LA-9303-M, Vol. I (ENDF-324)

Manual

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ENDF Nuclear Data Processing System, Volume I: User's Manual

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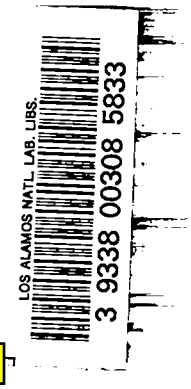

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THE NJOY NUCLEAR DATA PROCESSING SYSTEM, VOLUME I: USER'S MANUAL

by

R. E. MacFarlane, D. W. Muir, and R. M. Boicourt

ABSTRACT

The NJOY nuclear data processing system is a comprehensive computer code package for producing cross sections for neutron and photon transport calculations from ENDF/B-IV and -V evaluated nuclear data. This user's manual provides a concise description of the code, input instructions, sample problems, and installation instructions.

I. INTRODUCTION TO VOL. I

The NJOY[1-3] nuclear data processing system is a comprehensive computer code package for producing pointwise and multigroup neutron and photon cross sections from ENDF/B-IV and -V evaluated nuclear data.[4] This document provides a concise description of the (10/81) version of the code, operating instructions, code installation instructions, and sample problems. Full descriptions of theory, methods, and programming details are given in subsequent volumes of this report.

II. CODE DESCRIPTION

The NJOY code consists of a set of modules, each performing a well-defined processing task. The RECONR module reconstructs pointwise (energy-dependent) cross sections from ENDF/B resonance parameters and interpolation schemes. BROADR Doppler-broadens and thins pointwise cross sections. UNRESR computes effective self-shielded pointwise cross sections in the unresolved-resonance region. HEATR generates pointwise heat production cross sections (kerma factors) and radiation-damage-energy production cross sections. THERMR produces

incoherent inelastic energy-to-energy matrices for free or bound scatterers, coherent elastic cross sections for hexagonal materials, and incoherent elastic cross sections. GROUPR generates self-shielded multigroup cross sections, group-to-group neutron scattering matrices, and photon production matrices from pointwise input. GAMINR calculates multigroup photon interaction cross sections and kerma factors and group-to-group photon scattering matrices. ERRORR produces multigroup covariance matrices from ENDF/B uncertainties. COVR reads the output of ERRORR and performs covariance plotting and output formatting operations. DTFR formats multigroup data for transport codes, such as DTF-IV[5] and ANISN.[6] CCCCR formats multigroup data for the CCCC standard[7] interface files ISOTXS, BRKOXS, and DLAYXS. MATXSR formats multigroup data for the MATXS cross-section interface file. The ACER module prepares libraries for the Los Alamos continuous-energy Monte Carlo code MCNP.[8] POWR prepares libraries for the EPRI-CELL and EPRI-CPM codes.* Finally, MODER changes ENDF/B "tapes" and other ENDF-like NJOY interface files back and forth between formatted (that is, BCD or ASCII) and blocked-binary modes. NJOY incorporates and improves upon the features of its direct ancestor, MINX.[9] It also includes and extends the photon production capabilities of LAPHANO,[10] the photon interaction capabilities of GAMLEG,[11] the heating capabilities of MACK,[12] the covariance capabilities of PUFF,[13] and the thermal capabilities of FLANGE-II[14] and HEXSCAT.[15]

The methods used in these modules are described in detail in subsequent volumes of this report. The following brief account will make the general flow of the code clear. RECONR reads an ENDF/B tape and produces a common energy grid for all reactions (the union grid) such that all cross sections can be obtained to within a specified tolerance by linear interpolation. Resonance cross sections are calculated with the methods of RESEND,[16] but a new method of choosing the energy grid is used that incorporates control of the number of significant figures generated and a resonance-integral criterion to reduce the number of grid points generated for some materials. Summation cross sections (for example, total, inelastic) are reconstructed from their parts. The resulting pointwise cross sections are written onto a "point-ENDF" (PENDF) tape for future use. BROADR reads a PENDF tape and Doppler-broadens the data using the method of SIGMA1,[17] modified for better behavior at high temperatures and low

*EPRI-CELL and EPRI-CPM are proprietary codes. Additional information can be obtained from the Electric Power Research Institute, 3412 Hillview Ave, Palo Alto, California 94394.

energies. The union grid allows all resonance reactions to be broadened simultaneously, resulting in a great savings of processing time. After broadening, the summation cross sections are again reconstructed from their parts. The results are written out on a PENDF tape for future use. UNRESR uses the methods of ETOX[18] to produce effective self-shielded pointwise cross sections, versus temperature and background cross section, in the unresolved-resonance region. The results are added to the PENDF tape in a special format. HEATR computes both heating and radiation-damage-energy production using momentum balance (for capture) or energy balance (for all other reactions). The ENDF/B photon production files are used in both methods when available. The heating results are added to the PENDF tape using ENDF/B reaction numbers in the 300 series, and the radiation damage results use the special identifier 444. THERMR produces pointwise cross sections in the thermal range. Bragg edges in coherent scattering are produced using the method of HEXSCAT[15] with an improved treatment at high energies. Energy-to-energy incoherent scattering matrices can be computed for free scattering or for bound scattering using a precomputed form factor $S(\alpha,\beta)$ in ENDF format. The secondary angle and energy grids are determined adaptively so as to represent the function to a desired precision by linear interpolation; the angular representation is converted to one based on equally probable angles. Elastic incoherent scattering is represented using equally probable angles computed analytically. The results for all the processes are added to the PENDF tape using special formats and reaction numbers.

GROUPR processes the pointwise cross sections produced by the modules described above into multigroup form using the Bondarenko flux-weighting model.[19] As an option, a pointwise flux solution can be generated for a heavy absorber in a light moderator. Self-shielded cross sections, scattering matrices, and photon production matrices are all averaged in a unified way, the only difference being in the function that describes the "feed" into secondary group g' with Legendre order ℓ from initial energy E. The feed for two-body scattering is computed using a center-of-mass Gaussian integration scheme, which provides high accuracy even for small Legendre components of the scattering matrix. Special features are included for delayed neutrons, the coupled angle and energy dependence of the thermal scattering matrix, and the discrete scattering angles arising for thermal coherent reactions. Prompt fission is treated with a group-to-group matrix. The results are written in a special "groupwise-ENDF" format

(GENDF) for later use by the output formatting modules. GAMINR uses a specialized version of GROUPR. Coherent and incoherent form factors[20] are processed in order to extend the useful range of the results to lower energies. Photon heat production cross sections are also generated. The results are saved on a GENDF tape. ERRORR can either produce its own multigroup cross sections using the methods of GROUPR or start from a precomputed set. The cross sections and ENDF covariance data are combined in a way that includes the effects of deriving one cross section from several others. Special features are included to process covariances for data given as resonance parameters or ratios (for example, fission $\bar{\nu}$). The COVR module uses the widely available DISSPLA* plotting software to make publication-quality plots[21] of covariance data; it also provides a site for user-supplied routines to prepare covariance libraries for various sensitivity systems. DTFR is a simple reformatting code that produces cross-section tables acceptable to most discrete-ordinates codes. It also converts the GROUPR fission matrix to χ and $\bar{\nu}\sigma_f$ and prepares a photon production matrix if desired. The user can define edit cross sections that are any linear combination of the cross sections on the GENDF tape. This makes complex edits such as gas production possible. DTFR also contains system-dependent plotting routines for the cross sections, P_0 scattering matrices, and photon production matrices. CCCCR is also a straightforward reformatting code. All of the CCCC-IV[7] options are supported. In the cross-section file (ISOTXS), the user can choose either isotope χ matrices or isotope χ vectors collapsed using any specified flux. The BRKOXS file includes self-shielding factors for elastic removal. Note that some of the cross sections producible with NJOY are not defined in the CCCC-IV files. MATXSR reformats GENDF data into the MATXS file format, which is suitable for input to the TRANSX postprocessor program. The MATXS format uses flexible naming conventions that allow it to store all NJOY data types except delayed neutron and delayed photon spectra.

In the reference version of the code, each module is a separate overlay. The main overlay (NJOY) simply calls in each primary overlay (for example, RECONR, GROUPR) as requested by the user's input commands. The NJOY level also contains utility routines used by all other modules (for example, free-form input, storage allocation, and ENDF/B input/output). The code can easily be decomposed into 15 independent programs and a user library.

*DISSPLA is a proprietary graphics software package. For more information, contact Integrated Software Systems Corp., 4186 Sorrento Valley Blvd., San Diego, California 92121.

III. NJOY INPUT INSTRUCTIONS

All NJOY input is in free form. A subroutine FREE has been included among the NJOY utilities to provide this capability. Fields on the input cards are delimited by any character not used for another purpose (+,-,numeral,E,H,*,R,/). For exponent fields, the E must be present, and spaces are not allowed before the E. Decimal points are not required after numbers. Hollerith entries may use nHSTRING or *STRING*. The form nR causes the following number to be repeated n times. The (/) terminates the input for one call to FREE (it may involve more than one card) leaving any unread variables unchanged. This feature is often used to default variables from the right. The part of the input line to the right of the (/) can be used for comments if desired.

As an example of when the (/) is useful, in several NJOY routines a record of Hollerith information is constructed from user input. This is accomplished by calling FREE with NZA = 17 (the number of Hollerith words required to fill the 66 columns available for an ENDF/B "comment"). The array is preset to 17 blank words, so that the user need not blank-fill the line explicitly. Instead, he can write *MESSAGE*/ where the (/) terminates the process of replacing the default blanks with actual input ("MESSAGE" in this example).

The user should be cautioned that if the (/) is omitted from an input data block that is incomplete, as in the Hollerith example above, FREE will go on reading successive input data cards until the expected NZA words are found, usually resulting in an error condition. For this reason, if the user is uncertain whether he has supplied enough input parameters to "satisfy" a particular call to FREE, it is good practice to use a (/) at the end of the input data for that data block.

Some input examples follow.

```
        LEGAL                          ILLEGAL
12  12.    1.2E1              1.2+1   1.2 E1
*U235*   4HU235               4RU235 (does not mean "right-justify")
5R0      2R 1.2E2
```

The input to the NJOY sample problems, Section IV, provides additional illustrations of the syntax of free-form input.

The flow through the modules of NJOY is controlled by module names and input/output logical unit numbers. A module typically reads data from an input unit, modifies it, and writes the results on an output unit. Sometimes auxiliary inputs or multiple outputs are required. The output of one module is often the input for another.

```
*RECONR*
 21  22
 .
 .  [input for RECONR]
 .
*BROADR*
 22  25
 .
 .  [input for BROADR]
 .
```

Because the files on most units are in ENDF/B format, the modules can be connected in many ways. The files can be saved at any point for later restart. Other combinations will be found in the sample problems.

NJOY provides for a special blocked-binary mode for the ENDF/B files. Such files are indicated with negative unit numbers. The MODER module can be used to convert back and forth between formatted (that is, BCD or ASCII) and blocked-binary modes. The user may assign unit numbers from 20 through 99 for linking modules. Many modules also accept 0 as a unit number, which means that the corresponding file is not used. Unit numbers from 10-19 are reserved for scratch files, and units 5-7 are used for system input and output files.

Detailed input instructions are included as comment cards at the start of each module (overlay); the current set of comment-card instructions is reproduced in this report as Appendix A. The following sections supplement the material in Appendix A by providing expanded descriptions of the significance of certain input parameters. Additional details will be found in subsequent volumes of this report.

A. NJOY Module

IOPT... When operating in a time-sharing environment (IOPT = 1), the code routes input prompts and short output messages to the terminal (TTY). The regular long output is still available for the system printer.

B. RECONR Module

NENDF... This is the unit containing an ENDF/B-IV or -V tape.* It is recommended that binary mode be used whenever possible (that is, use MODER).

ERR... A reasonable value is 0.005 (½ %). For materials with many resonances, such as ^{93}Nb and ^{238}U, it may be necessary to relax (increase) this somewhat in order to reduce the running time.

*ENDF/B tapes are available from the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory, Upton, New York.

TEMPR... Resonances can be constructed directly at an elevated temperature using the $\psi\chi$ resonance shapes (with some loss in accuracy and great savings in time) for single-level Breit-Wigner or Adler-Adler representations. In general, it is recommended that resonance reconstruction be performed at zero Kelvin (TEMPR = 0); BROADR can then be used to Doppler-broaden to the desired temperature with great accuracy.

NDIGIT... All energies are adjusted to have exactly this number of significant digits before the cross section is computed, and no two energies are allowed to be equal. For formatted output, NDIGIT must be less than or equal to 7; larger values are allowed with binary output, if permitted by the word length of the computer.

ERRMAX,ERRINT... These parameters control an optional resonance-integral thinning procedure, which helps reduce the number of energy points generated during resonance reconstruction. The option can be turned off by specifying ERRMAX = ERR.

C. BROADR Module

ISTART... Since Doppler broadening is comparatively expensive, it is often useful to "restart" from previous data at a lower temperature. For example, in attempting to produce cross sections at 300, 900, and 2100 K, the job runs out of time while doing the last temperature. Set ISTART = 1 and TEMP1 = 900, and continue the job using the output of the aborted run as input. (If ISTART = 0, none of the input cross sections are copied to the output.)

ISTRAP... "Bootstrap" refers to using the output of one broadening run as the input for a subsequent higher temperature run. If thinning was used, the second run can be much faster than the first. However, errors will accumulate.

ERRTHN... Cross sections become smoother with Doppler broadening and can be thinned. It is recommended that ERRTHN $\leq$ ERR be used. (See Item B above.)

THNMAX... Broadening and thinning are not normally performed above 1 MeV or the inelastic threshold, whichever is lower. In some cases, it is useful to further reduce this energy, for example to the top of the resolved-resonance energy range or to an energy that avoids sharp steps or triangular representations of resonances found for some evaluations (for example, ENDF/B-V lead).

D. HEATR Module

NPK,MTK... Usually only the total kerma is needed (NPK = 0). For structural metals, MTK = 444 can be requested to obtain the total radiation damage production cross section. Other partials are useful in connection with IPRINT = 2.

NQA,MTA,QA... Because of lack of uniformity in evaluation practices, or because of the varying energy values of the separate isotopes in an element, it is sometimes necessary to override the evaluator's Q-values.

IPRINT = 2... This option is provided mainly for evaluators. Computed kerma factors are compared with limits obtained from kinematics, and the capture photon spectrum is compared to the available energy. If this option reveals many violations of energy balance, the results of both heating and gamma dose calculations must be held in doubt.

LOCAL... If photon production data are available, the energy carried away by photons is normally subtracted from the energy available for local heating (LOCAL = 0); the energy appears elsewhere in the system as a result of photon interactions. If photon transport is not treated, this energy should be included in the local heating (LOCAL = 1).

E. THERMR Module

NENDF,MATDE... The thermal ENDF data (only MF = 7 is used) are available on a special set of tapes (320-325).[22] Each material has a special MAT number to be used for MATDE and a special list of temperatures. No tape or MATDE value is required for free gas scattering.

NIN,MATDP... The MAT numbers on the input PENDF tape are the MAT numbers from the main evaluation, not the thermal MAT number. The temperatures on the PENDF tape must include the desired values from the thermal tape.

NATOM... For example, 2 for hydrogen in water.

MTREF... Thermal data generated by this module are written onto the PENDF tape using MT = MTREF, which must be in the range 201-250. The MATXSR module recognizes the MT-numbers given in Table I.

F. GROUPR Module

NTEMP,TEMP... The requested temperatures must occur on the input PENDF tape.

NSIGZ,SIGZ... One or more "background" cross sections must be specified in barns for the calculation of self-shielded group constants using the Bondarenko formalism. For infinite dilution, NSIGZ = 1, and by convention, SIGZ = 1.E10. If unresolved data have been added to the PENDF tape using UNRESR, the NSIGZ SIGZ values in GROUPR do not have to agree with the σ_0 values used in UNRESR. In both codes, SIGZ is read in, in descending order, with σ_0 = 1.E10 first.

WGHT... If the user wishes to supply his own weight function, he must use a "TAB1" record. This is a particular ENDF/B data structure which, if a single

TABLE I

REACTION NUMBERS FOR THERMAL SCATTERING

ENDF/B-V	ENDF/B-IV	CONTENTS
221	201	free gas
222	202	H in H_2O
223	203	inelastic H in CH_2
224	204	elastic H in CH_2
225	205	inelastic H in ZrH
226	206	elastic H in ZrH
227	207	benzene
228	208	D in D_2O
229	209	inelastic graphite
230	210	elastic graphite
233	219	inelastic Be
234	220	elastic Be
231	229	inelastic BeO
232	230	elastic BeO
235	—	inelastic Zr in ZrH
236	—	elastic Zr in ZrH

interpolation scheme INT is employed, has the following form.

```
card 1          0.   0.   0    0    1    N
card 2          N    INT
cards 3,4,... (E(I),WGHT(I),I=1,N)/
```

Here N is the number of energy-weight pairs, and INT specifies the functional form to be used to connect the points. For example, INT = 2 specifies that WGHT is a linear function of E between points and INT = 5 specifies that log(WGHT) is a linear function of log(E) between points. The (/) shown after the final weight is required. This is a departure from the normal NJOY convention where (/) is needed only if the reading of a data block is to be terminated prematurely.

MFD,MTD,MTNAME... GROUPR requires that the user specify each reaction type to be processed using its ENDF/B "MT-number." Further, it is illegal to request a reaction type that is absent in the evaluation. The MT-numbers used in a given evaluation can be obtained from the "dictionary" (MF1, MT451), a list of all the "files" (MF-numbers) and "sections" (MT-numbers) for this material (MAT-number). The user should first examine the list of sections of file 3. Each section describes a different nuclear reaction, so the user can select from this list the reactions he wishes to process. A table of ENDF/B MT-numbers is reproduced here as Appendix B.

In order to process reaction "vectors" (as opposed to group-to-group transfer matrices), one inputs data cards such as

```
3    103    *(N,P)*/
3    105/    .
```

Here MFD=3 specifies a vector, MTD=103 is the section to be processed, and "(N,P)" is the user-supplied name for the reaction. This name is only used to label the listing and is optional as shown by the second line. There are several special MT-numbers recognized by NJOY while processing vectors.

MT	Meaning
252	$\bar{\mu}$ (average scattering cosine)
253	ξ (average log decrement)
258	mean lethargy
259	mean reciprocal velocity
452	total fission yield
455	delayed fission yield
456	prompt fission yield

The first three are computed from fundamental definitions, not file 3. The last three are computed using MF1 yields and MF3 fission cross sections.

To process one matrix reaction (that is, group-to-group scattering), use use MFD=6 as in this example:

```
6    16    *(N,2N)*/.
```

The reaction types with scattering data are most easily found under MF=4 in the dictionary. Caution: MF4, MT103-150 are charged particle angular distributions and should not be requested as matrices.

As a convenience feature, a consecutive sequence of MTDs can be specified as follows.

```
3     51    *FIRST INELASTIC LEVEL*/
3    -76    *HIGHER INELASTIC LEVELS*/
6     51    *FIRST INELASTIC LEVEL*/
6    -76    *HIGHER INELASTIC LEVELS*/
```

All values of MTD from 51 through 76 will then be processed into both vectors and matrices.

