL = = = = = = = = = = = = = = REFERENCES = = = = = = = = = = = = = =

5	-	6	7#		
10	-	4	9#		
15	-	9	10#		
ERROR	-	5			
I	-	6	7RD	9	10RD
IB	-	7RD	10RD		
IFLAG	-	1AG	4	5	
IG	-	7RD	10RD		
MCR	-	1AG	6	9	
NBG	-	1AG	2DI	7RD	10RD
NGG	-	1AG	2DI	7RD	10RD
NPM	-	1AG	2DI		
READX	-	1			
RETURN	-	8	11		
X	-	1AG	2DI	7RD	10RD

```
      1            SUBROUTINE MIXCX (X,NGG,NBG,NPM,IFLAG)                                MIXCX
                   C                                                                     MIXCX
                   C    THIS ROUTINE MULTIPLIES THE MICROSCOPIC MATRICES BY THE SPECIFIED MIXCX
                   C    NUMBER DENSITIES AND PRINTS THE MACROSCOPIC MATRICES.            MIXCX
                   C                                                                     MIXCX
      2            COMMON C,EG(50),EMG(50),EMNB(100),EMNF(100),GAMM(50),IM,IOO,IRES,I BLANK
                  1WO,IZM,MA(100),MB(50),MC(50),MCR,MM,MS,MZ(10),NBG,NENB,NENF,NFG,NG BLANK
                  2AM,NGG,NMAT(10),NNM(126),NPM,R(101),RW(100),RXSC(100),RXSF(100),SW BLANK
                  3(100),SXSC(100),SXSF(100),XMD(50),AWRSAV                          BLANK
      3            COMMON /TAPES/ ISI,ISO,IEN                                         TAPES
      4            DIMENSION X(NGG,NBG,NPM)                                           MIXCX
      5            IPR=IOO-10*(IOO/10)                                                MIXCX
      6            IF (MS.EQ.0) GO TO 20                                              MIXCX
      7            DO 15 M=1,MS                                                       MIXCX
      8            K=MB(M)                                                            MIXCX
      9            L=MC(M)                                                            MIXCX
     10            A=XMD(M)                                                           MIXCX
     11            DO 15 I=1,NGG                                                      MIXCX
     12            DO 15 J=1,NBG                                                      MIXCX
     13            IF (L) 10,5,10                                                     MIXCX
     14      5     X(I,J,K)=X(I,J,K)*A                                                MIXCX
     15            GO TO 15                                                           MIXCX
     16      10    X(I,J,K)=X(I,J,K)+A*X(I,J,L)                                       MIXCX
     17      15    CONTINUE                                                           MIXCX
     18      20    DO 45 I=1,NPM                                                      MIXCX
     19            IF (IPR.GT.2.AND.I.LE.MCR) GO TO 25                                MIXCX
     20            IF (IFLAG.EQ.0) WRITE (ISO,50) I                                   MIXCX
     21            IF (IFLAG.EQ.1) WRITE (ISO,55) I                                   MIXCX
     22      25    KA=1                                                               MIXCX
     23            KB=8                                                               MIXCX
     24      30    KC=MIN0(KB,NBG)                                                    MIXCX
     25            IF (IPR.GT.2.AND.I.LE.MCR) GO TO 40                                MIXCX
     26            WRITE (ISO,60) (K,K=KA,KC)                                         MIXCX
     27            WRITE (ISO,65)                                                     MIXCX
     28            DO 35 J=1,NGG                                                      MIXCX
     29      35    WRITE (ISO,70) J,(X(J,K,I),K=KA,KC)                                MIXCX
     30      40    KA=KA+8                                                            MIXCX
     31            KB=KB+8                                                            MIXCX
     32            IF (KA.LE.NBG) GO TO 30                                            MIXCX
     33      45    CONTINUE                                                           MIXCX
     34            RETURN                                                             MIXCX
                   C    A NON-FATAL ERROR MESSAGE WILL BE PRINTED COMPLAINING THAT THE MIXCX
                   C    ARGUMENTS IN THE CALLING SEQUENCE APPEAR IN BLANK COMMON.  THIS MIXCX
                   C    IS DUE TO THE USE OF VARIABLE DIMENSIONING.                    MIXCX
                   C                                                                   MIXCX
     35      50    FORMAT (*1          PHOTON PRODUCTION MATRIX FOR MATERIAL (OR MIXTU MIXCX
                  1RE)*,I3,/)                                                          MIXCX
     36      55    FORMAT (*1          PHOTON ENERGY PRODUCTION MATRIX FOR MATERIAL ( MIXCX
                  1OR MIXTURE)*,I3,/)                                                  MIXCX
     37      60    FORMAT (1H0,5X,8(2X,5HGROUP,I3,3X))                                MIXCX
```



```
     38      65    FORMAT (1H )                                                       MIXCX
     39      70    FORMAT (I4,1P8E13.5)                                               MIXCX
     40            END                                                                MIXCX
```