Fissionable materials introduce some additional complexity. GROUPR produces a prompt fission group-to-group matrix that can be converted into the traditional $\bar{\nu}\sigma_f$ and χ vectors by later modules (for example, DTFR). For simple evaluations, it is only necessary to make this request.

```
3    18    *FISSION XSEC*/
6    18    *FISSION MATRIX*/
```

In several important evaluations, however, the evaluator has divided the fission process into parts: MT19, direct fission (n,f); MT20, second-chance fission (n,n')f; MT21, third-chance fission (n,2n)f; and MT38, fourth-chance fission (n,3n)f. The procedure makes possible a more accurate representation of the high-energy portion of the fission spectrum when fission is induced by neutrons with energies above 5 or 6 MeV. For such evaluations (for example, ^{235}U, ^{238}U, ^{239}Pu), the following input is recommended.

```
3    18   *TOTAL FISSION*/
3    19   *(N,F)*/
3    20   *(N,N)F*/
3    21   *(N,2N)F*/
3    38   *(N,3N)F*/
6    19   *(N,F)*/
6    20   *(N,N)F*/
6    21   *(N,2N)F*/
6    38   *(N,3N)F*/
```

Note that 6/18 is omitted. A subsequent module, such as DTFR or MATXSR, can add the partial matrices to obtain the total fission matrix.

A final complication of fission is the existence of delayed neutrons from fission. For those materials that contain delayed neutron data, the user should request these.

```
3    455  *DELAYED NUBAR*/
5    455  *DELAYED CHI*/
```

A later module can add the delayed data to the prompt matrix in order to obtain "steady-state" values for $\bar{\nu}\sigma_f$ and χ.

The matrix representation of fission is very general, but the results are bulky and expensive, especially for large group structures (for example, the 620-group dosimetry set). For such cases, the short-cut fission spectrum option (MFD=5) can be used. The MTD-value selects the parameters as follows.

MTD Requested	Spectrum from MF/MT	Incident Energy
18 or 452	5/18	1 MeV
19 or 456	5/19	1 MeV
455	5/455	2 MeV

The incident energy can be changed at line 407 of GROUPR.

If the evaluation includes photon production data, GROUPR will prepare a neutron-to-photon transfer matrix for each reaction requested. These reactions are identified in the material dictionary by the presence of MF=12 (photon

production yields), MF13 (photon production cross sections), or both. For each reaction, input a data card with MFD=MF+4; for example,

```
16   102  *CAPTURE GAMMA PRODUCTION*/
17     3  *NON-ELASTIC GAMMA PRODUCTION*/ .
```

The ENDF/B-V format includes multiplicities (MF9) or cross sections (MF10) for the production of radioactive nuclides, including isomers. These files are converted into multigroup form by requesting MFD=90+level or MFD=100+level, respectively; for example,

```
90   16   *N2N GROUND STATE*/
91   16   *N2N ISOMER PRODUCTION*/ .
```

Several examples of GROUPR input will be found in the sample problems.

G. GAMINR Module

MFD=-1... This option provides the user with a standard list of reaction types suitable for all elements: vectors for 501, 502, 504, 516, 602, and 621; matrices for 502, 504, and 516. Note that 621 is assigned specially for the photon heat production cross section.

H. ERRORR Module

NPEND,NGOUT... The user must supply either a PENDF tape, NPEND, or a GENDF tape, NGOUT, with processed pointwise or groupwise data produced by another NJOY module. Group cross sections need not be in the same group structure as the requested output covariances, although, if the input group structure is much coarser than the output structure, rather crude approximations will be made in deriving an effective set of fine-group cross sections from the coarse input data.

NIN,NOUT... Although ERRORR lacks an explicit multimaterial loop, the same effect can be achieved by executing a series of ERRORR runs, with the output covariance tape NOUT of one run becoming the input covariance tape NIN of the next. Only two unit numbers need be employed, with the data going back and forth between them until the multimaterial library is complete. To save time, binary files should be used for this purpose.

IREAD... For Version V, the list of reactions for which covariances are produced is constructed in one of several ways, depending on the value of IREAD. If IREAD=0, the reaction list is assumed to be identical to the list of sections contained in file 31 or file 33 (see MFCOV below). If IREAD=1, only the "covariance" reactions specifically named by the user will be included in the reaction list. For certain applications, this option can save considerable execution

time. In either case, IREAD=0 or 1, a complete set of covariance matrices is output. That is, covariance matrices are produced for every reaction-pair combination that can be formed from the given reaction list. For those reaction pairs where the evaluator has not specified the covariances, the output matrix contains only zeros. If IREAD=2, the reaction list is initially constructed in the same way as for IREAD=0. This list is then supplemented with a list of extra reactions $MAT1_k/MT1_k$ ($MAT1_k \neq MATD$), specified by the user. The output in this case contains matrices for all of the ($MATD/MT_i$; $MATD/MT_j$) combinations, as before, plus matrices for all ($MATD/MT_i$; $MAT1_k/MT1_k$) combinations. However, covariances among the extra reactions, that is ($MAT1_k/MT1_k$; $MAT1_m/MT1_m$), are not computed. In an evaluation containing cross-material covariances, subsections involving the "other" materials will be ignored if IREAD=0 or 1. These subsections can be selectively processed by specifying IREAD=2. Input for a sample problem that illustrates the use of IREAD=2 is given in the next section.

MFCOV... This parameter is used to specify whether covariances of fission $\bar{\nu}$ (MFCOV=31) or cross sections (MFCOV=33) are needed. If MFCOV=31, it is necessary to supply multigrouped $\bar{\nu}$ values on a GENDF tape (that is, NPEND must be 0); the sample problem below shows the calculational sequence required. MFCOV=32 is reserved for a planned future capability to compute uncertainties in self-shielded cross sections. If MFCOV=33, the contribution of the uncertainty in individual resonance parameters (file 32) is included in the calculated uncertainty in infinite-dilution group cross sections.

Given below is the complete NJOY input for a calculation of a multigroup $\bar{\nu}$ covariance library (^{238}U part only).

```
0
5
*MODER*/ MOUNT ENDF TAPES 515, 516, and 555 ON UNITS 20, 21, AND 22.
1 -23
*ENDF/B-V NUBAR COVARIANCE MATERIALS*/
20 1380
20 1381
21 1390
22 1395
22 1398
20 1399
0/
*MODER*/ COPY ENDF FOR USE AS A PENDF.
-23 -24
*GROUPR*/ PREPARE GENDF WITH MULTIGROUPED NUBARS.
-23 -24 0 25
```

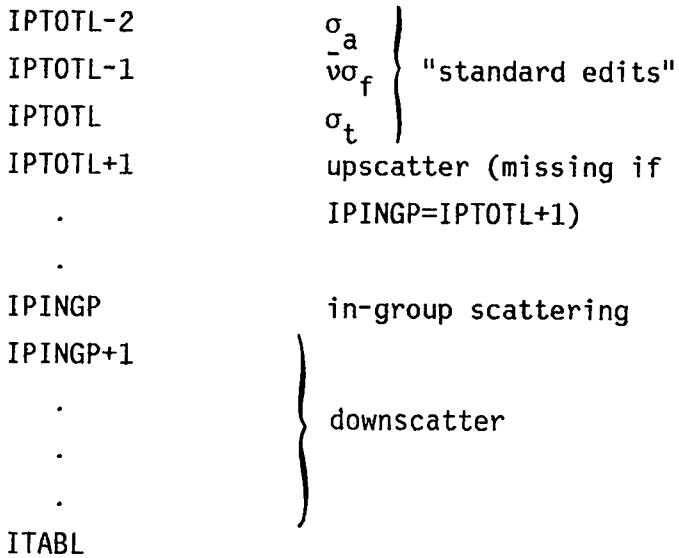
```
1380 3 0 3 0 1 1 0
*BIG3 + 2 NUBAR*/
0.
1.E10
3 452 *TOTAL NUBAR*/
0/
1381
3 452 *TOTAL NUBAR*/
0/
1390
3 452 *TOTAL NUBAR*/
0/
1395
3 452 *TOTAL NUBAR*/
0/
1398
3 452 *TOTAL NUBAR*/
3 455 *DELAYED NUBAR*/
3 456 *PROMPT NUBAR*/
0/
1399
3 452 *TOTAL NUBAR*/
0/
0/
*ERROR*/ PREPARE MULTIGROUP NUBAR COVARIANCE LIBRARY.
-23 0 25 26/
1398 19 1 1
2 31
1380 452
1381 452
1390 452
1395 452
1399 452
0/
1
1.E7 1.7E7
*STOP*
```

Note the use of the MODER module to prepare a special ENDF tape containing selected evaluations from other ENDF tapes. Because only high-energy $\bar{\nu}$ data is requested (10-17 MeV), it is unnecessary to use RECONR to prepare a PENDF tape for GROUPR. A copy of the ENDF tape is used instead.

I. DTFR Module

IPTOTL,IPINGP,ITABL,NED... The standard transport table as used in many codes has the following structure for each group.

Position	Contents
1	response function edit
.	cross sections (missing
.	if IPTOTL=3)



If IEDIT=1, the first NED positions are printed out as separate tables. If there is not enough room for all the downscatter between IPINGP and ITABL, the array is truncated in such a way as to preserve the scattering cross section; a similar procedure is used for upscatter.

NTHERM,MTI,MTC,NLC... These parameters control the addition of thermal upscatter to the transport table. In the lowest NTHERM groups, the static elastic scattering is replaced by MTI and the total is readjusted appropriately. If MTC is requested, it is added to the in-group of the appropriate tables and the total is increased by MTC.

JPOS,MT,MULT... This system allows the user to specify a response function that is any linear combination of the vector cross sections processed by GROUPR. Before reaction MT is added into JPOS, it is multiplied by MULT. For example, total helium production in ENDF/B-IV ^{12}C is (n,α) + 3 × (n,n')3α and is formed by the cards

```
*N.HE4*/
 1 107 /
 1  91 3/
```

with NED=2 and IPTOTL=1+3=4.

Several special values are recognized by DTFR.

MT	Meaning
300	P_0 flux
470	fission χ (steady-state)
471	delayed χ
455	delayed $\bar{\nu}$

J. CCCCR

NGGRUP,MAXUP... In the current version of the code, these parameters should both be zero. There is no coding for photon files and no provision for upscatter.

ICHIX... Either a vector χ or a matrix χ can be produced by isotope; for vectors, the GROUPR fission matrix can be collapsed with the library flux or an input flux. There is no provision for a set χ vector or χ matrix.

IFOPT,NSBLK... Several options are available for blocking and subblocking matrices. For large group structures, IFOPT=1 and NSBLK=NGROUP are recommended.

K. MATXSR

NTYPE,NPART... A MATXS file can include any or all of four "types" of data; neutron cross sections and transfer matrices ("NSCAT"), gamma production matrices ("NGAMA"), photon interaction cross sections and transfer matrices ("GSCAT"), and thermal neutron scattering ("NTHERM"). Depending on which data types are desired, group structures will be required for neutron ("NEUT") or photons ("GAMA") or both.

HTYPE,HPART,HMAT... Data types, particles, materials (and reactions) are identified by Hollerith names rather than integer flags as in the CCCC formats. Data type and particle names are left-justified.

```
*NSCAT *
*NEUT  *
```

The MATXSR user need not be concerned with conventions for naming reactions, as this is handled automatically.

In a typical MATXS run, the first several cards of input might be these.

```
-21    -22     23
  1      1     *T2LASL NJOY*/
  2      3      4
  * */
  *TYPICAL MATXS RUN WITH THREE DATA TYPES*/
  *BASIC DATA FROM ENDF/B-IV*/
  * */
  *NEUT *      *GAMA  */
 30     12
  *NSCAT*      *NGAMA*   *GSCAT */
```

In this example, three data types are requested for a MATXS file on unit 23. Neutron interaction and gamma production data (in blocked binary) are input from unit 21 and photon interaction data (in blocked binary) are to be found on unit 22. The code expects to find input data averaged over 30 neutron groups and 12 photon groups. Four cards of Hollerith identification are given.

Card input for the first data type ("NSCAT") is given next.

```
1    1    4    3
1
1
*H   1 *   1    1   1269
*FENAT *   5    2   1192
*PU240 *   1    1   1265
```

The code will search through unit 21 for MAT=1269, and output data for the first temperature and dilution factor under the name *H 1 *. The output for *FENAT * will include the first five temperatures and the first two dilution factors for MAT=1192. Particle one ("NEUT") is specified as both the incident (IINP) and outgoing (IOUTP) particles.

Input for the final two data types might be as follows.

```
1    1    4    3
1
2
*H   1 *   1    1   1269
*FENAT *   5    2   1192
*PU240 *   1    1   1265
1    1    4    3
2
2
*H    *    1    1      1
*FE   *    1    1     26
*PU   *    1    1     94
```

Note that for photon interaction data (GSCAT), all evaluations are elemental.

IFOPT,NSBLK... These parameters control the size of the matrix records on the MATXS file. If IFOPT=1 and NSBLK=1, then a single record contains all Legendre orders of the entire scattering matrix for a given reaction. The choice of IFOPT=2 separates each Legendre order into a separate record. The NSBLK parameter may be set equal to the number of groups (NOUTG) for the outgoing particle, and each group will be a separate record.

IV. SAMPLE PROBLEMS

The sample problems are designed to demonstrate the major options of NJOY without using too much computer time. For the convenience of the reader, parts of the sample problem output are reproduced in Appendix C. Complete output is available on special request for use in checking an installation of NJOY.

A. Example 1

This run tests group averaging and pointwise file generation for a light isotope (ENDF/B-V carbon). Linearization, Doppler broadening, thinning, heat

production, and thermal scattering are included. ENDF/B tapes 511 and 322 are required.

In RECONR, the addition of 127 points by linearization to the 776 points in the initial union grid gives 903 points, which can be seen in BROADR and in MF3/MT1 on the PENDF tape. In BROADR, only MT2 (elastic) and MT102 (radiative capture) are broadened. Thinning does not remove many points because these cross sections are relatively smooth.

The HEATR run adds both total heat production (MT301) and total damage energy production (MT444) to the PENDF tape, as can be seen by the list of reactions in MF1/MT451. There are two THERMR runs: the first one computes cross sections and matrices for free carbon atoms and stores the results under MT221, and the second run computes both coherent elastic and incoherent inelastic scattering for graphite using MT230 and MT229, respectively. The effective normal temperature shown is the default value. Also note that THERMR uses the 296 K data from tape 322 to satisfy the request for 300 K data.

In the GROUPR run, note that the "LR-flags" on MT52-91 were picked up; these sections provide a "pseudo level" representation of the $(n,n')3\alpha$ reaction. The LR-flag was also processed in HEATR. Note that heating and damage (MT301, MT444) are processed in the same way as any other ENDF/B reaction. The thermal data shown here (MT221,229,230) are supplementary; they are not included in MT=1. Subsequent codes such as DTFR must replace MT2 with MT221 or MT229,230 in the thermal range (groups 1-4) and revise the total accordingly. Caution: GROUPR numbers groups in order of increasing energy.

On the PENDF tape, note that the dictionary and comments are updated. The format used for MF=6 is specially designed for NJOY thermal data. The file uses a "TAB2" record to set up a loop over incident energy (52 points). At each energy (1.E-5, 3.16E-5, etc.), a "LIST" record is given that contains N1 (that is, 640) words organized on a cycle of N2 (that is, 10) words. Each cycle contains a secondary energy, a scattering probability, and 8 equally probable scattering cosines.

B. Example 2

This run processes one isotope for a practical CCCC library. It tests resonance reconstruction, Doppler broadening to several temperatures, unresolved cross sections, self-shielded multigroup cross sections, and CCCC-IV interface files (ISOTXS, BRKOXS, and DLAYXS). Tape 404 is required.

Because this is a resonance material, RECONR includes a table of estimated errors in the resonance integrals due to significant figure reduction and the

resonance-integral thinning criteria. In this material, these errors are negligible, but note that 547 energy intervals were affected by the integral check, and 73 energy points were only one significant figure apart for NDIGIT=6. Additional points were removed from the final grid by "back-thinning" to the specified reconstruction tolerance. The BROADR run in this example generates several output temperatures. Each one is written as a separate material on the PENDF tape. Note that the zero-Kelvin cross sections do not appear on tape 23; also note the smoothing effect of Doppler broadening on "POINTS OUT." On the UNRESR listing, effective self-shielded cross sections are given for each energy with σ_0 horizontally and reaction vertically (P_0 total, elastic, fission, capture, P_1 total). The σ_0 list in UNRESR does not have to agree with the σ_0 list in GROUPR.

In GROUPR, it was only necessary to request those reactions with appreciable temperature dependence at the higher temperatures. These normally include MT=1, 2, 18, 19, 102, 301, and 201-250. Also, MT259 is requested to get accurate group-averaged velocities for ISOTXS. In CCCCR, the option to block matrices by group was used. This is the best form for large group structures. The isotope fission chi was produced using the GROUPR flux to collapse the fission matrix. Note also that the BRKOXS file includes shielding factors for elastic removal. XSPO in BRKOXS is simply $4\pi a^2$ using the scattering length from MF2.

C. Example 3

The run demonstrates the generation of photon interaction cross sections with DTF and MATXS output. The photon interaction tape DLC7E is required.*

First, a RECONR run is used to linearize the cross sections. This example illustrates a multiple isotope run. The GAMINR run uses the standard list of reactions. Note how the photon heat production is assembled from the partial reactions and written out as MT=621. In DTFR, the code automatically shifts over to photons when it sees MT501, so read "PHOTON" instead of "NEUTRON" on this listing. Note that one special edit is provided for heating in eV·barns, so the table length is set to 1+3+12=16, and the position of the total is 1+3=4. In these tables, the first 16 numbers are the positions for the first (highest energy) photon group, and so on for the other groups. That is, the group numbering has been restored to the conventional order.

*Available from the Radiation Shielding Information Center at the Oak Ridge National Laboratory, Oak Ridge, Tennessee.

The MATXS listing is fairly self-explanatory. Once again, the groups are numbered in the conventional order. In an isotropic matrix, such as "GPAIR" (gamma pair production), groups are given in the DTF ordering; that is; 10←9, 10←8, 10←7, etc. Also note the "INDEX" at the end of the listing. It provides a concise reference to all the materials and reactions on the library.

D. Example 4

This run demonstrates NJOY's capability to produce cross-section covariances from ENDF/B data. Tape 511 is used. The material processed is the ENDF/B-V "standards" material ^{235}U.

After converting the mode of the ENDF tape, the RECONR module is used to prepare a PENDF file on unit 22. Note that very coarse tolerances (ERR, ERRMAX, ERRINT) are used. Because only relative covariances are given in this evaluation (that is, there are no sub-subsections with LB=0), the output multigroup relative covariances from the ERRORR module are nearly independent of the cross-section magnitudes; hence, high accuracy is not needed in the resonance reconstruction calculation.

The first ERRORR run operates directly on the PENDF file and produces cross-section covariances (MFCOV=33). The multigroup energy structure includes 1 and 1000 eV, plus any energies in the ENDF file 33 that fall between these limits. This group-structure option (IGN=19) is very useful for test purposes, such as preparing covariance plots of ENDF data using the ERRORR and COVR modules. Because of the use of IGN=19, and because the evaluator has used LB=5, which in a sense is already processed, many of the output numbers here are identical with ENDF entries. (For example, compare the first line of the printed relative covariances with line 10 057 of MAT1395.)

Next, the GROUPR module is used to prepare a GENDF file containing 30-group (IGN=3) fission $\bar{\nu}$ values. This GENDF (on unit 24) is then used as input to a second ERRORR run, in which the ENDF file 31 ($\bar{\nu}$ covariances) is processed (MFCOV=31). In this case, a user-specified 7-group structure is employed. Note that the resulting multigroup $\bar{\nu}$ covariances are added to the cross-section covariances written on unit 23 in the previous ERRORR run, to make a new ERRORR output file on unit 25.

V. PROGRAM DETAILS

The programming details, calculational methods, and theories used by the modules of NJOY are discussed in detail in subsequent volumes of this report. The following sections provide a general overview.

A. Programming Language

NJOY uses ANSI-standard FORTRAN-IV with a few exceptions (for example, CDC overlay commands, mixed-mode arithmetic, expressions as array indices). Machine-dependent functions such as timers, input/output, and character manipulation are isolated in special subroutines. The resulting code, with minor modifications, has been compiled using CDC, CRAY, IBM, and UNIVAC compilers. Some loops have been rearranged to facilitate vectorization.

B. Storage Allocation

Variable dimensioning and dynamic storage allocation are used extensively to provide efficient use of the main memory; an easy-to-use system of subroutines called STORAG reserves, releases, retrieves pointers, and repacks stored data when necessary. With this system, most variables are stored in a large container array for each module. In the reference version of NJOY, the container arrays have been chosen for the efficient use of about $150\ 000_8$ words. For many problems, the size of these arrays can be decreased. Increasing the number of words available, if possible, will make BROADR run faster. Dynamic storage allocation leads to a complex set of trade-offs, such as number of groups versus Legendre order in GROUPR. In addition, a few fixed limits remain, such as 620 groups, 10 temperatures, and 10 σ_0-values in GROUPR. Diagnostic messages are provided when any limits are exceeded. The current allocations have been adequate for all practical problems attempted to date.

C. Running Time

Typical run times are difficult to quote for such a complex system. Tables II and III give CRAY-1 times for practical problems.* These are central-processor times plus an approximately 30% surcharge for memory and I/O.

A few general principles may help the user to guess times for his jobs. The pointwise modules RECONR, BROADR, and HEATR require time proportional to the number of energy points in the cross sections, hence the number of resonances. UNRESR depends mostly on the number of energy points in MF2, MT151. In GROUPR, the time required for vectors depends on the number of energy points, but not on the number of groups, and only weakly on the number of σ_0 values requested. The matrix time does increase with the number of groups. Even more important is the energy range--discrete inelastic reactions require much more time if many groups above 10 MeV are requested, due to the extreme anisotropy found there.

*NJOY runs about 1.6 times faster on the CRAY-1 than on the CDC-7600.

TABLE II

POINTWISE PROCESSING TIMES FOR
SEVERAL MATERIALS BY MODULE
(approximate CP + I/O in seconds for CRAY-1)

Module	H-1	C-NAT	Fe-NAT	U-235	U-238
RECONR[a]	5	6	160	55	572
BROADR[b]	7	13	190	147	1500
UNRESR				400	210
HEATR	50	65[c]	540[c]	290	633
THERMR	400[d]	450[e]	170	120	208

a. 0.2% tolerance

b. 4 to 7 temperatures

c. With damage

d. In water

e. In graphite

TABLE III

ADDITIONAL TYPICAL PROCESSING TIMES FOR NJOY
(approximate CP + I/O in seconds for CRAY-1)

Processing Task	Time
C-NAT GROUPR (80 neutron groups, 24 photon groups, T = 300 K, σ_0 = 1E10)	220
C-NAT GROUPR (30 neutron groups, 12 photon groups, 300 K, infinite dilution)	145
Fe-NAT GROUPR (80 x 24, 6 temperatures, 6 dilutions)	1960
U-238 GROUPR (80 x 24, 7 temperatures, 7 dilutions)	2100
Complete 24-group photon interaction GAMINR run for all elements	2710

This code is extremely "I/O bound." Run times can often be reduced by requesting larger input/output buffers from the system. The blocked-binary mode should be used whenever possible. Also, I/O time in BROADR can be reduced by allocating more storage if available (see /STORE/ and NAMAX in BROADR).

VI. CODE CONVERSION

The reference version of NJOY operates on CDC-7600 equipment at Los Alamos. The code includes comment cards that allow many of the changes required to convert to an IBM system to be made very simply. A typical comment-card example follows.

```
      .
      .
      .
CCDC
      INTEGER H(5)
CCDC
CIBM
C     REAL*8 H(5)
CIBM
      .
      .
      .
      .
```

In the (10/81) version there are 146 such blocks of CDC machine-dependent coding and 177 blocks of IBM coding. To convert to IBM form, insert a "C" in column 1 of all card images bracketed with "CCDC" cards, and remove the "C" from column 1 of all cards bracketed by "CIBM" cards. This can be done with a simple preprocessing program such as the one listed in Appendix D.

Additional changes may be required in BANNER (time, date, machine), ERROR (system fatal exit, traceback), character handling for free-form input (FREE, PACK), input/output routines (OPENZ, CLOSEZ, REPOZ, SKIPRZ, REED, RITE), and mathematical subroutines (E1,GAMI). The largest group of system-dependent routines has to do with plotting. COVR uses the DISSPLA software system, which is available at many installations. DTFR uses a local SC-4020 library, which is not widely available; however, the plotting calls have been left in the code as a guide for the conversion to other systems.

As a demonstration of portability, versions of NJOY have been installed on the following machines (operating systems): CDC-7600 (LTSS) and CRAY-1 (CTSS) at Los Alamos National Laboratory, CDC-7600 (LTSS) at the Magnetic Fusion Energy

Computing Center at Lawrence Livermore National Laboratory, CDC-7600 (SCOPE) at the Brookhaven National Laboratory, IBM-360/195 (MTD/FTX) at Argonne National Laboratory, UNIVAC-1108 at the Hanford Engineering Development Laboratory of Westinghouse, and the IBM-360/195 at the Oak Ridge National Laboratory.