SYMBOL	REFERENCES
5	13 14*
10	13 16*
15	7 11 12 15 17*
20	6 18*
25	19 22*
30	24* 32
35	28 29*
40	25 30*
45	18 33*
50	20WR 35*
55	21WR 36*
60	26WR 37*
65	27WR 38*
70	29WR 39*
A	10= 14 16
ANRSAV	2C0
C	2C0
EG	2C0
EMG	2C0
EMNB	2C0
EMNF	2C0
GAMM	2C0
I	11 14 16 18 19 20WR 21WR 25 29WR
IFN	3C0
IFLAG	1AG 20 21
IM	2C0
INO	2C0 5
IPR	5= 19 25
IRES	2C0
ISI	3C0
ISO	3C0 20WR 21WR 26WR 27WR 29WR
IWO	2C0
IZM	2C0
J	12 14 16 28 29WR
K	8= 14 16 26WR 29WR
KA	22= 26WR 29WR 30= 32
KB	23= 24 31=
KC	24= 26WR 29WR
L	9= 13 16
M	7 8 9 10
MA	2C0
MB	2C0 8
MC	2C0 9
MCR	2C0 19 25
MTNO	24
MIXCX	1
MM	2C0
MS	2C0 6 7

SURROUTINE MIXCX (X,NGG,NBG,NPM,IFLAG)