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APPENDIX A

INPUT INSTRUCTIONS

Los Alamos Identification No. LP-795

```
**********************************************************************
*                                                                    *
* NJOY NUCLEAR CROSS SECTION PROCESSING SYSTEM                       *
*     VERSION 10/81                                                  *
*                                                                    *
**********************************************************************
*                                                                    *
* NJOY IS A SYSTEM OF PROCESSING MODULES INTENDED TO CONVERT         *
* ENDF/B VERS. IV OR V CROSS SECTION DATA INTO FORMS USEFUL          *
* FOR PRACTICAL APPLICATIONS.                                        *
*                                                                    *
* RECONR...RECONSTRUCT POINTWISE CROSS SECTIONS FROM ENDF/B          *
*     RESONANCE PARAMETERS AND INTERPOLATION SCHEMES.                *
*                                                                    *
* BROADR...DOPPLER BROADEN AND THIN POINTWISE CROSS SECTIONS.        *
*                                                                    *
* UNRESR...COMPUTE EFFECTIVE POINTWISE SELF-SHIELDED CROSS           *
*     SECTIONS IN THE UNRESOLVED ENERGY RANGE.                       *
*                                                                    *
* HEATR...COMPUTE HEAT PRODUCTION CROSS SECTIONS (KERMA)             *
*     AND DAMAGE ENERGY PRODUCTION.                                  *
*                                                                    *
* THERMR...GENERATE NEUTRON SCATTERING CROSS SECTIONS AND            *
*     POINT-TO-POINT SCATTERING KERNELS IN THE THERMAL RANGE         *
*     FOR FREE OR BOUND ATOMS.                                       *
*                                                                    *
* GROUPR...GENERATE SELF-SHIELDED MULTIGROUP CROSS SECTIONS AND      *
*     GROUP-TO-GROUP SCATTERING AND PHOTON PRODUCTION MATRICES.      *
*                                                                    *
* GAMINR...COMPUTE MULTIGROUP PHOTON INTERACTION CROSS SECTIONS,     *
*     SCATTERING MATRICES, AND HEAT PRODUCTION.                      *
*                                                                    *
* ERRORR...CONSTRUCT MULTIGROUP COVARIANCE MATRICES.                 *
*                                                                    *
* COVR...PROCESS COVARIANCE DATA FROM ERRORR                         *
*                                                                    *
* MODER...CONVERT BETWEEN ENDF/B STANDARD CODED MODE AND THE         *
*     NJOY BLOCKED BINARY MODE.                                      *
*                                                                    *
* DTFR...OUTPUT AND PLOT MULTIGROUP DATA FOR DISCRETE ORDINATES      *
*     TRANSPORT CODES.                                               *
*                                                                    *
* CCCCR...FORMAT MULTIGROUP DATA INTO THE CCCC STANDARD              *
*     INTERFACE FILES ISOTXS, BRKOXS, AND DLAYXS.                    *
*                                                                    *
* MATXSR...CONVERT MULTIGROUP DATA INTO THE COMPREHENSIVE MATXS      *
*     CROSS SECTION INTERFACE FORMAT.                                *
*                                                                    *
* ACER...PREPARE LIBRARY FOR THE LOS ALAMOS CONTINUOUS ENERGY        *
*     MONTE-CARLO CODE MCNP.                                         *
*                                                                    *
* POWR...CONVERT MULTIGROUP DATA INTO LIBRARIES FOR THE THERMAL      *
*     POWR REACTOR CODES EPRI-CELL AND EPRI-CPM.                     *
*                                                                    *
* EACH MODULE IS A SEPARATE OVERLAY.  THE MAIN PROGRAM CONTROLS      *
* THE ORDER IN WHICH MODULES ARE USED AND CONTAINS UTILITY           *
* SUBROUTINES USED BY ALL MODULES.                                   *
*                                                                    *
*---INPUT SPECIFICATIONS (FREE FORMAT)-----------------------------*
*                                                                    *
* CARD1       INPUT OPTION                                           *
*    IOPT     0 FOR CARD INPUT AND FULL OUTPUT.                      *
*             1 FOR TERMINAL INPUT WITH SHORT OUTPUT ON TERMINAL     *
* CARD2                                                              *
```

```
*    IVERF     ENDF/B VERSION NUMBER (4 OR 5 ONLY)                *
* CARD 3                                                          *
*    MOPT      SIX CHARACTER MODULE NAME DELIMITED WITH *,         *
*              E.G., *RECONR* (ONLY FIRST FOUR CHARACTERS ARE     *
*              USED).  REPEAT FOR EACH MODULE DESIRED).  USE      *
*              *STOP* TO TERMINATE PROGRAM.                       *
*                                                                 *
* SEE THE COMMENTS AT THE START OF EACH MODULE FOR                *
* ITS SPECIFIC INPUT INSTRUCTIONS.                                *
*                                                                 *
*---CODE CONVERSION-----------------------------------------------*
*                                                                 *
* CONVERSION FROM CDC TO IBM OR BACK IS CONTROLLED BY THE COMMENT*
* CARDS CCDC AND CIBM.  TO CONVERT FROM CDC TO IBM, PUT A C IN    *
* COLUMN 1 OF EVERY LINE BETWEEN TWO CCDC CARDS AND REMOVE THE C *
* FROM COLUMN 1 OF EVERY LINE BETWEEN TWO CIBM CARDS.  A FEW      *
* REMAINING CHANGES MAY BE NEEDED BECAUSE OF SYSTEM DIFFERENCES   *
* BETWEEN INSTALLATIONS                                           *
*                                                                 *
*******************************************************************

PROGRAM RECONR
*******************************************************************
*                                                                 *
* RECONSTRUCT POINTWISE CROSS SECTIONS                            *
*                                                                 *
* RESONANCE CROSS SECTIONS ARE CALCULATED USING THE METHODS OF    *
* RESEND, WITH MODIFICATIONS TO THE METHOD OF GENERATING THE      *
* ENERGY GRID AND THE METHOD OF COMBINING RESONANCE AND           *
* BACKGROUND CROSS SECTIONS.                                      *
*                                                                 *
* THIS PROGRAM GENERATES AN ENERGY GRID WHICH IS THE UNION OF     *
* AN INPUT GRID (IF ANY), THE RESONANCE ENERGIES (IF ANY), AND    *
* THE ENERGIES OF CROSS SECTIONS IN MF3 AND MF13 (OR MF23).       *
* THE POINTWISE CROSS SECTIONS ARE THEN COMPUTED ON THIS GRID     *
* AND POINTS ARE ADDED SO THAT THE RESONANCE CROSS SECTIONS AND   *
* ANY CROSS SECTIONS REPRESENTED BY NON-LINEAR INTERPOLATION      *
* ARE REPRODUCED WITHIN A SPECIFIED TOLERANCE BY LINEAR INTER-    *
* POLATION.  PSI-CHI RECONSTRUCTION CAN BE USED IF DESIRED.       *
* SECTIONS WHICH ARE NOT CROSS SECTIONS (MU,NU) AND PHOTON        *
* MULTIPLICITIES (MF12) ARE NOT PROCESSED.  REDUNDANT REACTIONS   *
* ARE RECONSTRUCTED TO BE THE SUM OF THEIR PARTS.  THE PENDF      *
* TAPE CONTAINS POINT CROSS SECTIONS IN MF3 AND MF13 (OR MF23)    *
* AND A DESCRIPTION OF THE PROCESSING IN MF1.  THE MF1 DICTION-   *
* ARY IS UPDATED.  THE C1 AND C2 FIELDS OF THE SECOND CARD IN     *
* MF1 CONTAIN THE TEMPERATURE AND RECONSTRUCTION TOLERANCE        *
* RESPECTIVELY.  AN MF2 APPROPRIATE TO NO RESONANCE PARAMETERS    *
* IS CONSTRUCTED WITH THE POTENTIAL SCATTERING LENGTH ADDED.      *
*                                                                 *
*---INPUT SPECIFICATIONS (FREE FORMAT)----------------------------*
*                                                                 *
* CARD 1                                                          *
*    NENDF     UNIT FOR ENDF/B TAPE                               *
*    NPEND     UNIT FOR PENDF TAPE                                *
* CARD 2                                                          *
*    LABEL     66 CHARACTER LABEL FOR NEW PENDF TAPE              *
*              DELIMITED WITH *, ENDED WITH /.                    *
* CARD 3                                                          *
*    MAT       MATERIAL TO BE RECONSTRUCTED                       *
*    NCARDS    NUMBER OF CARDS OF DESCRIPTIVE DATA FOR NEW MF1    *
*              (DEFAULT=0.)                                       *
*    NGRID     NUMBER OF USER ENERGY GRID POINTS TO BE ADDED.     *
*              (DEFAULT=0.)                                       *
```

```
* CARD 4                                                              *
*    ERR       FRACTIONAL RECONSTRUCTION TOLERANCE USED WHEN          *
*              RESONANCE-INTEGRAL ERROR CRITERION (SEE ERRINT)        *
*              IS NOT SATISFIED.                                      *
*    TEMPR     RECONSTRUCTION TEMPERATURE (DEG KELVIN)                *
*              (DEFAULT=0.)                                           *
*    NDIGIT    NO. SIGNIFICANT DIGITS (DEFAULT=6)                     *
*    ERRMAX    FRACTIONAL RECONSTRUCTION TOLERANCE USED WHEN          *
*              RESONANCE-INTEGRAL ERROR CRITERION IS SATISFIED        *
*              (ERRMAX.GE.ERR, DEFAULT=20.*ERR)                       *
*    ERRINT    MAXIMUM RESONANCE-INTEGRAL ERROR (IN BARNS)            *
*              PER GRID POINT (DEFAULT=ERR/10000)                     *
* CARD 5                                                              *
*    CARDS     NCARDS OF DESCRIPTIVE COMMENTS FOR MT451               *
*              EACH CARD DELIMITED WITH *, ENDED WITH /.              *
* CARD 6                                                              *
*    ENODE     USERS ENERGY GRID POINTS                               *
*       CARDS 3, 4, 5, 6 MUST BE INPUT FOR EACH MATERIAL DESIRED      *
*       MAT=0/ TERMINATES EXECUTION OF RECONR.                        *
*                                                                     *
**********************************************************************

PROGRAM BROADR
**********************************************************************
*                                                                    *
* DOPPLER BROADEN AND THIN NEUTRON POINT CROSS SECTIONS              *
*                                                                    *
* A MODIFIED VERSION OF THE KERNEL BROADENING METHOD DEVELOPED       *
* FOR SIGMA1 (D.E.CULLEN, LLNL) IS USED.  CROSS SECTIONS             *
* FOR LOW THRESHOLD REACTIONS ARE UNIONIZED ON THE GRID OF THE       *
* TOTAL CROSS SECTION, THEN BROADENED AND THINNED IN PARALLEL.       *
* HIGH THRESHOLD REACTIONS ARE NOT BROADENED.  THE RESULTS ARE       *
* WRITTEN OUT IN PENDF FORMAT WITH EACH TEMPERATURE REPRESENTED      *
* AS A DIFFERENT MAT.  DICTIONARIES ARE CORRECTED TO REFLECT         *
* UNIONIZATION AND THINNING.  FOR HIGH TEMPERATURES AND LOW          *
* ENERGIES WHERE THE METHOD OF SIGMA1 BREAKS DOWN, A NEW DIRECT      *
* EXPANSION OF THE DOPPLER INTEGRAL IS USED.                         *
*                                                                    *
*---INPUT SPECIFICATIONS (FREE FORMAT)-----------------------------*
*                                                                    *
* CARD 1                                                             *
*    NIN       INPUT PENDF TAPE                                      *
*    NOUT      OUTPUT PENDF TAPE                                     *
* CARD 2                                                             *
*    MAT1      MATERIAL TO BE PROCESSED                              *
*    NTEMP2    NUMBER OF FINAL TEMPERATURES (MAXIMUM=6)              *
*    ISTART    RESTART (0 NO, 1 YES)                                 *
*    ISTRAP    BOOTSTRAP (0 NO, 1 YES)                               *
*    TEMP1     STARTING TEMPERATURE FROM NIN                         *
*    ERRTHN    FRACTIONAL TOLERANCE FOR THINNING                     *
*    THNMAX    MAX. ENERGY FOR BROADENING AND THINNING               *
*              (DEFAULT=1 MEV)                                       *
* CARD 3                                                             *
*    TEMP2     FINAL TEMPERATURES (DEG KELVIN)                       *
* CARD 4                                                             *
*    MAT1      NEXT MAT NUMBER TO BE PROCESSED WITH THESE            *
*              PARAMETERS.  TERMINATE WITH MAT1=0.                   *
*                                                                    *
*---INPUT OPTIONS--------------------------------------------------*
*                                                                    *
* THE OUTPUT TAPE WILL CONTAIN THE NTEMP2 FINAL TEMPERATURES         *
* SPECIFIED.  IT IS NECESSARY TO HAVE TEMP1.LE.TEMP2(1).             *
* IF TEMP2.EQ.TEMP1, THE DATA WILL BE THINNED ONLY.                  *
```

```
*                                                                     *
* RESTART    CONTINUE BROADENING AN EXISTING PENDF TAPE.  ALL        *
*            TEMPERATURES ARE COPIED THROUGH TEMP1.  ADDITIONAL      *
*            FINAL TEMPERATURES ARE ADDED BY STARTING WITH THE       *
*            DATA AT TEMP1.                                          *
*                                                                    *
* BOOTSTRAP  IF BOOTSTRAP IS NOT REQUESTED, EACH FINAL TEMPERA-      *
*            TURE IS GENERATED BY BROADENING DIRECTLY FROM           *
*            TEMP1 TO TEMP2.  IF BOOTSTRAP IS REQUESTED, EACH        *
*            FINAL TEMPERATURE IS BROADENED FROM THE PRECEDING       *
*            TEMPERATURE.  THIS OPTION IS FASTER DUE TO THE          *
*            THINNING IN THE PREVIOUS STEP.  HOWEVER, ERRORS         *
*            ACCUMULATE.                                             *
*                                                                    *
**********************************************************************

PROGRAM UNRESR
**********************************************************************
*                                                                    *
* COMPUTE UNRESOLVED RESONANCE CROSS-SECTIONS                        *
*                                                                    *
* THE METHOD OF ETOX IS USED TO COMPUTE SELF-SHIELDED                *
* UNRESOLVED RESONANCE CROSS-SECTIONS ON THE ENERGY GRID OF          *
* THE UNRESOLVED PARAMETERS.  SUBSEQUENT INTERPOLATION IS            *
* TO BE ON THE CROSS-SECTIONS AND NOT ON THE PARAMETERS.             *
* ADDITIONAL ENERGY GRID POINTS ARE ADDED AT QUARTER LETHARGY        *
* INTERVALS IF ONLY THREE OR FEWER GRID POINTS ARE FOUND.            *
* THE ACCURATE HWANG QUADRATURE SET IS USED FOR THE INTEGRALS.       *
*                                                                    *
*---INPUT SPECIFICATIONS (FREE FORMAT)-----------------------------*
*                                                                    *
* CARD 1                                                             *
*   NENDF    UNIT FOR ENDF/B TAPE                                    *
*   NIN      UNIT FOR INPUT PENDF TAPE                               *
*   NOUT     UNIT FOR OUTPUT PENDF TAPE                              *
* CARD 2                                                             *
*   MATD     MATERIAL TO BE PROCESSED                                *
*   NTEMP    NO. OF TEMPERATURES (MAX. NO. ALLOWED=9)                *
*   NSIGZ    NO. OF SIGMA ZEROES (MAX. NO. ALLOWED=8)                *
*   IPRINT   PRINT OPTION (0=MIN, 1=MAX) (DEFAULT=0)                 *
* CARD 3                                                             *
*   TEMP     TEMPERATURES IN KELVIN (INCLUDING ZERO)                 *
* CARD 4                                                             *
*   SIGZ     SIGMA ZERO VALUES (INCLUDING INFINITY)                  *
*       CARDS 2, 3, 4 MUST BE INPUT FOR EACH MATERIAL DESIRED        *
*       MATD=0/ TERMINATES EXECUTION OF UNRESR.                      *
*                                                                    *
**********************************************************************

PROGRAM HEATR
**********************************************************************
*                                                                    *
* COMPUTE HEATING KERMA (KINETIC ENERGY RELEASE IN MATERIAL)         *
* AND RADIATION DAMAGE ENERGY PRODUCTION                             *
*                                                                    *
* THE PROMPT KERMA IS COMPUTED POINTWISE ON THE GRID OF THE          *
* TOTAL CROSS SECTION FROM THE INPUT PENDF TAPE AND WRITTEN          *
* ONTO THE OUTPUT PENDF TAPE AT INFINITE DILUTION USING THE          *
* 300 SERIES OF MT NUMBERS.  ALL TEMPERATURES ON THE INPUT PENDF     *
* TAPE FOR THE DESIRED MATERIAL ARE PROCESSED.  THE DICTIONARY       *
* IS REVISED.  REACTION Q VALUES ARE OBTAINED FROM THE ENDF/B        *
* TAPE UNLESS THE USER ENTERS HIS OWN VALUE.  PARTIAL KERMAS         *
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* CAN BE REQUESTED FOR SELF-SHIELDING CALCULATIONS OR OTHER       *
* PURPOSES.  THE CODE USES THE ENERGY BALANCE METHOD WHERE        *
* PHOTON FILES ARE AVAILABLE AND DEPOSITS ALL PHOTON ENERGY       *
* LOCALLY WHEN FILES ARE NOT AVAILABLE.  THIS ASSURES             *
* CONSISTENCY BETWEEN NEUTRON HEATING AND ENERGY DEPOSITION BY    *
* SUBSEQUENT PHOTON INTERACTIONS.  AN EXCEPTION IS MADE FOR       *
* CAPTURE WHERE RECOIL IS COMPUTED BY MOMENTUM CONSERVATION.      *
* PHOTON FILES ARE USED TO ESTIMATE THE AVERAGE PHOTON MOMENTUM   *
* WHEN AVAILABLE.  A DIAGNOSTIC MESSAGE IS PRINTED IF THE         *
* MOMENTUM CALCULATION LEADS TO A SIGNIFICANT ERROR IN            *
* ENERGY CONSERVATION.                                            *
*                                                                 *
* IF DESIRED, THE ENERGY-BALANCE KERMA FACTORS CAN BE COMPARED    *
* WITH CONSERVATIVE KINEMATIC LIMITS (SET IPRINT=2).              *
*                                                                 *
* DAMAGE ENERGY IS COMPUTED USING THE LINDHARD ELECTRONIC         *
* SCREENING DAMAGE FUNCTION WITH A 25 EV DISPLACEMENT             *
* THRESHOLD.                                                      *
*                                                                 *
*---INPUT SPECIFICATIONS (FREE FORMAT)-----------------------------*
*                                                                 *
* CARD 1                                                          *
*    NENDF     UNIT FOR ENDF/B TAPE                               *
*    NIN       UNIT FOR INPUT PENDF TAPE                          *
*    NOUT      UNIT FOR OUTPUT PENDF TAPE                         *
* CARD 2                                                          *
*    MATD      MATERIAL TO BE PROCESSED                           *
*    NPK       NUMBER OF PARTIAL KERMAS DESIRED (DEFAULT=0)       *
*    NQA       NUMBER OF USER Q VALUES (DEFAULT=0)                *
*    NTEMP     NUMBER OF TEMPERATURES TO PROCESS                  *
*              (DEFAULT=0, MEANING ALL ON PENDF)                  *
*    LOCAL     0/1=GAMMA RAYS TRANSPORTED/DEPOSITED LOCALLY       *
*              (DEFAULT=0)                                        *
*    IPRINT    PRINT (0 MIN, 1 MAX, 2 CHECK) (DEFAULT=0)          *
* CARD 3       FOR NPK GT 0 ONLY                                  *
*    MTK       MT NUMBERS FOR PARTIAL KERMAS DESIRED              *
*              TOTAL (MT301) WILL BE PROVIDED AUTOMATICALLY.      *
*              PARTIAL KERMA FOR REACTION MT IS MT+300            *
*              AND MAY NOT BE PROPERLY DEFINED UNLESS             *
*              A GAMMA FILE FOR MT IS ON ENDF TAPE.               *
*              SPECIAL VALUES ALLOWED--                           *
*                303   NON-ELASTIC (ALL BUT MT2)                  *
*                304   INELASTIC (MT51 THRU 91)                   *
*                318   FISSION (MT18 OR MT19, 20, 21, 38)         *
*                401   DISAPPEARANCE (MT102 THRU 120)             *
*              DAMAGE ENERGY PRODUCTION VALUES--                  *
*                444   TOTAL                                      *
*                445   ELASTIC (MT2)                              *
*                446   INELASTIC (MT51 THRU 91)                   *
*                447   DISAPPEARANCE (MT102 THRU 120)            *
*          CARDS 4 AND 5 FOR NQA GT 0 ONLY                        *
* CARD 4                                                          *
*    MTA       MT NUMBERS FOR USERS Q VALUES                      *
* CARD 5                                                          *
*    QA        USER SPECIFIED Q VALUES (EV)                       *
*                                                                 *
*******************************************************************

PROGRAM THERMR
*******************************************************************
*                                                                 *
*  GENERATE NEUTRON SCATTERING CROSS SECTIONS AND POINT-TO-POINT  *
*  SCATTERING KERNELS IN THE THERMAL RANGE                        *
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*                                                                      *
*  ADD POINTWISE SCATTERING CROSS SECTIONS AND SCATTERING              *
*  MATRICES TO AN EXISTING PENDF TAPE.  CROSS SECTIONS ARE             *
*  ADDED TO MF3 AND MATRICES ARE WRITTEN IN MF6 (USING A               *
*  MODIFIED FORMAT).  BOTH USING MTREF FOR INELASTIC AND               *
*  MTREF+1 FOR ELASTIC (IF ANY).                                       *
*  MULTIPLE SCATTERING TYPES (IE, H FREE AND H IN H2O) CAN BE          *
*  WRITTEN ON ONE PENDF TAPE BY USING DIFFERENT VALUES OF MTREF        *
*  FOR EACH THERMR RUN.  IF DATA FOR ONE MTREF IS ALREADY ON           *
*  THE TAPE, IT WILL BE REPLACED WITH THE NEW CROSS SECTIONS.          *
*  THE ENERGY GRID FOR COHERENT SCATTERING IS DETERMINED               *
*  ADAPTIVELY SO AS TO REPRESENT THE SHARP BRAGG EDGES TO              *
*  A SPECIFIED TOLERANCE USING LINEAR INTERPOLATION.  THE              *
*  SECONDARY ENERGY GRID FOR INELASTIC SCATTERING IS ALSO DETER-       *
*  MINED ADAPTIVELY.  ANGULAR DEPENDENCE IS REPRESENTED AS             *
*  EQUALLY PROBABLE COSINES.  THE INITIAL ENERGY GRID IS WIRED IN      *
*  (SEE EGRID IN CALCEM).  A SPECIAL PROJECTION INTERPOLATION          *
*  SCHEME IS USED IN GROUPR TO INTEGRATE THIS RELATIVELY               *
*  COARSE GRID.                                                        *
*  CURRENT CAPABILITIES...                                             *
*     1.)  COMPUTE FREE-GAS SCATTERING MATRICES AND NORMALIZE          *
*          TO THE ELASTIC CROSS SECTION ON THE OLD PENDF TAPE.         *
*     2.)  COMPUTE INCOHERENT MATRICES FROM READ-IN                    *
*          S(ALPHA,BETA) DATA.                                         *
*     3.)  COMPUTE COHERENT SCATTERING FROM HEXAGONAL LATTICES.        *
*     4.)  COMPUTE INCOHERENT ELASTIC SCATTERING.                      *
*  FUTURE CAPABILITIES...                                              *
*     1.)  GENERATE S(ALPHA,BETA) FROM BASIC PHYSICS DATA.             *
*                                                                      *
*---INPUT SPECIFICATIONS (FREE FORMAT)-------------------------------*
*                                                                      *
*  CARD 1                                                              *
*     NENDF       ENDF/B TAPE FOR MF7 DATA                             *
*     NIN         OLD PENDF TAPE                                       *
*     NOUT        NEW PENDF TAPE                                       *
*  CARD 2                                                              *
*     MATDE       MATERIAL DESIRED ON ENDF TAPE                        *
*     MATDP       MATERIAL DESIRED ON PENDF TAPE                       *
*     NBIN        NUMBER OF EQUI-PROBABLE ANGLES                       *
*     NTEMP       NUMBER OF TEMPERATURES                               *
*     IINC        INELASTIC OPTIONS                                    *
*                    0      NONE                                       *
*                    1      COMPUTE AS FREE GAS                        *
*                    2      RESERVED                                   *
*                    3      COMPUTE S(A,B) AND MATRIX                  *
*                    4      READ S(A,B) AND COMPUTE MATRIX             *
*     ICOH        ELASTIC OPTIONS                                      *
*                    0      NONE                                       *
*                    1      GRAPHITE                                   *
*                    2      BERYLLIUM                                  *
*                    3      BERYLLIUM OXIDE                            *
*                   11      POLYETHYLENE                               *
*                   12      H(ZRH)                                     *
*                   13      ZR(ZRH)                                    *
*     NATOM       NUMBER OF PRINCIPAL ATOMS                            *
*     MTREF       MT FOR INELASTIC REACTION (201-250 ONLY)             *
*     IPRINT      PRINT OPTION (0=MINIMUM, 1=MAXIMUM,                  *
*                 2=MAX. NORMAL + INTERMEDIATE RESULTS)                *
*                 (DEFAULT=0)                                          *
*  CARD 3                                                              *
*     TEMPR       TEMPERATURES (KELVIN)                                *
*  CARD 4  FOR IINC=4 ONLY                                             *
*     EFTEMP      EFFECTIVE TEMPERATURES FOR SHORT COLLISION TIME       *
*                 (DEFAULT FOR EACH TEMPERATURE IS STANDARD VALUE      *
```

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*                FROM GENERAL ATOMIC REPORT IF AVAILABLE,          *
*                OTHERWISE MATERIAL TEMPERATURE)                   *
*  CARD 5                                                          *
*     TOL         TOLERANCE                                        *
*     EMAX        MAXIMUM ENERGY FOR THERMAL TREATMENT             *
*                                                                  *
********************************************************************

PROGRAM GROUPR
********************************************************************
*                                                                  *
* COMPUTE SELF-SHIELDED GROUP-AVERAGED CROSS SECTIONS              *
*                                                                  *
* PRODUCES SELF-SHIELDED CROSS SECTIONS, NEUTRON SCATTERING        *
* MATRICES, AND PHOTON PRODUCTION MATRICES.  SCATTERING AND        *
* PHOTON MATRICES MAY BE SELF-SHIELDED IF DESIRED (SEE INIT).      *
* BONDARENKO WEIGHTING IS NORMALLY USED.   OPTIONALLY, THE FLUX    *
* CAN BE COMPUTED FOR AN INFINITE MIXTURE OF HEAVY ABSORBER        *
* AND LIGHT MODERATOR.  DELAYED NEUTRON DATA AND THERMAL           *
* SCATTERING MATRICES ARE HANDLED SPECIALLY.                       *
*                                                                  *
* THE INTEGRATION OVER INITIAL ENERGY IS HANDLED IN THE SAME       *
* WAY FOR ALL REACTION TYPES BY USING THE INTEGRAND                *
*                    FEED*XSEC*FLUX                                *
* FEED IS THE SOURCE INTO FINAL ENERGY GROUP GPRIME AND            *
* LEGENDRE ORDER L FROM INITIAL ENERGY E (SEE GETFF).  FOR         *
* VECTORS, THE FEED IS 1. OR A YIELD (NUBAR, MUBAR).  FOR TWO      *
* BODY SCATTERING, A CENTER-OF-MASS GAUSSIAN INTEGRATION IS USED   *
* TO OBTAIN ACCURATE RESULTS EVEN FOR SMALL LEGENDRE COMPONENTS    *
* OF THE GROUP-TO-GROUP SCATTERING.  ADDITIONAL INITIAL ENERGY     *
* QUADRATURE POINTS ARE ADDED TO INTEGRATE THE KNOWN POLYNOMIAL    *
* ORDER OF THIS FEED FUNCTION.  FEED FOR TABULATED CONTINUUM       *
* REACTIONS IS COMPUTED EXACTLY ON THE ENDF/B GRID POINTS AND      *
* THEN INTERPOLATED AT E.  A SPECIAL PROJECTION INTERPOLATION      *
* SCHEME IS USED FOR THERMAL MATRICES (SEE GETAED).  THE FEED      *
* FOR ANALYTIC CONTINUUM REACTIONS IS EXACT.                       *
*                                                                  *
*---INPUT SPECIFICATIONS (FREE FORMAT)-----------------------------*
*                                                                  *
* CARD1                                                            *
*    NENDF    UNIT FOR ENDF/B TAPE                                 *
*    NPEND    UNIT FOR PENDF TAPE                                  *
*    NGOUT1   UNIT FOR INPUT GOUT TAPE (DEFAULT=0)                 *
*    NGOUT2   UNIT FOR OUTPUT GOUT TAPE (DEFAULT=0)                *
* CARD2                                                            *
*    MATB     MATERIAL TO BE PROCESSED                             *
*             MATB LT 0 IS A FLAG TO ADD MTS TO AND/OR REPLACE     *
*             INDIVIDUAL MTS ON NGOUT1.                            *
*    IGN      NEUTRON GROUP STRUCTURE OPTION                       *
*    IGG      GAMMA GROUP STRUCTURE OPTION                         *
*    IWT      WEIGHT FUNCTION OPTION                               *
*    LORD     LEGENDRE ORDER                                       *
*    NTEMP    NUMBER OF TEMPERATURES                               *
*    NSIGZ    NUMBER OF SIGMA ZEROES                               *
*    IPRINT   LONG PRINT OPTION (0/1=MINIMUM/MAXIMUM)              *
*             (DEFAULT=1)                                          *
* CARD3                                                            *
*    TITLE    RUN LABEL (UP TO 80 CHARACTERS DELIMITED BY *,       *
*             ENDED WITH /)  (DEFAULT=BLANK)                       *
* CARD4                                                            *
*    TEMP     TEMPERATURES IN KELVIN                               *
* CARD5                                                            *
*    SIGZ     SIGMA ZERO VALUES (INCLUDING INFINITY)               *
```

```
*                                                                      *
*          IF IGN=1, READ NEUTRON GROUP STRUCTURE (6A AND 6B)          *
* CARD6A                                                               *
*    NGN     NUMBER OF GROUPS                                          *
* CARD6B                                                               *
*    EGN     NGN+1 GROUP BREAKS (EV)                                   *
*                                                                      *
*          IF IGG=1, READ GAMMA GROUP STRUCTURE (7A AND 7B)            *
* CARD7A                                                               *
*    NGG     NUMBER OF GROUPS                                          *
* CARD7B                                                               *
*    EGG     NGG+1 GROUP BREAKS (EV)                                   *
*                                                                      *
*          WEIGHT FUNCTION OPTIONS (8A,8B,8C,8D)                       *
* CARD8A     FLUX CALCULATOR PARAMETERS (IWT.LT.0 ONLY)                *
*    EHI     BREAK BETWEEN COMPUTED FLUX AND BONDARENKO FLUX           *
*              (MUST BE IN RESOLVED RANGE)                             *
*    SIGPOT  ESTIMATE OF POTENTIAL SCATTERING CROSS SECTION            *
*    NFLMAX  MAXIMUM NUMBER OF COMPUTED FLUX POINTS                    *
*    NINWT   TAPE UNIT FOR NEW FLUX PARAMETERS (DEFAULT=0)             *
*    JSIGZ   INDEX OF REFERENCE SIGMA ZERO IN SIGZ ARRAY               *
*            (DEFAULT=0)                                               *
* CARD8B     TABULATED (IWT=1 OR -1 ONLY)                              *
*    WGHT    READ WEIGHT FUNCTION AS TAB1 RECORD.                      *
*            END WITH A /.                                             *
* CARD8C     ANALYTIC FLUX PARAMETERS (IWT=4 OR -4 ONLY)               *
*    EB      THERMAL BREAK (EV)                                        *
*    TB      THERMAL TEMPERATURE (EV)                                  *
*    EC      FISSION BREAK (EV)                                        *
*    TC      FISSION TEMPERATURE (EV)                                  *
* CARD8D     INPUT RESONANCE FLUX (IWT=0 ONLY)                         *
*    NINWT   TAPE UNIT FOR FLUX PARAMETERS                             *
*                                                                      *
* CARD9                                                                *
*    MFD     FILE TO BE PROCESSED                                      *
*    MTD     SECTION TO BE PROCESSED                                   *
*    MTNAME  DESCRIPTION OF SECTION TO BE PROCESSED                    *
*          REPEAT FOR ALL REACTIONS DESIRED                            *
*          MFD=0/ TERMINATES THIS TEMPERATURE/MATERIAL.                *
* CARD10                                                               *
*    MATD    NEXT MAT NUMBER TO BE PROCESSED                           *
*            MATD=0/ TERMINATES GROUPR RUN.                            *
*                                                                      *
*---OPTIONS FOR INPUT VARIABLES---------------------------------------*
*                                                                      *
*     IGN          MEANING                                           *
*     ---          -------                                           *
*      1           ARBITRARY STRUCTURE (READ IN)                     *
*      2           CSEWG 239 GROUP STRUCTURE                         *
*      3           LASL 30 GROUP STRUCTURE                           *
*      4           ANL 27 GROUP STRUCTURE                            *
*      5           RRD 50 GROUP STRUCTURE                            *
*      6           GAM-I 68 GROUP STRUCTURE                          *
*      7           GAM-II 100 GROUP STRUCTURE                        *
*      8           LASER-THERMOS 35 GROUP STRUCTURE                  *
*      9           EPRI-CPM 69 GROUP STRUCTURE                       *
*     10           LASL 187-GROUP STRUCTURE                          *
*     11           LASL 70-GROUP STRUCTURE                           *
*     12           SAND-II 620-GROUP STRUCTURE                       *
*     13           LASL 80-GROUP STRUCTURE                           *
*                                                                      *
*     IGG          MEANING                                           *
*     ---          -------                                           *
*      0           NONE                                              *
```

```
*       1           ARBITRARY STRUCTURE (LIST RECORD)                  *
*       2           CSEWG 94 GROUP STRUCTURE                           *
*       3           LASL 12 GROUP STRUCTURE                            *
*       4           STEINER 21 GROUP GAMMA-RAY STRUCTURE               *
*                           (ORNL-TM-2564)                             *
*       5           STRAKER 22 GROUP STRUCTURE                         *
*       6           LASL 48-GROUP STRUCTURE                            *
*       7           LASL 24-GROUP STRUCTURE                            *
*                                                                      *
*      IWT          MEANING                                            *
*      ---          -------                                            *
*       1           READ IN SMOOTH WEIGHT FUNCTION                     *
*       2           CONSTANT                                           *
*       3           1/E                                                *
*       4           1/E + FISSION SPECTRUM + THERMAL MAXWELLIAN        *
*       5           EPRI-CELL LWR                                      *
*       6           (THERMAL) -- (1/E) -- (FISSION + FUSION)           *
*       7           FAST REACTOR                                       *
*       8           THERMAL--1/E--FAST REACTOR--FISSION + FUSION       *
*      -N           COMPUTE FLUX WITH WEIGHT N                         *
*       0           READ IN RESONANCE FLUX FROM NINWT                  *
*                                                                      *
*      MFD          MEANING                                            *
*      ---          -------                                            *
*       3           CROSS SECTION OR YIELD VECTOR                      *
*       5           FISSION CHI BY SHORT-CUT METHOD                    *
*       6           NEUTRON-NEUTRON MATRIX                             *
*      16           NEUTRON-GAMMA MATRIX (PHOTON YIELDS GIVEN)         *
*      17           NEUTRON-GAMMA MATRIX (PHOTON XSECS GIVEN)          *
*      90+LEVEL     RADIOACTIVE NUCLIDE PRODUCTION (MF=9)              *
*     100+LEVEL     RADIOACTIVE NUCLIDE PRODUCTION (MF=10)             *
*                                                                      *
*      MTD          MEANING                                            *
*      ---          -------                                            *
*      -N           PROCESS ALL MT NUMBERS FROM THE PREVIOUS           *
*                           ENTRY TO N INCLUSIVE                       *
*      221-250      RESERVED FOR THERMAL SCATTERING                    *
*      258          AVERAGE LETHARGY                                   *
*      259          AVERAGE INVERSE VELOCITY (M/SEC)                   *
*                                                                      *
************************************************************************

PROGRAM GAMINR
************************************************************************
*                                                                      *
* COMPUTE MULTIGROUP PHOTON CROSS SECTIONS                             *
*                                                                      *
* PRODUCE MULTIGROUP PHOTON INTERACTION CROSS SECTIONS                 *
* AND HEATING KERMA FACTORS USING ENDF/B CROSS SECTIONS                *
* AND COHERENT AND INCOHERENT FORM FACTORS.  INITIAL ENERGY            *
* QUADRATURE TECHIQUES ARE IDENTICAL TO THOSE USED IN GROUPR.          *
* SECONDARY ENERGY-ANGLE QUADRATURE IS PERFORMED USING GAUSSIAN        *
* INTEGRATION.                                                         *
*                                                                      *
*---INPUT SPECIFICATIONS (FREE FORMAT)--------------------------------*
*                                                                      *
* CARD1                                                                *
*    NENDF    UNIT FOR ENDF/B TAPE                                     *
*    NPEND    UNIT FOR PENDF TAPE                                      *
*    NGAM1    UNIT FOR INPUT NGAM TAPE (DEFAULT=0)                     *
*    NGAM2    UNIT FOR OUTPUT NGAM TAPE (DEFAULT=0)                    *
* CARD2                                                                *
*    MATB     MATERIAL TO BE PROCESSED                                 *
```

```
*            INPUT MATERIALS IN ASCENDING ORDER                  *
*    IGG     GAMMA GROUP STRUCTURE OPTION                        *
*    IWT     WEIGHT FUNCTION OPTION                              *
*    LORD    LEGENDRE ORDER                                      *
*    IPRINT  PRINT OPTION (0/1=MINIMUM/MAXIMUM) (DEFAULT=1)      *
* CARD3                                                          *
*    TITLE   RUN LABEL UP TO 80 CHARACTERS (DELIMITED BY *,      *
*            ENDED WITH /)                                       *
* CARD4      (IGG=1 ONLY)                                        *
*    NGG     NUMBER OF GROUPS                                    *
*    EGG     NGG+1 GROUP BOUNDS (EV)                             *
* CARD5      (IWT=1 ONLY)                                        *
*    WGHT    WEIGHT FUNCTION AS TAB1 RECORD                      *
* CARD6                                                          *
*    MFD     FILE TO BE PROCESSED                                *
*    MTD     SECTION TO BE PROCESSED                             *
*    MTNAME  DESCRIPTION OF SECTION TO BE PROCESSED              *
*            REPEAT FOR ALL REACTIONS DESIRED                    *
*            MFD=0/ TERMINATES THIS MATERIAL                     *
*            MFD=-1/ IS A FLAG TO PROCESS ALL SECTIONS PRESENT   *
*            FOR THIS MATERIAL  (TERMINATION IS AUTOMATIC)`      *
* CARD7                                                          *
*    MATD    NEXT MAT NUMBER TO BE PROCESSED                     *
*            TERMINATE GAMINR RUN WITH MATD=0.                   *
*                                                                *
*---OPTIONS FOR INPUT VARIABLES-----------------------------------*
*                                                                *
*        IGG     MEANING                                         *
*        ---     -------                                         *
*         0      NONE                                            *
*         1      ARBITRARY STRUCTURE (READ IN)                   *
*         2      CSEWG 94 GROUP STRUCTURE                        *
*         3      LASL 12 GROUP STRUCTURE                         *
*         4      STEINER 21-GROUP GAMMA-RAY STRUCTURE            *
*         5      STRAKER 22 GROUP STRUCTURE                      *
*         6      LASL 48-GROUP STRUCTURE                         *
*         7      LASL 24-GROUP STRUCTURE                         *
*                                                                *
*        IWT     MEANING                                         *
*        ---     -------                                         *
*         1      READ IN                                         *
*         2      CONSTANT                                        *
*         3      1/E + ROLLOFFS                                  *
*                                                                *
******************************************************************