MZ	-	2C0					
NBG	-	1AG	2C0	4DI	12	24	32
NBNB	-	2C0					
NBNF	-	2C0					
NFG	-	2C0					
NGAM	-	2C0					
NGG	-	1AG	2C0	4DI	11	28	
NMAT	-	2C0					
NPM	-	2C0					
NPM	-	1AG	2C0	4DI	18		
R	-	2C0					
RETURN	-	34					
RM	-	2C0					
RXSC	-	2C0					
RXSF	-	2C0					
SM	-	2C0					
SXSC	-	2C0					
SXSF	-	2C0					
TAPES	-	3C0					
X	-	1AG	4DI	14*	16*	29WR	
XMD	-	2C0	10				

```
    1           SUBROUTINE VECTOR (X,PHI,S,NGG,NBG,NPM,IM,IFLAG)                VECTOR
                C                                                               VECTOR
                C     VECTOR MULTIPLIES THE MACROSCOPIC MATRICES BY THE APPROPRIATE FLUX VECTOR
                C     VECTORS AND THE SCALAR RENORMALIZATION CONSTANT TO GIVE THE SOURCE VECTOR
                C     VECTORS.                                                  VECTOR
                C                                                               VECTOR
    2           COMMON C,EG(50),EMG(50),EMNB(100),EMNF(100),GAMM(50),IM,IOO,IRES,I BLANK
               1WO,IZM,MA(100),MB(50),MC(50),MCR,MM,MS,MZ(10),NBG,NENB,NENF,NFG,NG BLANK
               2AM,NGG,NMAT(10),NNM(126),NPM,R(101),RW(100),RXSC(100),RXSF(100),SW BLANK
               3(100),SXSC(100),SXSF(100),XMD(50),AWRSAV                        BLANK
    3           COMMON /TAPES/ ISI,ISO,IEN                                      TAPES
    4           DIMENSION X(NGG,NBG,NPM), PHI(IM,NBG), S(IM,NGG)                VECTOR
    5           IF (IOO.EQ.10*(IOO/10)) RETURN                                  VECTOR
    6           IPR=IOO-10*(IOO/10)                                             VECTOR
    7           DO 5 I=1,NGG                                                    VECTOR
    8           DO 5 J=1,IM                                                     VECTOR
    9       5   S(J,I)=0.0                                                      VECTOR
   10           DO 10 I=1,IM                                                    VECTOR
   11           K=MA(I)                                                         VECTOR
                C     K  TELLS ME THAT THE I-TH INTERVAL IS IN THE K-TH ZONE.   VECTOR
   12           KK=MZ(K)                                                        VECTOR
                C     KK TELLS ME THAT THE KK-TH MIXTURE IS USED IN THE K-TH ZONE. VECTOR
   13           DO 10 J=1,NGG                                                   VECTOR
   14           DO 10 N=1,NBG                                                   VECTOR
   15           S(I,J)=S(I,J)+C*X(J,N,KK)*PHI(I,N)                              VECTOR
   16       10  CONTINUE                                                       VECTOR
   17           IF (IFLAG.EQ.0) WRITE (ISO,25)                                  VECTOR
   18           IF (IFLAG.EQ.1) WRITE (ISO,30)                                  VECTOR
   19           DO 15 J=1,IM                                                    VECTOR
   20       15  WRITE (ISO,35) J,R(J),R(J+1),(S(J,I),I=1,NGG)                   VECTOR
   21           IF (IPR.EQ.2.OR.IPR.EQ.4) GO TO 20                              VECTOR
   22           RETURN                                                          VECTOR
   23       20  I=IM*NGG                                                       VECTOR
   24           IF (IFLAG.EQ.0) IHOL=6HSOURCE                                   VECTOR
   25           IF (IFLAG.EQ.1) IHOL=6HENERGY                                   VECTOR
   26           CALL PUNCR (S,I,IHOL)                                           VECTOR
   27           RETURN                                                          VECTOR
                C     A NON-FATAL ERROR MESSAGE WILL BE PRINTED COMPLAINING THAT THE VECTOR
                C     ARGUMENTS IN THE CALLING SEQUENCE APPEAR IN BLANK COMMON.  THIS VECTOR
                C     IS DUE TO THE USE OF VARIABLE DIMENSIONING.               VECTOR
                C                                                               VECTOR
   28       25  FORMAT (*1         PHOTON PRODUCTION SOURCE VECTORS AT INDICATED ME VECTOR
               1SH INTERVALS*,/)                                                VECTOR
   29       30  FORMAT (*1         PHOTON ENERGY PRODUCTION SOURCE VECTORS AT INDIC VECTOR
               1ATED MESH INTERVALS*,/)                                         VECTOR
   30       35  FORMAT (*      FOR MESH INTERVAL*,I3,* BOUNDED BY RADII R=*,1PE12.4 VECTOR
               1,*  AND R=*,1PE12.4,*   THE VECTOR IS*,/,(1P8E16.8))           VECTOR
   31           END                                                             VECTOR
```

SYMBOL	REFERENCES
S	7 8 9*
1..	13 13 14 16*
15	19 20*
2..	21 23*
25	17WR 28*
3..	18WR 29*
35	20WR 30*
A..RSAV	2C0
C	2C0 15
EG	2C0
EMG	2C0
EMNB	2C0
EMNF	2C0
GAMN	2C0
I	7 9 10 11 15 20WR 23= 26AG
IEN	3C0
IFLAG	1AG 17 18 24 25
IHOL	24= 25= 26AG
I..	1AG 2C0 4DI 8 10 19 23
IOO	2C0 5 6
IPR	6= 21
IPES	2C0
ISI	3C0
ISO	3C0 17WR 18WR 20WR
IWO	2C0
IZM	2C0
J	8 9 13 15 19 20WR
K	11= 12
KK	12= 15
MA	2C0 11
MB	2C0
MC	2C0
MCR	2C0
MM	2C0
MS	2C0
MZ	2C0 12
N	14 15
NBG	1AG 2C0 4DI 14
NENB	2C0
NENF	2C0
NFG	2C0
NGAM	2C0
NGG	1AG 2C0 4DI 7 13 20WR 23
NMAT	2C0
NNM	2C0
NPM	1AG 2C0 4DI
PHI	1AG 4DI 15
PHINCR	26