PROGRAM ERRORR
******************************************************************
*                                                                *
* PRODUCE CROSS SECTION COVARIANCES FROM ERROR FILES IN ENDF/B   *
* FORMAT                                                         *
*                                                                *
* FIRST, THE UNION ENERGY GRID OF THE USERS GROUP STRUCTURE      *
* AND THE ENDF COVARIANCE ENERGIES IS DETERMINED.  THE ARRAY     *
* OF COEFFICIENTS FOR DERIVED CROSS SECTIONS IS ALSO CONSTRUCTED.*
* THEN MULTIGROUP CROSS SECTIONS ARE COMPUTED ON THE UNION       *
* GRID (SEE GRPAV), OR THEY ARE READ FROM A MULTIGROUP CROSS     *
* SECTION LIBRARY AND THEN COLLAPSED TO THE UNION GRID.  THE     *
* METHODS OF GROUPR ARE USED FOR CROSS SECTION AVERAGING.  ENDF  *
* COVARIANCES AND THE GROUP CROSS SECTIONS ARE THEN COMBINED     *
* TO GET THE BASIC COVARIANCE MATRICES (SEE COVCAL).  FINALLY,   *
* THE BASIC MATRICES ARE COMBINED TO GET COVARIANCES FOR         *
* DERIVED REACTIONS, THE MATRICES ARE COLLAPSED TO THE USER-S    *
```

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* GROUP STRUCTURE, AND THE RESULTS ARE PRINTED AND/OR WRITTEN    *
* ONTO AN OUTPUT GENDF TAPE FOR LATER USE (SEE COVOUT).          *
*                                                                *
*---INPUT SPECIFICATIONS (FREE FORMAT)--------------------------*
*                                                                *
*  CARD 1                                                        *
*    NENDF    UNIT FOR ENDF/B TAPE                              *
*    NPEND    UNIT FOR PENDF TAPE                               *
*    NGOUT    UNIT FOR INPUT GROUP XSEC (GENDF) TAPE            *
*             (IF ZERO, GROUP XSECS WILL BE CALCULATED)         *
*             (IF MFCOV.EQ.31(SEE BELOW) , NGOUT CANNOT BE 0)   *
*             (DEFAULT=0)                                       *
*    NOUT     UNIT FOR OUTPUT COVARIANCE TAPE (DEFAULT=0)       *
*    NIN      UNIT FOR INPUT COVARIANCE TAPE (DEFAULT=0)        *
*             (NIN AND NOUT MUST BE BOTH CODED OR BOTH BINARY)  *
*  CARD 2                                                        *
*    MATD     MATERIAL TO BE PROCESSED                          *
*    IGN      NEUTRON GROUP OPTION                              *
*             (IGN DEFINITION SAME AS GROUPR, EXCEPT IGN=19,    *
*             WHICH MEANS READ IN AN ENERGY GRID, AS IN IGN=1,  *
*             AND SUPPLEMENT THIS WITH THE ENDF COVARIANCE GRID *
*             WITHIN THE RANGE OF THE USER-SPECIFIED ENERGIES)  *
*             (DEFAULT=1)                                       *
*    IPRINT   PRINT OPTION (0/1=MINIMUM/MAXIMUM) (DEFAULT=1)    *
*    IRELCO   COVARIANCE FORM (0/1=ABSOLUTE/RELATIVE) (DEFAULT=1) *
*  CARD 3     (OMIT IF NGOUT.NE.0)                              *
*    IWT      WEIGHT FUNCTION OPTION                            *
*    MPRINT   PRINT OPTION FOR GROUP AVERAGING (0=MIN., 1=MAX.) *
*    TEMPIN   TEMPERATURE (DEFAULT=300)                         *
*                                                               *
*---FOR ENDF/B VERSION 4 (IVERF=4) ONLY-------------------------*
*                                                               *
*  CARD 4                                                       *
*    NEK      NUMBER OF DERIVED XSEC ENERGY RANGES              *
*             (IF ZERO, ALL XSECS ARE INDEPENDENT)              *
*  CARD 5     (OMIT IF NEK=0)                                   *
*    EK       NEK+1 DERIVED XSEC ENERGY BOUNDS                  *
*  CARD 6     (OMIT IF NEK=0)                                   *
*    AKXY     DERIVED CROSS SECTION COEFFICIENTS                *
*                                                               *
*---FOR ENDF/B VERSION 5 (IVERF=5) ONLY-------------------------*
*                                                               *
*  CARD 7                                                       *
*    IREAD    0/1/2=PROGRAM CALCULATED MTS/INPUT MTS AND EKS/   *
*             CALCULATED MTS PLUS EXTRA MAT1-MT1 PAIRS FROM INPUT *
*             (DEFAULT=0)                                       *
*    MFCOV    ENDF COVARIANCE FILE (31, 32, OR 33) TO BE        *
*             PROCESSED (DEFAULT=33).                           *
*             NOTE--CONTRIBUTION TO GROUP CROSS SECTION         *
*             COVARIANCES FROM RESONANCE-PARAMETER UNCERTAINTIES *
*             (MF=32) IS INCLUDED WHEN MF=33 IS REQUESTED.      *
*                                                               *
*  FOLLOWING CARDS ONLY IF IREAD.EQ.1                           *
*  CARD 8                                                       *
*    NMT      NO. MTS TO BE EVALUATED                           *
*    NEK      NO. DERIVED CROSS SECTION ENERGY RANGES           *
*             (DEFAULT=1) (NEK=0 IS FLAG FOR DEFAULT)           *
*  CARD 8A                                                      *
*    MTS      NMT MTS                                           *
*  CARD 8B                                                      *
*    EK       NEK+1 DERIVED CROSS SECTION ENERGY BOUNDS         *
*             (DEFAULT=1.E-5,2.E7)                              *
*  CARD 9                                                       *
*    AKXY     DERIVED CROSS SECTION COEFFICIENTS                *
```

```
*                                                                     *
*  FOLLOWING CARDS ONLY IF IREAD.EQ.2                                 *
*  CARD 10                                                            *
*    MAT1                                                             *
*    MT1                                                              *
*             REPEAT FOR ALL MAT1-MT1 PAIRS DESIRED                   *
*             TERMINATE WITH MAT1=0.                                  *
*                                                                     *
*---------------------------------------------------------------------*
*                                                                     *
*  CARD 11   (FOR IGN.EQ.1.OR.IGN.EQ.19)                              *
*    NGN     NUMBER OF GROUPS                                         *
*  CARD 11A                                                           *
*    EGN     NGN+1 GROUP BOUNDS (EV)                                  *
*  CARD 12   (FOR IWT.EQ.1 ONLY)                                      *
*    WGHT    WEIGHT FUNCTION AS A TAB1 RECORD                         *
*                                                                     *
***********************************************************************


PROGRAM COVR
***********************************************************************
*                                                                     *
* PROCESS COVARIANCE DATA FROM ERRORR.                                *
*                                                                     *
* PLOT A MATRIX OF CORRELATION COEFFICIENTS                           *
* AND AN ASSOCIATED PAIR OF STANDARD DEVIATION                        *
* VECTORS,I.E.,A COVARIANCE MATRIX.  THE CORRELATION                  *
* MATRIX IS PLOTTED AS A SHADED CONTOUR PLOT AND THE VECTORS          *
* ARE PLOTTED AS SEMI-LOG PLOTS,ONE ROTATED BY 90 DEGREES.            *
* THE LOG ENERGY GRIDS FOR THE VECTOR PLOTS ARE IDENTICAL             *
* TO THE GRIDS FOR THE MATRIX PLOT.                                   *
* NOTE---IF MORE THAN ONE MATERIAL APPEARS ON THE INPUT TAPE,         *
* THE MAT NUMBERS MUST BE IN ASCENDING ORDER.                         *
* THIS PROGRAM EMPLOYS THE PROPRIETARY PLOTTING SOFTWARE              *
* PACKAGE, DISSPLA.                                                   *
*                                                                     *
*---INPUT SPECIFICATIONS (FREE FORMAT)-------------------------------*
*                                                                     *
*  CARD 1                                                             *
*     NIN             INPUT TAPE UNIT                                 *
*     NOUT            OUTPUT TAPE UNIT                                *
*                     (DEFAULT=0=NONE)                                *
*  CARD 2                                                             *
*     GAPREF          REFERENCE SHADING GAP WIDTH                     *
*                     (DEFAULT=.020)                                  *
*     GAP1            FULL-CORRELATION SHADING GAP WIDTH              *
*                     (DEFAULT=.008)                                  *
*     XGAP            FACTOR FOR NEGATIVE CORRELATION GAP             *
*                     ADJUSTMENT (DEFAULT=1.75)                       *
*                                                                     *
*     NOTE.  THE ABOVE DEFAULTS ARE ACTIVATED BY ENTERING ZEROES      *
*     OR JUST A SLASH.  A SECOND SET OF DEFAULTS FOR GAPREF AND       *
*     GAP1 ARE ACTIVATED BY INPUTTING A VALUE OF GAPREF GREATER       *
*     THAN 0.2.  IN THIS CASE, THE VALUES USED ARE 0.030*FACT         *
*     AND 0.016*FACT, RESPECTIVELY, WHERE FACT IS THE INPUT           *
*     VALUE OF GAPREF.                                                *
*  CARD 3                                                             *
*     IRELCO          RELATIVE COVARIANCE OPTION                      *
*                     0/1=ABSOLUTE/RELATIVE COVARIANCES               *
*                     (DEFAULT=1)                                     *
*     NCASE            NO. CASES TO BE RUN (MAXIMUM=40)               *
*                      (DEFAULT=1)                                    *
*     NOLEG           PLOT LEGEND OPTION                              *
```

```
*                    -1/0/1=LEGEND FOR FIRST SUBCASE ONLY/          *
*                    LEGEND FOR ALL PLOTS/NO LEGENDS                *
*                    (DEFAULT=0)                                    *
*     NSTART         SEQUENTIAL FIGURE NUMBER                       *
*                    0/N=NOT NEEDED/FIRST FIGURE IS FIGURE N.       *
*                    (DEFAULT=0)                                    *
*  CARD 4                                                           *
*     MAT            DESIRED MAT NUMBER                             *
*     MT             DESIRED MT NUMBER                              *
*     MAT1           DESIRED MAT1 NUMBER                            *
*     MT1            DESIRED MT1 NUMBER                             *
*                    (DEFAULT FOR MT, MAT1 AND MT1 ARE 0,0,0        *
*                    MEANING PROCESS ALL MTS FOR THIS MAT           *
*                    WITH MAT1=MAT)                                 *
*          REPEAT CARD 4 NCASE TIMES                                 *
*                                                                    *
**********************************************************************

PROGRAM MODER
**********************************************************************
*                                                                    *
*  CHANGE THE MODE OF AN ENDF/B TAPE.                                *
*                                                                    *
*  ALSO WORKS FOR PENDF, GENDF AND COVARIANCE TAPES.                 *
*                                                                    *
*---INPUT SPECIFICATIONS (FREE FORMAT)-----------------------------*
*                                                                    *
* CARD 1        UNIT NUMBERS                                       *
*      NIN      INPUT UNIT                                         *
*               ABS (NIN) GE 1 AND LE 19 IS A FLAG                 *
*               TO LOOP OVER DIFFERENT TAPES AND MATERIALS         *
*      NOUT     OUTPUT UNIT                                        *
*                                                                  *
*  A POSITIVE UNIT IS CODED (MODE 3).                              *
*  A NEGATIVE UNIT IS BLOCKED BINARY (NJOY MODE).                  *
*                                                                  *
*                                                                  *
*      CARDS 2 AND 3 FOR ABS (NIN) GE 1 AND LE 19 ONLY,            *
*                    FOR ENDF/B AND PENDF TAPES                    *
*                                                                  *
* CARD 2                                                           *
*      TPID     TAPEID FOR NOUT.  66 CHARACTERS ALLOWED           *
*               (DELIMITED WITH *, ENDED WITH /)                  *
* CARD 3                                                           *
*      NIN      INPUT UNIT                                        *
*               TERMINATE MODER BY SETTING NIN=0                  *
*      MATD     MATERIAL ON THIS TAPE TO ADD TO NOUT              *
**********************************************************************

PROGRAM DTFR
**********************************************************************
*                                                                    *
* CONVERT OUTPUT OF GROUPR TO DTF FORMAT.                            *
*                                                                    *
* PROCESSES NEUTRON AND GAMMA PRODUCTION CROSS SECTIONS AND          *
* MATRICES.  THE NEUTRON TABLES CAN HAVE REDUCED TABLE LENGTH.       *
* UP-SCATTER IS ALLOWED.  THE ABSORPTION REACTION IS COMPUTED        *
* FROM THE TOTAL CROSS SECTION AND TOTAL SCATTERING.  ANY EDITS      *
* CAN BE PRODUCED WHICH ARE EITHER GIVEN IN THE ENDF/B FILE          *
* OR ARE LINEAR COMBINATIONS OF ENDF/B CROSS SECTIONS.  THE          *
* FISSION NU*SIGF AND CHI ARE COMPUTED FROM THE FISSION MATRICES     *
* FOR ALL PARTIAL FISSION REACTIONS.  CHI INCLUDES SOURCE            *
```

```
* WEIGHTING.  THE PL TABLES FOR L.GT.0 CONTAIN THE PL WEIGHTED    *
* TOTAL IN THE TOTAL POSITION AND THE PL TRANSPORT CROSS SECTION *
* IN THE ABSORPTION POSITION.  THE GAMMA TABLES HAVE GAMMA GROUP *
* 1 IN POSITION 1, 2 IN POSITION 2, ETC, WITH A TABLE LENGTH     *
* EQUAL TO THE NUMBER OF GAMMA GROUPS.                           *
*                                                                *
* WARNING... THIS PROGRAM IS EXTREMELY MACHINE DEPENDENT         *
* BECAUSE OF ITS PLOTTING CAPABILITY.  THE CODING IS LEFT        *
* AS A GUIDE FOR CONVERSION TO OTHER SYSTEMS.                    *
*                                                                *
*---INPUT SPECIFICATIONS (FREE FORMAT)--------------------------*
*                                                                *
* CARD 1        UNITS                                            *
*    NIN        INPUT UNIT WITH DATA FROM GROUPR (BINARY).       *
*    NOUT       OUTPUT UNIT CONTAINING DTF TABLES (CODED).       *
*               (DEFAULT=0=NONE)                                 *
*    NPEND      INPUT UNIT WITH PENDF TAPE FOR POINT PLOTS.      *
*               (DEFAULT=0=NONE)                                 *
* CARD 2        OPTIONS                                          *
*    IPRINT     PRINT CONTROL (0 MINIMUM, 1 MAXIMUM)             *
*    IFILM      FILM CONTROL (0/1/2=NO/YES WITH 1 PLOT PER FRAME/ *
*               YES WITH 4 PLOTS PER FRAME (DEFAULT=0)           *
*    IEDIT      EDIT CONTROL (0/1=IN TABLE/SEPARATE) (DEFAULT=0) *
*              (SEPARATE ONLY FOR 30 NEUTRON GROUP X 12 PHOTON   *
*              GROUP DATA)                                       *
*                                                                *
*       CARDS 3 THROUGH 5 ONLY FOR IEDIT=0                       *
*                                                                *
* CARD 3        NEUTRON TABLES                                   *
*    NLMAX      NUMBER OF NEUTRON TABLES DESIRED.                *
*    NG         NUMBER OF NEUTRON GROUPS                         *
*    IPTOTL     POSITION OF TOTAL CROSS SECTION                  *
*    IPINGP     POSITION OF IN-GROUP SCATTERING CROSS SECTION.   *
*    ITABL      NEUTRON TABLE LENGTH DESIRED.                    *
*    NED        NUMBER OF ENTRIES IN EDIT TABLE (DEFAULT=0).     *
*    NTHERM     NUMBER OF THERMAL GROUPS (DEFAULT=0).            *
*  CARD 3A ONLY FOR NTHERM NE 0                                  *
* CARD 3A       THERMAL INCOHERENT AND COHERENT MTS              *
*    MTI        MT FOR THERMAL INCOHERENT DATA                   *
*    MTC        MT FOR THERMAL COHERENT DATA (DEFAULT=0)         *
*    NLC        NO. COHERENT LEGENDRE ORDERS (DEFAULT=0)         *
* CARD 4        EDIT NAMES                                       *
*       SIX CHARACTER HOLLERITH NAMES FOR EDITS FOR AS MANY      *
*       CARDS AS NEEDED.  THERE WILL BE IPTOTL-3 NAMES READ.     *
*       EACH NAME IS DELIMITED WITH *.                           *
* CARD 5        EDIT SPECIFICATIONS                              *
*       NED TRIPLETS OF NUMBERS ON AS MANY CARDS AS NEEDED.      *
*       POSITIONS CAN APPEAR MORE THAN ONCE.                     *
*       REACTION TYPES CAN APPEAR MORE THAN ONCE.                *
*    JPOS       POSITION OF EDIT QUANTITY.                       *
*    MT         ENDF/B REACTION NUMBER.                          *
*    MULT       MULTIPLICITY TO BE USED WHEN ADDING THIS MT.     *
*                                                                *
* CARD 6        GAMMA RAY TABLES                                 *
*    NPTABL     NUMBER OF GAMMA TABLES DESIRED (DEFAULT=0)       *
*    NGP        NUMBER OF GAMMA GROUPS (DEFAULT=0)               *
* CARD 7        MATERIAL DESCRIPTION                             *
*       ONE CARD FOR EACH TABLE SET DESIRED.                     *
*       MAT=0/ TERMINATES EXECUTION OF DTFR.                     *
*    HISNAM     HOLLERITH ISOTOPE NAME                           *
*    MAT        MATERIAL NUMBER AS IN ENDF/B (DEFAULT=0)         *
*    JSIGZ      INDEX NUMBER OF SIGMA-ZERO DESIRED (DEFAULT=1)   *
*    DTEMP      TEMPERATURE DESIRED (DEFAULT=300)                *
*                                                                *
******************************************************************
```

```
PROGRAM CCCCR
*********************************************************************
*                                                                   *
*  PRODUCE CCCC-IV FILES FROM NJOY INTERMEDIATE CROSS SECTION       *
*  LIBRARY                                                          *
*                                                                   *
*  WORKING FROM A GROUPR OUTPUT TAPE, THIS MODULE PRODUCES          *
*  THE FOLLOWING THREE STANDARD INTERFACE FILES,                    *
*                                                                   *
*           ISOTXS       BRKOXS       DLAYXS,                     *
*                                                                   *
*  AS SPECIFIED BY THE COMMITTEE FOR COMPUTER CODE COORDINATION     *
*  (CCCC), TO FACILITATE THE EXCHANGE OF NUCLEAR DATA FOR REACTOR   *
*  CALCULATIONS (REFERENCE 1).                                      *
*      IN A GIVEN RUN, ALL THREE FILES CAN BE PRODUCED USING THE    *
*  SAME USER-SPECIFIED LIST OF ISOTOPES.  THE CODE WILL IGNORE      *
*  ISOTOPES WHICH ARE NOT PRESENT ON THE GROUPR TAPE (AND IN THE    *
*  CASE OF DLAYXS, ISOTOPES WITHOUT DELAYED NEUTRON DATA).          *
*      THE ISOTXS CODING ALLOWS FOR NSBLK EQUAL TO ONE OR NGROUP.   *
*  IN ADDITION, FILES WITH HIGHER ORDER MATRICES CAN BE PRODUCED    *
*  WITH A SEPARATE BLOCK FOR EACH L-ORDER (IFOPT=2) OR WITH ALL     *
*  ORDERS IN ONE BLOCK (IFOPT=1).  THIS FLEXIBILITY ACCOMMODATES    *
*  LARGE GROUP STRUCTURES.  FISSION VECTORS OR FISSION              *
*  MATRICES CAN BE PRODUCED.                                        *
*      IN BRKOXS, THE POTENTIAL SCATTERING CROSS SECTION FOR ALL    *
*  ENERGY GROUPS IS EQUAL TO THE USER-INPUT VALUE (XSPO).           *
* THE ELASTIC REMOVAL F-FACTOR IS SUPPLIED AS THE SIXTH REACTION.   *
*                                                                   *
*  1. R.D.ODELL. STANDARD INTERFACE FILES AND PROCEDURES            *
*     FOR REACTOR PHYSICS CODES, VERSION IV,                        *
*     LASL REPORT LA-6941-MS (SEPT.77)                              *
*                                                                   *
*                                                                   *
*---INPUT SPECIFICATIONS (FREE FORMAT)-----------------------------*
*                                                                   *
*-CCCCR-                                                           *
* CARD 1 UNITS                                                     *
*    NIN       INPUT UNIT FOR DATA FROM GROUPR                     *
*    NISOT     OUTPUT UNIT FOR ISOTXS (O IF ISOTXS NOT WANTED)     *
*    NBRKS     OUTPUT UNIT FOR BRKOXS (O IF BRKOXS NOT WANTED)     *
*    NDLAY     OUTPUT UNIT FOR DLAYXS (O IF DLAYXS NOT WANTED)     *
* CARD 2 IDENTIFICATION                                            *
*    LPRINT     PRINT FLAG (O/1=NOT PRINT/PRINTED)                 *
*    IVERS      FILE VERSION NUMBER (DEFAULT=O)                    *
*    HUSE       USER IDENTIFICATION (12 CHARACTERS)                *
*               DELIMITED BY *, ENDED BY /.                        *
*               (DEFAULT=BLANK)                                    *
* CARD 3                                                           *
*    HSETID     HOLLERITH IDENTIFICATION OF SET (12 CHARACTERS)    *
*               DELIMITED BY *, ENDED BY /.                        *
*               (DEFAULT=BLANK)                                    *
* CARD 4 FILE CONTROL                                              *
*    NGROUP     NUMBER OF NEUTRON ENERGY GROUPS                    *
*    NGGRUP     NUMBER OF GAMMA ENERGY GROUPS                      *
*    NISO       NUMBER OF ISOTOPES DESIRE                          *
*    MAXORD     MAXIMUM LEGENDRE ORDER                             *
*    IFOPT      MATRIX BLOCKING OPTION (1/2=BLOCKING BY            *
*                                 REACTION/LEGENDRE ORDER)        *
* CARD 5 ISOTOPE PARAMETERS (ONE CARD PER ISOTOPE)                 *
*       (FIRST FOUR WORDS ARE HOLLERITH, UP TO SIX CHARACTERS      *
*       EACH, DELIMITED BY *)                                      *
```

```
*    HISNM     HOLLERITH ISOTOPE LABEL                                  *
*    HABSID    HOLLERITH ABSOLUTE ISOTOPE LABEL                         *
*    HIDENT    IDENTIFIER OF DATA SOURCE LIBRARY (ENDF/B)               *
*    HMAT      ISOTOPE IDENTIFICATION                                   *
*    IMAT      NUMERICAL ISOTOPE IDENTIFIER (ENDF/B MAT NUMBER)         *
*    XSPO      AVERAGE POTENTIAL SCATTERING CROSS SECT. (BRKOXS)        *
*                                                                       *
*-CISOTX- (ONLY IF NISOT.GT.0)                                          *
* CARD 1 FILE CONTROL                                                   *
*    NSBLOK    SUBBLOCKING OPTION FOR SCATTERING MATRIX                 *
*              (1 OR NGRUP SUB-BLOCKS ALLOWED)                          *
*    MAXUP     MAXIMUM NUMBER OF UPSCATTER GROUPS (ALWAYS ZERO)         *
*    MAXDN     MAXIMUM NUMBER OF DOWNSCATTER GROUPS                     *
*    ICHIX     FISSION CHI REPRESENTATION                               *
*                   -1   VECTOR (USING GROUPR FLUX)                     *
*                    0   NONE                                           *
*                   +1   VECTOR (USING INPUT FLUX)                      *
*                 .GT.1  MATRIX                                         *
* CARD 2 CHI VECTOR CONTROL (ICHIX=1 ONLY)                              *
*    SPEC      NGROUP FLUX VALUES USED TO COLLAPSE THE GROUPR           *
*              FISSION MATRIX INTO A CHI VECTOR                         *
* CARD 3 CHI MATRIX CONTROL (ICHIX.GT.1 ONLY)                           *
*    SPEC      NGROUP VALUES OF SPEC(I)=K DEFINE THE RANGE OF           *
*              GROUPS I TO BE AVERAGED TO OBTAIN SPECTRUM K.            *
*              INDEX K RANGES FROM 1 TO ICHI.                           *
*              THE MODEL FLUX IS USED TO WEIGHT EACH GROUP I.           *
* CARD 4 ISOTOPE CONTROL (ONE CARD PER ISOTOPE)                         *