R	2C0 20WR
RETURN	5 22 27
RW	2C0
RXSC	2C0
RXSF	2C0
S	1AG 4DI 9= 15= 20WR 26AG
SW	2C0
SXSC	2C0
SXSF	2C0
TAPES	3C0
VECTOR	1
X	1AG 4DI 15
XHO	2C0

SUBROUTINE PUNCR (VECP,INP,IHOL)

```
    1            SUBROUTINE PUNCR (VECP,INP,IHOL)                          PUNCR
    2            COMMON /TAPES/ NINP,NOUT,IEN                              PUNCR
    3            DIMENSION VECP(1)                                         PUNCR
                 C      THE PURPOSE OF THIS CODE IS TO PUNCH AND           PUNCR
                 C      SERIALLY NUMBER A FLOATING POINT VECTOR            PUNCR
                 C      IN THE STANDARD DTF CROSS SECTION FORMAT.          PUNCR
                 C      CALLING SEQUENCE ENTRIES ]                         PUNCR
                 C      VECP IS THE VECTOR TO BE PUNCHED.                  PUNCR
                 C      IBP IS THE START OF THAT VECTOR.                   PUNCR
                 C      INP IS THE IS THE NUMBER TO PUNCH.                 PUNCR
                 C      COMMON PARAMETERS ]                                PUNCR
                 C      NOUT IS THE SYSTEM OUTPUT UNIT NUMBER.             PUNCR
                 C      TEMPORARY STORAGE ]                                PUNCR
                 C      NPP IS THE MAXIMUM NUMBER TO PUNCH.                PUNCR
                 C      ICARD IS THE CARD COUNT.                           PUNCR
                 C      INPT IS THE WORKING COUNT.                         PUNCR
                 C      IBPW IS THE START OF THE LOOP.                     PUNCR
                 C      IEPW IS THE END OF THE LOOP.                       PUNCR
                 C      NPPW IS THE WORKING NUMBER TO DO ON THAT CARD.     PUNCR
    4            IBP=1                                                     PUNCR
    5            NPP=6                                                     PUNCR
    6            ICARD=1                                                   PUNCR
    7            INPT=INP                                                  PUNCR
    8            IF (INPT.LT.0) GO TO 70                                   PUNCR
    9            IBPW=IBP                                                  PUNCR
                 C      RETURN FOR NEXT PUNCH.                             PUNCR
   10        5   CONTINUE                                                  PUNCR
   11            IF (INPT.GT.0) GO TO 15                                   PUNCR
                 C      RETURN.                                            PUNCR
   12       10   CONTINUE                                                  PUNCR
   13            RETURN                                                    PUNCR
                 C      PROCESS UNIT.                                      PUNCR
   14       15   CONTINUE                                                  PUNCR
   15            IF (INPT-NPP) 75,20,25                                    PUNCR
                 C      EQUAL TO CARD FULL.                                PUNCR
   16       20   CONTINUE                                                  PUNCR
   17            INPT=0                                                    PUNCR
                 C      GREATER THAN CARD FULL.                            PUNCR
   18       25   CONTINUE                                                  PUNCR
   19            NPPW=NPP                                                  PUNCR
                 C      COMPUTE ENDING VALUE.                              PUNCR
   20       30   CONTINUE                                                  PUNCR
   21            IEPW=IBPW+NPPW-1                                          PUNCR
   22            INPT=INPT-NPPW                                            PUNCR
   23            GO TO (35,45,50,55,60,65), NPPW                           PUNCR
                 C      ONE NUMBER.                                        PUNCR
   24       35   CONTINUE                                                  PUNCR
   25            PUNCH 80, (VECP(I),I=IBPW,IEPW),IHOL,ICARD                PUNCR
                 C      INCREASE CARD COUNT.                               PUNCR
   26       40   CONTINUE                                                  PUNCR
```