*    KBR       ISOTOPE CLASSIFICATION                                   *
*    AMASS     GRAM ATOMIC WEIGHT                                       *
*    EFISS     TOTAL THERMAL ENERGY/FISSION                             *
*    ECAPT     TOTAL THERMAL ENERGY/CAPTURE                             *
*    TEMP      ISOTOPE TEMPERATURE                                      *
*    SIGPOT     AVERAGE EFFECTIVE POTENTIAL SCATTERING                  *
*    ADENS     DENSITY OF ISOTOPE IN MIXTURE                            *
*                                                                       *
*-CBRKXS- (ONLY IF NBRKS.GT.0)                                          *
* CARD 1 (2I6) FILE DATA                                                *
*    NTI       NUMBER OF TEMPERATURES DESIRED                           *
*              (-N MEANS ACCEPT FIRST N TEMPERATURES)                   *
*    NZI       NUMBER OF SIGPO VALUES DESIRE                            *
*              (-N MEANS ACCEPT FIRST N DILUTION FACTORS)               *
* CARD 2 (NOT NEEDED IF NTI.LT.0)                                       *
*    ATEM(NTI) VALUES OF DESIRED TEMPERATURES                           *
* CARD 3 (NOT NEEDED IF NZI.LT.0)                                       *
*    ASIG(NZI) VALUES OF DESIRED SIGPO                                  *
*                                                                       *
*-CDLAYX-- NO INPUT REQUIRED                                            *
*                                                                       *
*************************************************************************

PROGRAM MATXSR
*************************************************************************
*                                                                       *
*  PRODUCE MATXS INTERFACE FILE FROM NJOY INTERMEDIATE CROSS            *
*  SECTION LIBRARY                                                      *
*                                                                       *
*      THE MATXS FILE IS A GENERALIZED, FLEXIBLE FORMAT SIMILAR         *
*  TO THE CCCC-ISOTXS FORMAT.  WORKING FROM A GROUPR AND/OR             *
*  GAMINR OUTPUT TAPE, THIS MODULE CAN PROCESS NEUTRON CROSS            *
*  SECTIONS, GAMMA PRODUCTION DATA AND GAMMA INTERACTION CROSS          *
*  SECTIONS ONTO A SINGLE OUTPUT FILE.  IN ITS PRESENT FORM THIS        *
*  MODULE WILL ACCEPT ALL RELEVANT REACTIONS PRESENT ON THE INPUT       *
*  TAPE(S) AND PRODUCE AN ARCHIVAL OUTPUT FILE WHICH CAN BE             *
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```
*  MANIPULATED BY A SEPARATE CODE CALLED TRANSX.                    *
*      A MATXS FILE SPECIFICATION MAY BE FOUND FOLLOWING THE        *
*  INPUT INSTRUCTIONS.                                              *
*                                                                   *
*                                                                   *
*---INPUT SPECIFICATIONS (FREE FORMAT)-----------------------------*
*                                                                   *
* CARD 1 UNITS                                                      *
*   NGEN1      INPUT UNIT FOR DATA FROM GROUPR                      *
*   NGEN2      INPUT UNIT FOR DATA FROM GAMINR                      *
*   NMATX      OUTPUT UNIT FOR MATXS                                *
* CARD 2 USER IDENTIFICATION                                        *
*   LPRINT     0/1 MEANS NO PRINT/PRINT                             *
*   IVERS      FILE VERSION NUMBER (DEFAULT=0)                      *
*   HUSE       USER ID (12 CHARACTERS, DELIMITED BY *, ENDED BY /)*
*              (DEFAULT=BLANK)                                      *
* CARD 3 FILE CONTROL                                               *
*   NPART      NUMBER OF PARTICLES FOR WHICH GROUP                  *
*                 STRUCTURES ARE GIVEN                              *
*   NTYPE      NUMBER OF DATA TYPES IN SET                          *
*   NHOLL      NUMBER OF CARDS TO BE READ FOR HOLLERITH             *
*              IDENTIFICATION RECORD.                               *
* CARD 4 SET HOLLERITH IDENTIFICATION                               *
*   HSETID     HOLLERITH IDENTIFICATION OF SET (A6)                 *
*              (EACH LINE CAN BE UP TO 72 CHARACTERS, DELIMITED     *
*              WITH *, ENDED BY /)                                  *
* CARD 5 PARTICLE IDENTIFIERS                                       *
*   HPART      HOLLERITH IDENTIFIERS FOR PARTICLES                  *
*              (UP TO 6 CHARACTERS EACH, DELIMITED BY *)            *
* CARD 6 ENERGY GROUPS                                              *
*   NGRP       NUMBER OF GROUPS FOR EACH PARTICLE                   *
* CARD 7 DATA TYPE IDENTIFIERS                                      *
*   HTYPE      HOLLERITH IDENTIFIERS FOR DATA TYPES                 *
*              (UP TO 6 CHARACTERS EACH, DELIMITED BY *)            *
*                                                                   *
* THE FOLLOWING SEQUENCE OF CARDS IS REPEATED FOR EACH DATA TYPE    *
*                                                                   *
* CARD 11 DATA TYPE CONTROL                                         *
*   IFOPT      BLOCKING OPTION FOR MATRICES (1/2 MEANS              *
*                 MATRICES NOT BLOCKED/BLOCKED BY L-ORDER)          *
*            WARNING-IFOPT=2 IS UNDER DEVELOPMENT                   *
*   NSBLK      SUB-BLOCKING PARAMETER (1/NING MEANS THAT A RECORD   *
*                 CONTAINS ALL INPUT GROUPS/ONE INPUT GROUP)        *
*   MAXORD     MAXIMUM LEGENDRE ORDER                               *
*   NMATN      NUMBER OF MAT NAMES TO BE READ                       *
* CARD 12 INPUT PARTICLES                                           *
*   IINP       PARTICLE NUMBERS OF ALL INCIDENT PARTICLES           *
* CARD 13 OUTPUT PARTICLES                                          *
*   IOUTP      PARTICLE NUMBERS OF ALL OUTGOING PARTICLES           *
* CARD 14 MATERIAL DATA (ONE CARD PER MATERIAL)                     *
*   HMAT       HOLLERITH MATERIAL IDENTIFIER                        *
*              (UP TO 6 CHARACTERS EACH, DELIMITED BY *)            *
*   NTEMP      MAX NUMBER OF TEMPERATURES                           *
*   NSIGZ      MAX NUMBER OF SIGMA ZERO VALUES                      *
*   IMAT       INTEGER MATERIAL IDENTIFIER                          *
*              (IF MATERIAL HAS AN ENDF/B MAT NUMBER, USE THAT)     *
*                                                                   *
*********************************************************************

PROGRAM ACER
*********************************************************************
*                                                                   *
* PREPARE A DATA LIBRARY FOR MCNP, THE LOS ALAMOS CONTINUOUS        *
```

```
* ENERGY MONTE CARLO CODE.                                              *
*                                                                       *
* REACTION CROSS SECTIONS ARE WRITTEN OUT ON THE GRID OF THE            *
* TOTAL CROSS SECTION FROM THE INPUT PENDF TAPE (ASSUMED TO             *
* BE LINEARIZED AND UNIONIZED).  REDUNDANT REACTIONS                    *
* (EXCEPT MT1 AND MT452) ARE REMOVED.  MT18 IS CONSIDERED               *
* REDUNDANT IF MT19 IS PRESENT.  ANGULAR DISTRIBUTIONS (MF4)            *
* AND TABULATED ENERGY DISTRIBUTIONS (MF5, LF1 OR 5) ARE                *
* CONVERTED INTO EQUAL PROBABILITY BINS.  THE INCIDENT ENERGY           *
* GRIDS OF BOTH ARE THINNED FOR LINEAR INTERPOLATION USING THE          *
* SPECIFIED TOLERANCE.  ANALYTIC SECONDARY ENERGY DISTRIBUTIONS         *
* ARE COPIED.  ALL PHOTON PRODUCTION CROSS SECTIONS ARE COM-            *
* BINED ON THE CROSS SECTION ENERGY GRID AND WRITTEN AS                 *
* MF13,MT3.  MULTIGROUP PHOTON PRODUCTION CROSS SECTIONS ARE            *
* OBTAINED FROM THE NGEND INPUT TAPE.  THE PHOTON DISTRIBUTIONS         *
* ARE SUMMED AND CONVERTED INTO A SET OF EQUALLY PROBABLE MEAN          *
* ENERGIES AND WRITTEN AS MF15,MT3LF3 (A SPECIALLY DEFINED LAW).        *
* MF14 IS MADE ISOTROPIC.  UNRESOLVED REGION PROBABILITY TABLES         *
* ARE GENERATED BY A LEAST SQUARES FIT TO THE SELF-SHIELDED             *
* CROSS SECTIONS ON MT152 (SEE UNRESR) AND WRITTEN OUT AS MT153         *
* IN A SPECIAL FORMAT.  THE DICTIONARY ON THE OUTPUT TAPE IS            *
* CORRECTED TO REFLECT THE CHANGES.                                     *
*                                                                       *
*---INPUT SPECIFICATIONS (FREE FORMAT)-----------------------------------*
*                                                                       *
* CARD1                                                                 *
*    NENDF     UNIT FOR INPUT ENDF/B TAPE                               *
*    NPEND     UNIT FOR INPUT PENDF TAPE                                *
*    NGEND     UNIT FOR INPUT MULTIGROUP PHOTON DATA                    *
*    NACE      UNIT FOR OUTPUT ACE TAPE                                 *
*    NOUT      UNIT FOR OUTPUT ETOPL TAPE                               *
* CARD2                                                                 *
*    IOPT      TYPE OF ACER RUN OPTION                                  *
*              (0/1/2=NORMAL/WRITE THERMAL DATA ONLY/                   *
*                     WRITE PROBABILITY TABLES ONLY)                    *
*              (IOPT=2 NOT YET OPERATIONAL)                             *
*    MATD      MATERIAL TO BE PROCESSED                                 *
*    TEMPD     TEMPERATURE DESIRED (KELVIN) (DEFAULT=300)               *
*    IPRINT    PRINT CONTROL (0 MIN, 1 MAX) (DEFAULT=1)                 *
*    NPRINT    0/NN=NO FICHE OUTPUT/UNIT FOR FICHE                      *
*              (DEFAULT=0)                                              *
* CARD3  FOR IOPT=0 ONLY                                                *
*    ERR       TOLERANCE FOR THINNING DISTRIBUTIONS                     *
*    NBINA     NUMBER OF BINS FOR MF4 AND MF5 (DEFAULT=32)              *
*    NBINP     NUMBER OF PHOTON AVERAGE ENERGIES (DEFAULT=20)           *
* CARD4  FOR IOPT=1 ONLY                                                *
*    MTI       MT FOR THERMAL INCOHERENT DATA                           *
*    NBINT     NUMBER OF BINS FOR INCOHERENT SCATTERING                 *
*    MTE       MT FOR THERMAL ELASTIC DATA                              *
*    IELAS     0/1=COHERENT/INCOHERENT ELASTIC                          *
*    EMAX      MAXIMUM ENERGY FOR THERMAL TREATMENT (EV)                *
*              (DEFAULT=1000.=DETERMINED FROM MF3, MTI)                 *
*    IWT       WEIGHTING OPTION                                         *
*              0/1=VARIABLE/CONSTANT (DEFAULT=VARIABLE)                 *
* CARD5  FOR IOPT=2 ONLY                                                *
*    NBAND     NO. OF BANDS IN PROBABILITY TABLES (2 OR 3)              *
*              (DEFAULT=2)                                              *
* CARD6  FOR NACE NE 0 AND IOPT=0 ONLY                                  *
*  TYPE OF THINNING IS DETERMINED BY SIGN OF THIN(1)                    *
*  (+/-=ENERGY SKIP/INTEGRAL FRACTION)                                  *
*    THIN(1)   E1 ENERGY BELOW WHICH TO USE ALL ENERGIES (EV)           *
*              OR IWTT WEIGHTING OPTION (1=FLAT,2=1/E)                  *
*              (1/E ACTUALLY HAS WEIGHT=10 WHEN E LT .1)                *
*    THIN(2)   E2 ENERGY ABOVE WHICH TO USE ALL ENERGIES                *
```

```
*              OR TARGET NUMBER OF POINTS                              *
*    THIN(3)   ISKF SKIP FACTOR--USE EVERY ISKF-TH ENERGY              *
*              BETWEEN E1 AND E2, OR RSIGZ REFERENCE SIGMA ZERO        *
*                                                                      *
************************************************************************

PROGRAM POWR
************************************************************************
*                                                                      *
*  PRODUCE INPUT FOR THE EPRI-CELL CODES GAMTAP (FAST) AND             *
*  LIBRAR (THERMAL), AND THE EPRI-CPM CODE CLIB.                       *
*                                                                      *
*---INPUT SPECIFICATIONS (FREE FORMAT)--------------------------------*
*                                                                      *
* CARD 1                                                              *
*    NGENDF   UNIT FOR INPUT GOUT TAPE                                 *
*    NOUT     UNIT FOR OUTPUT TAPE                                     *
* CARD 2                                                              *
*    LIB      LIBRARY OPTION (1=FAST, 2=THERMAL, 3=CPM)                *
*    IPRINT   PRINT OPTION (0=MINIMUM, 1=MAXIMUM)                      *
*             (DEFAULT=0)                                              *
*    ICLAPS   GROUP COLLAPSING OPTION (0=COLLAPSE FROM 185 GROUP       *
*             TO DESIRED GROUP STRUCTURE, 1=NO COLLAPSE)               *
*             (DEFAULT=0)                                              *
*                                                                      *
*---FOR LIB=1--------------------------------------------------------*
*                                                                      *
* CARD 3                                                              *
*    MATD     MATERIAL TO BE PROCESSED                                 *
*             IF MATD LT 0, READ-IN ABSORPTION DATA ONLY FOR           *
*             THIS MATERIAL WITH MAT=ABS(MATD) DIRECTLY FROM           *
*             INPUT DECK (SEE CARD 6)                                  *
*   FOLLOWING THREE PARAMETERS IRRELEVANT FOR MATD LT 0                *
*    RTEMP    REFERENCE TEMPERATURE (DEGREES KELVIN)                   *
*             (DEFAULT=300  K)                                         *
*    IFF      F-FACTOR OPTION                                          *
*             (0/1=DO NOT CALCULATE F-FACTORS/CALCULATE IF FOUND)      *
*             (DEFAULT=1)                                              *
*    NSGZ     NO. OF SIGMA ZEROES TO PROCESS FOR THIS MATERIAL         *
*             (DEFAULT=0=ALL FOUND ON INPUT TAPE)                      *
*    IZREF    REF. SIGZERO FOR ELASTIC MATRIX (DEFAULT=1)              *
* CARDS 4 AND 5 FOR NORMAL RUN ONLY (MATD GT 0)                       *
* CARD 4                                                              *
*    WORD     DESCRIPTION OF NUCLIDE (UP TO 16 CHARACTERS,             *
*             DELIMITED WITH *, ENDED WITH /)  (DEFAULT=BLANK)         *
* CARD 5                                                              *
*    FSN       TITLE OF FISSION SPECTRUM (UP TO 48 CHARACTERS,         *
*              DELIMITED WITH *, ENDED WITH /)  (DEFAULT=BLANK)        *
* CARD 6 FOR READING IN ABSORPTION DATA ONLY                          *
*    ABS       NGND ABSORPTION VALUES (DEFAULT VALUES=0)              *
* REPEAT CARDS 3 THROUGH 6 FOR EACH MATERIAL DESIRED.                 *
* TERMINATE WITH MATD=0/ (I.E., A 0/ CARD).                           *
*                                                                      *
*---FOR LIB=2--------------------------------------------------------*
*                                                                      *
* CARD 3                                                              *
*    MATD     MATERIAL TO BE PROCESSED                                 *
*    IDTEMP   TEMPERATURE ID (DEFAULT=300  K)                          *
*    NAME     HOLLERITH NAME OF ISOTOPE (UP TO 10 CHARACTERS,          *
*             DELIMITED WITH *, ENDED WITH /)  (DEFAULT=BLANK)         *
* CARD 4      DEFAULT FOR ALL VALUES=0.                               *
*    ITRC     TRANSPORT CORRECTION OPTION (0 NO, 1 YES)                *
*    MTI      THERMAL INELASTIC MT                                     *
```

```
*    MTC      THERMAL ELASTIC MT                                          *
* CARD 5      DEFAULT FOR ALL VALUES=0.                                   *
*    XI                                                                   *
*    ALPHA                                                                *
*    MUBAR                                                                *
*    NU                                                                   *
*    KAPPA FISSION                                                        *
*    KAPPA CAPTURE                                                        *
*    LAMBDA                                                               *
*    SIGMA S    IF 0, SET TO SCATTERING CROSS SECTION AT GROUP 35         *
* REPEAT CARDS 3 THRU 5 FOR EACH MATERIAL AND TEMPERATURE DESIRED         *
* (MAXIMUM NUMBER OF TEMPERATURES ALLOWED IS 7.)                          *
* TERMINATE WITH MATD=0/ (I.E., A 0/ CARD).                               *
*                                                                         *
*---FOR LIB=3-------------------------------------------------------------*
*                                                                         *
* CARD 3                                                                  *
*    NLIB     NUMBER OF LIBRARY.                                         *
*    IDAT     DATE LIBRARY IS WRITTEN (I FORMAT).                        *
*    NEWMAT   NUMBER OF MATERIALS TO BE ADDED.                           *
*    IOPT     ADD OPTION (0=MATS WILL BE READ IN,                        *
*                         1=USE ALL MATS FOUND ON NGENDF).               *
*    MODE     0/1/2=REPLACE ISOTOPE(2) IN CPMLIB/                        *
*                   ADD/CREATE A NEW LIBRARY (DEFAULT=0)                  *
*    IF5      FILE5 (BURNUP DATA) OPTION                                 *
*             0/1/2=DO NOT PROCESS FILE5 BURNUP DATA/                    *
                    PROCESS BURNUP DATA ALONG WITH REST OF DATA/         *
*                   PROCESS BURNUP DATA ONLY (DEFAULT=0)                  *
*             (DEFAULT=0)                                                *
*    IF4      FILE4 (CROSS SECTION DATA) OPTION                          *
*             0/1=DO NOT PROCESS/PROCESS                                 *
*             (DEFAULT=1)                                                *
* CARD 4 FOR IOPT=0 ONLY                                                  *
*    MAT      ENDF MAT NUMBER OF ALL DESIRED MATERIALS.                  *
*             FOR MATERIALS NOT ON GENDF TAPE, USE IDENT FOR MAT.        *
*             IF MAT LT 0, ADD 100 TO OUTPUT IDENT                       *
*             (FOR SECOND ISOMER OF AN ISOTOPE)                          *
* CARD 5                                                                  *
*    NINA     NINA INDICATOR.                                            *
*             0/1/2/3=NORMAL/                                            *
*                   NO FILE2 DATA, CALCULATE ABSORPTION IN FILE4/        *
*                   NO FILE2 DATA, READ IN ABSORPTION IN FILE4/          *
*                   READ IN ALL FILE2 AND FILE4 DATA.                    *
*    NTEMP    NO. OF TEMPERATURES TO PROCESS FOR THIS MATERIAL           *
*             (DEFAULT=0=ALL FOUND ON INPUT TAPE)                        *
*    NSIGZ    NO. OF SIGMA ZEROES TO PROCESS FOR THIS MATERIAL           *
*             (DEFAULT=0=ALL FOUND ON INPUT TAPE)                        *
*    SGREF    REFERENCE SIGMA ZERO                                       *
*    FOLLOWING 2 PARAMETERS ARE FOR NINA=0 OR NINA=3.                    *
*    IRES     RESONANCE ABSORBER INDICATOR (0/1=NO/YES)                  *
*    SIGP     POTENTIAL CROSS SECTION FROM ENDF/B.                       *
*    FOLLOWING 5 PARAMETERS ARE FOR NTAPEA=0 ONLY                        *
*    MTI      THERMAL INELASTIC MT                                       *
*    MTC      THERMAL ELASTIC MT                                         *
*    IP1OPT   0/1=CALCULATE P1 MATRICES/                                 *
*                  CORRECT P0 SCATTERING MATRIX INGROUPS.                *
*  ******IF A P1 MATRIX IS CALCULATED FOR ONE OF THE ISOTOPES           *
*        HAVING A P1 MATRIX ON THE OLD LIBRARY, FILE 6 ON THE           *
*        NEW LIBRARY WILL BE COMPLETELY REPLACED.******                 *
*    INORF    0/1=INCLUDE RESONANCE FISSION IF FOUND/                    *
*                  DO NOT INCLUDE                                        *
*    FOLLOWING TWO PARAMETERS FOR MODE=0 ONLY                            *
*    POS      POSITION OF THIS ISOTOPE IN CPMLIB                         *
*    POSR     (FOR IRES=1) POSITION OF THIS ISOTOPE IN RESONANCE         *
```

```
*            TABULATION IN CPMLIB                                    *
*  REPEAT CARD 5 FOR EACH NUCLIDE.                                   *
* FOLLOWING THREE CARDS ARE FOR IF5 GT 0 ONLY                        *
* CARD 6                                                             *
*    NTIS     NO. TIME-DEPENDENT ISOTOPES                           *
*    NFIS     NO. FISSIONABLE BURNUP ISOTOPES                       *
* CARD 7                                                             *
*    IDENTB   IDENT OF EACH OF THE NFIS ISOTOPES                    *
* CARD 8                                                             *
*    IDENTA   IDENT OF TIME-DEPENDENT ISOTOPE                       *
*    DECAY    DECAY CONSTANT (DEFAULT=0.)                           *
*    YIELD    NFIS YIELDS (DEFAULT=0.)                              *
*  REPEAT CARD 8 FOR EACH OF THE NTIS ISOTOPES.                     *
* CARD 9 FOR IF5=2 ONLY                                              *
*    AW       ATOMIC WEIGHT                                         *
*    INDFIS   FISSION INDICATOR                                     *
*    NTEMP    NO. TEMPERATURES ON OLD LIBRARY                       *
*  REPEAT CARD 9 FOR EACH OF THE NTIS ISOTOPES.                     *
* CARD 10                                                            *
*    LAMBDA   RESONANCE GROUP GOLDSTEIN LAMBDAS                     *
*  ******REMEMBER THAT THE 69-GROUP STRUCTURE HAS 13 RESONANCE      *
*         GROUPS WHILE THE COLLAPSED 185-GROUP STRUCTURE HAS 15.    *
*         USE A SLASH AT END OF EACH LINE OF CARD 10 INPUT.******   *
*  REPEAT CARD 10 FOR EACH NUCLIDE HAVING NINA=0, NINA=3, OR        *
*                 IRES=1.                                           *
* CARDS 11 AND 11A FOR NUCLIDES HAVING NINA=3 ONLY.                  *
* CARD 11                                                            *
*    RESNU     NRG NUS VALUES TO GO WITH THE LAMBDA VALUES           *
* CARD 11A                                                           *
*    TOT       NRG TOTAL XSEC VALUES TO GO WITH THE LAMBDA VALUES    *
*  READ CARDS 11 AND 11A FOR EACH NUCLIDE HAVING NINA=3.            *
* CARDS 12 FOR NINA GT 2 ONLY                                        *
*    AW        ATOMIC WEIGHT                                        *
*    TEMP      TEMPERATURE                                          *
*    FPA       NGND ABSORPTION VALUES (DEFAULT=0.)                  *
* CARDS 12A, 12B, 12C FOR NUCLIDES HAVING NINA=3 ONLY.               *
* CARD 12A                                                           *
*    NUS       NGND NUS VALUES                                      *
*    FIS       NGND FISSION VALUES                                  *
*    XTR       NGND TRANSPORT VALUES                                *
* CARD 12B                                                           *
*    IA        GROUP.  0 MEANS NO SCATTERING FROM THIS GROUP        *
*    L1        LOWEST GROUP TO WHICH SCATTERING OCCURS              *
*    L2        HIGHEST GROUP TO WHICH SCATTERING OCCURS             *
* CARD 12C  FOR IA GT 0 ONLY                                         *
*    SCAT      L2-L1+1 SCATTERING VALUES                            *
*  REPEAT CARD 12B AND 12C FOR EACH GROUP                           *
* REPEAT CARDS 12 FOR EACH OF THE NINA GT 2 NUCLIDES                 *
*                                                                    *
**********************************************************************
```