SUBROUTINE PUNCR (VECP,INP,IHOL)

```
      27            ICARD=ICARD+1                                                  PUNCR
      28            IBPW=IEPW+1                                                    PUNCR
      29            GO TO 5                                                        PUNCR
      30      45    CONTINUE                                                       PUNCR
      31            PUNCH 85, (VECP(I),I=IBPW,IEPW),IHOL,ICARD                     PUNCR
      32            GO TO 40                                                       PUNCR
      33      50    CONTINUE                                                       PUNCR
      34            PUNCH 90, (VECP(I),I=IBPW,IEPW),IHOL,ICARD                     PUNCR
      35            GO TO 40                                                       PUNCR
      36      55    CONTINUE                                                       PUNCR
      37            PUNCH 95, (VECP(I),I=IBPW,IEPW),IHOL,ICARD                     PUNCR
      38            GO TO 40                                                       PUNCR
      39      60    CONTINUE                                                       PUNCR
      40            PUNCH 100, (VECP(I),I=IBPW,IEPW),IHOL,ICARD                    PUNCR
      41            GO TO 40                                                       PUNCR
            C       PUNCH FULL CARD.                                               PUNCR
      42      65    CONTINUE                                                       PUNCR
      43            PUNCH 105, (VECP(I),I=IBPW,IEPW),IHOL,ICARD                    PUNCR
      44            GO TO 40                                                       PUNCR
            C       PRINT ERROR MESSAGE.                                           PUNCR
      45      70    CONTINUE                                                       PUNCR
      46            WRITE (NOUT,110)                                               PUNCR
      47            GO TO 10                                                       PUNCR
            C       COUNT LESS THAN MAXIMUM.                                       PUNCR
      48      75    CONTINUE                                                       PUNCR
      49            NPPW=INPT                                                      PUNCR
      50            INPT=0                                                         PUNCR
      51            GO TO 30                                                       PUNCR
            C                                                                      PUNCR
      52      80    FORMAT (1P1(3X,E9.2),60X,A6,I2)                                PUNCR
      53      85    FORMAT (1P2(3X,E9.2),48X,A6,I2)                                PUNCR
      54      90    FORMAT (1P3(3X,E9.2),36X,A6,I2)                                PUNCR
      55      95    FORMAT (1P4(3X,E9.2),24X,A6,I2)                                PUNCR
      56     100    FORMAT (1P5(3X,E9.2),12X,A6,I2)                                PUNCR
      57     105    FORMAT (1P6(3X,E9.2),A6,I2)                                    PUNCR
      58     110    FORMAT (42H0 SPECIFICATION FOR PUNCH BLOCK IN ERROR. )         PUNCR
      59            END                                                            PUNCR
```

SYMBOL		REFERENCES								
5	-	10*	29							
10	-	12*	47							
15	-	11	14*							
20	-	15	16*							
25	-	15	18*							
30	-	20*	51							
35	-	23	24*							
40	-	26*	32	35	38	41	44			
45	-	23	30*							
50	-	23	33*							
55	-	23	36*							
60	-	23	39*							
65	-	23	42*							
70	-	8	45*							
75	-	15	48*							
80	-	25PU	52*							
85	-	31PU	53*							
90	-	34PU	54*							
95	-	37PU	55*							
100	-	40PU	56*							
105	-	43PU	57*							
110	-	46WR	58*							
I	-	25PU	31PU	34PU	37PU	40PU	43PU			
IAP	-	4=	9							
IAPW	-	9=	21	25PU	28=	31PU	34PU	37PU	40PU	43PU
ICARD	-	6=	25PU	27=	31PU	34PU	37PU	40PU	43PU	
IEN	-	2C0								
IFPW	-	21=	25PU	28	31PU	34PU	37PU	40PU	43PU	
IHOL	-	1AG	25PU	31PU	34PU	37PU	40PU	43PU		
INP	-	1AG	7							
INPT	-	7=	8	11	15	17=	22=	49	50=	
NINP	-	2C0								
NOUT	-	2C0	46WR							
NPP	-	5=	15	19						
NPPW	-	19=	21	22	23	49=				
PUNCR	-	1								
RETURN	-	13								
TAPES	-	2C0								
VECP	-	1AG	3DI	25PU	31PU	34PU	37PU	40PU	43PU	