APPENDIX B

DEFINITION OF ENDF/B REACTION NUMBERS USED BY NJOY

MT	Description
1	Total cross section (redundant, equal to the sum of all partial cross sections)
2	Elastic scattering cross section
3	Nonelastic cross section (redundant, equal to the sum of all partial cross sections except elastic scattering)
4	Total inelastic cross section (redundant, equal to the sum of MT = 51, 52, 53, ..., 90, 91)
6	(n,2n) cross section for first excited state (describes first neutron)
7	(n,2n) cross section for first excited state (describes first neutron)
8	(n,2n) cross section for third excited state (describes first neutron)
9	(n,2n) cross section for fourth excited state (describes first neutron)
16	direct (n,2n) cross section [total (n,2n) cross section is sum of MT = 6, 7, 8, 9, and 16]
17	(n,3n) cross section
18	Total fission cross section (sum of MT = 19, 20, 21, 38)
19	(n,f) cross section (first chance fission)
20	(n,n'f) cross section (second chance fission)
21	(n,2nf) cross section (third chance fission)
22	(n,n´α) cross section
23	(n,n´3α) cross section
24	(n,2nα) cross section
25	(n,3nα) cross section
26	(n,2n) isomeric state cross section

28 (n,n´p) cross section

29 (n,n´2α) cross section

30 (n,2n2α) cross section

32 (n,n´d) cross section

33 (n,n´t) cross section

34 (n,n´^{3}He)

35 (n,n´d2α) cross section

36 (n,n´t2α) cross section

37 (n,4n) cross section

38 (n,3nf) cross section (fourth-chance fission)

46 cross section for describing the second neutron from (n,2n) reaction for first excited state

47 cross section for describing the second neutron from (n,2n) reaction for second excited state

48 cross section for describing the second neutron from (n,2n) reaction for third excited state

49 cross section for describing the second neutron from (n,2n) reaction for fourth excited state
(Note: MT = 46, 47, 48, and 49 should not be included in the sum for the total (n,2n) cross section)

51 (n,n') to the first excited state

52 (n,n') to the second excited state

.
.
.

90 (n,n') to the 40th excited state

91 (n,n´) to the continuum

102 (n,γ) radiative capture cross section

103 (n,p) cross section

104 (n,d) cross section

105 (n,t) cross section

106	$(n,^3He)$ cross section
107	(n,α) cross section
108	$(n,2\alpha)$ cross section
109	$(n,3\alpha)$ cross section
111	(n,2p) cross section
112	$(n,p\alpha)$ cross section
113	$(n,t2\alpha)$ cross section
114	$(n,d2\alpha)$ cross section
203	Total hydrogen production
204	Total deuterium production
205	Total tritium production
206	Total ^3He production
207	Total ^4He production
251	$\bar{\mu}_L$, the average cosine of the scattering angle (laboratory system) for elastic scattering
252	ξ, the average logarithmic energy decrement for elastic scattering
253	γ, the average of the square of the logarithmic energy decrement for elastic scattering, divided by twice the average logarithmic decrement for elastic scattering
301-450	Energy release rate parameters, $E*\sigma$, for total and partial cross sections. Subtract 300 from this number to obtain the specific reaction type identification. For example, MT = 302 = (300 + 2) denotes elastic scattering
452	$\bar{\nu}$, average total (prompt plus delayed) number of neutrons released per fission event
455	Delayed neutrons from fission
456	Prompt neutrons from fission
501	Total photon interaction cross section
502	Photon coherent scattering
504	Photon incoherent scattering
516	Pair production, nuclear and electron field (that is, pair plus triple production)

602 Photoelectric

700 (n,p_0) cross section (cross section for leaving the residual nucleus in the ground state)

701 (n,p_1) cross section for 1st excited state

702 (n,p_2) cross section for 2nd excited state

703 (n,p_3) cross section for 3rd excited state

704 (n,p_4) cross section for 4th excited state

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.

718 (n,p_c) cross section for continuum excited state

719 (n,p_c') cross section for continuum specifically not included in σ total (redundant, used for describing outgoing proton)

720 (n,d_0) cross section for ground state

721 (n,d_1) cross section for 1st excited state

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.
.

738 (n,d_c) cross section for continuum

739 (n,d_c') cross section for continuum specifically not included in σ_T (redundant, used for describing outgoing deuteron)

740 (n,t_0) cross section for ground state

741 (n,t_1) cross section for 1st excited state

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.
.

758 (n,t_c) cross section for continuum

759 (n,t_c') cross section for continuum specifically not included in σ_T (redundant, used for describing outgoing triton)

760 $(n,{}^3He_0)$ cross section for ground state

761 $(n,{}^3He_1)$ cross section for 1st excited state

.
.
.

778 $(n,^3He_c)$ cross section for continuum

779 $(n,^3He_c')$ cross section for continuum specifically not included in σ_T (redundant, used for describing outgoing ^3He)

780 (n,α_0) cross section for ground state

781 (n,α_1) cross section for 1st excited state

.
.
.

798 (n,α_c) cross section for continuum

799 (n,α_c') cross section for continuum specifically not included in σ_T (redundant, used to describe outgoing α-particle)

The above MT numbers can also be used as "LR-flags" to indicate the mode of decay of the residual nucleus. For instance, MT68/LR22 denotes a discrete (n,n') scattering event that leaves the residual nucleus in the 18th excited level; the residual nucleus then decays by α emission. The following MT-numbers are used only as LR-flags:

LR	Description
31	Indicates that γ-emission is the mode of decay of the residual nucleus formed in the primary reaction.
39	Indicates that internal conversion is the mode of decay of the residual nucleus formed in the primary reaction.
40	Indicates that electron-positron pair formation is the mode of decay of the residual nucleus formed in the primary reaction.

APPENDIX C

NJOY TEST PROBLEMS

I. EXAMPLE 1, POINTWISE PROCESSING

```
MOUNT ENDF/B-V TAPE 511 ON UNIT 20.
MOUNT ENDF/B-III THERMAL TAPE 322 ON UNIT 26.
 0
 5
 *MODER*
 20 -21
 *RECONR*
 -21 -22
 *PENDF TAPE FOR C FROM ENDF/B TAPE 511*/
 1306 3 0
 .005 0. 6 /
 *6-C-NAT FROM TAPE 511*/
 *PROCESSED BY THE NJOY NUCLEAR DATA PROCESSING SYSTEM*/
 *SEE ORIGINAL ENDF/B-V TAPE FOR DETAILS OF EVALUATION*/
 0/
 *BROADR*
 -22 -23
 1306 1 0 0 0. .005 1.E6
 300.
 0/
 *HEATR*
 -21 -23 -22
 1306 1 0 0 0 0
 444
 *THERMR*
 26 -22 -24
 1065 1306 8 1 1 0 1 221 0
 300.
 .05 4.6
 *THERMR*
 26 -24 -23
 1065 1306 8 1 4 1 1 229 0
 300.
 /
 .05 4.6
 *GROUPR*
 -21 -23 0 -24
 1306 3 3 3 3 1 1 1
 *CARBON IN GRAPHITE*/
 300
 1.E10
 3 1 *TOTAL*/
 3 2 *ELASTIC*/
 3 4 *INELASTIC*/
 3 51 *DISCRETE INELASTIC*/
 3 -68 *HIGHER LEVELS*/
 3 91 *CONTINUUM INELASTIC*/
 3 102 *N,G*/
 3 103 *(N,P)*/
 3 104 *(N,D)*/
 3 107 *(N,A)*/
 3 203 *TOTAL H PRODUCTION*/
 3 204 *TOTAL H2 PRODUCTION*/
 3 207 *TOTAL HE4 PRODUCTION*/
 3 221 *FREE THERMAL SCATTERING*/
 3 229 *GRAPHITE INELASTIC THERMAL SCATTERING*/
 3 230 *GRAPHITE ELASTIC THERMAL SCATTERING*/
 3 251 *MUBAR*/
 3 252 *XI*/
 3 253 *GAMMA*/
 3 301 *TOTAL HEAT PRODUCTION*/
```

```
6 2 *ELASTIC*/
6 51 *DISCRETE INELASTIC*/
6 -68 *HIGHER LEVELS*/
6 91 *CONTINUUM INELASTIC*/
6 221 *FREE THERMAL SCATTERING*/
6 229 *GRAPHITE INELASTIC THERMAL SCATTERING*/
6 230 *GRAPHITE ELASTIC THERMAL SCATTERING*/
17 51 *INELASTIC GAMMA PRODUCTION*/
16 102 *CAPTURE GAMMA PRODUCTION*/
0/
0/
*MODER*
-23 25
*STOP*
1**************************************************************************
*                                        *                               *
*   $$   $$       $$   $$$$$   $$   $$   *                               *
*   $$$  $$       $$  $$$$$$$   $$ $$    *  NUCLEAR                      *  VERS.10/81   *
*   $$$$ $$       $$  $$   $$    $$$$     *  CROSS SECTION                *  RAN AT LANL  *
*   $$ $$$$  $$   $$  $$   $$     $$      *  PROCESSING                   *  ON MACH. U   *
*   $$  $$$  $$$$$$$  $$$$$$$     $$      *  SYSTEM                       *  ON 11/09/81  *
*   $$   $$   $$$$$    $$$$$      $$      *                               *  AT 18:46:05  *
*                                        *                               *               *
**************************************************************************

MODER...CHANGE THE MODE OF AN ENDF/B TAPE OR NJOY OUTPUT TAPE                .641S

INPUT UNIT (+ FOR CODED, - FOR BB) ...          20
OUTPUT UNIT (+ FOR CODED, - FOR BB) ..         -21

TAPE LABEL
---------------------------------------
 ENDF/B-V TAPE 511 (STANDARDS MATERIALS)
                                                                          11.003S
**************************************************************************

RECONR...RECONSTRUCT POINTWISE CROSS SECTIONS IN PENDF FORMAT               11.052S

UNIT FOR ENDF/B TAPE ..................         -21
UNIT FOR PENDF TAPE ...................         -22

LABEL FOR PENDF TAPE
---------------------------------------
 PENDF TAPE FOR C FROM ENDF/B TAPE 511

TAPE LABEL
---------------------------------------
 ENDF/B-V TAPE 511 (STANDARDS MATERIALS)

MATERIAL TO BE PROCESSED ..............        1306
RECONSTRUCTION TOLERANCE ..............        .005
RECONSTRUCTION TEMPERATURE ............         0.K
NO. SIGNIFICANT FIGURES ...............           6
RESONANCE-INTEGRAL-CHECK TOLERANCE ...        .100
MAX RESONANCE-INTEGRAL ERROR .........  5.000E-07

DESCRIPTIVE CARDS FOR PENDF TAPE
---------------------------------------
  6-C-NAT FROM TAPE 511
  PROCESSED BY THE NJOY NUCLEAR DATA PROCESSING SYSTEM
  SEE ORIGINAL ENDF/B-V TAPE FOR DETAILS OF EVALUATION


PROCESSING MAT    1306
```

```
---------------------------------------
   6-C -     ORNL        EVAL-DEC73 C.Y.FU AND F.G.PEREY

MAT HAS NO RESONANCE PARAMETERS

POINTS IN INITIAL UNIONIZED GRID =  776
POINTS ADDED BY LINEARIZATION = 127                                    15.844S
                                                                       20.550S
*******************************************************************************

BROADR...DOPPLER BROADENING OF ENDF/B DATA                             20.586S

UNIT FOR INPUT PENDF TAPE ..........          -22
UNIT FOR OUTPUT PENDF TAPE .........          -23
MATERIAL TO BE PROCESSED ...........         1306
NUMBER OF FINAL TEMPERATURES .......            1
RESTART (O NO, 1 YES) ..............            0
BOOTSTRAP (O NO, 1 YES) ............            0
STARTING MATERIAL TEMPERATURE ......          0.K
THINNING TOLERANCE .................         .005
MAX. ENERGY ........................    1.00E+06
FINAL TEMPERATURES .................    3.00E+02

                                                                       21.676S
BROADENED MAT1306 FROM  0.          TO  3.0000E+02 K
        POINTS IN=    903  POINTS OUT=   866
        MT   2 102
                                                                       22.743S
*******************************************************************************

HEATR...PROMPT KERMA                                                   22.773S

INPUT ENDF/B UNIT ..................          -21
INPUT PENDF UNIT ...................          -23
OUTPUT PENDF UNIT ..................          -22
MAT TO BE PROCESSED ................         1306
NO. TEMPERATURES (O=ALL) ...........            0
GAMMA HEAT (O NONLOCAL, 1 LOCAL) ...            0
PRINT OPTION (O MIN, 1 MORE, 2 CHK) ..          0
PARTIAL KERMA MT-S DESIRED .........          444

PROCESSING AT TEMPERATURE= 3.0000E+02

                                                                       30.316S
*******************************************************************************

THERMR...COMPUTE THERMAL SCATTERING CROSS SECTIONS AND MATRICES        30.349S

UNIT FOR ENDF/B TAPE ...............           26
UNIT FOR INPUT PENDF TAPE ..........          -22
UNIT FOR OUTPUT PENDF TAPE .........          -24
MATERIAL TO BE PROCESSED (ENDF) ....         1065
MATERIAL TO BE PROCESSED (PENDF) ...         1306
NUMBER OF ANGLE BINS ...............            8
NUMBER OF TEMPERATURES .............            1
INELASTIC OPTION ...................            1
ELASTIC OPTION .....................            0
NUMBER OF PRINCIPAL ATOMS ..........            1
REFERENCE MT .......................          221
PRINT OPTION (O MIN, 1 MAX) ........            0
TEMPERATURES (KELVIN) ..............  3.0000E+02
TOLERANCE ..........................  5.0000E-02
MAX ENERGY FOR THERMAL TREATMENT ...  4.6000E+00
```

```
WROTE THERMAL DATA FOR TEMP= 3.00E+02                                   44.451S
                                                                        44.515S
*************************************************************************

THERMR...COMPUTE THERMAL SCATTERING CROSS SECTIONS AND MATRICES         44.516S

UNIT FOR ENDF/B TAPE ..................          26
UNIT FOR INPUT PENDF TAPE .............         -24
UNIT FOR OUTPUT PENDF TAPE ............         -23
MATERIAL TO BE PROCESSED (ENDF) .......        1065
MATERIAL TO BE PROCESSED (PENDF) ......        1306
NUMBER OF ANGLE BINS ..................           8
NUMBER OF TEMPERATURES ................           1
INELASTIC OPTION ......................           4
ELASTIC OPTION ........................           1
NUMBER OF PRINCIPAL ATOMS .............           1
REFERENCE MT ..........................         229
PRINT OPTION (0 MIN, 1 MAX) ...........           0
TEMPERATURES (KELVIN) ................ 3.0000E+02
EFFECTIVE TEMPERATURES ............... 7.1339E+02
TOLERANCE ............................ 5.0000E-02
MAX ENERGY FOR THERMAL TREATMENT ..... 4.6000E+00

SHORT COLLISION TIME USED FOR TRANSFERS GREATER THAN  1.00 EV.

DIFFERENCE BETWEEN TEMPERATURES DESIRED AND FOUND IS  4.00E+00

WROTE THERMAL DATA FOR TEMP= 3.00E+02                                   92.400S
                                                                        92.173S
*************************************************************************

GROUPR...COMPUTE SELF-SHIELDED GROUP-AVERAGED CROSS-SECTIONS            92.215S

UNIT FOR ENDF/B TAPE ..................         -21
UNIT FOR PENDF TAPE ...................         -23
UNIT FOR INPUT GOUT TAPE ..............           0
UNIT FOR OUTPUT GOUT TAPE .............         -24
MAT TO BE PROCESSED ...................        1306
NEUTRON GROUP STRUCTURE OPTION ........           3
GAMMA GROUP OPTION ....................           3
WEIGHT FUNCTION OPTION ................           3
LEGENDRE ORDER ........................           3
PRINT OPTION (0 MIN, 1 MAX) ...........           1

RUN TITLE
----------------------------------------
     CARBON IN GRAPHITE

TEMPERATURES (KELVIN) .................    3.00E+02
SIGMA ZEROES ..........................    INFINITY

NEUTRON GROUP STRUCTURE......LASL 30 GROUP
    1     1.3900E-04 -    1.5200E-01
    2     1.5200E-01 -    4.1400E-01
    3     4.1400E-01 -    1.1300E+00
     .
     .

   28     1.2000E+07 -    1.3500E+07
   29     1.3500E+07 -    1.5000E+07
   30     1.5000E+07 -    1.7000E+07

GAMMA GROUP STRUCTURE......LASL 12 GROUP
```

```
    1     1.0000E+04 -    1.0000E+05
    2     1.0000E+05 -    5.0000E+05
    3     5.0000E+05 -    1.0000E+06
    4     1.0000E+06 -    2.0000E+06
    5     2.0000E+06 -    3.0000E+06
    6     3.0000E+06 -    4.0000E+06
    7     4.0000E+06 -    5.0000E+06
    8     5.0000E+06 -    6.0000E+06
    9     6.0000E+06 -    7.0000E+06
   10     7.0000E+06 -    8.0000E+06
   11     8.0000E+06 -    9.0000E+06
   12     9.0000E+06 -    2.0000E+07

WEIGHT FUNCTION.....1/E FOR ALL L

PROCESSING MAT   1306
-------------------------------------
 6-C-NAT FROM TAPE 511

GROUP CONSTANTS AT T=3.000E+02 DEG K                          93.472S
FOR MF 3 AND MT  1 TOTAL

ENRGY  GROUP CONSTANTS AT
GROUP  INFINITE DILUTION

  1    8.108E+00
 FLX   7.000E+00
  2    4.762E+00
 FLX   1.002E+00
  3    4.748E+00
 FLX   1.004E+00
  .
  .
  .
 28    1.361E+00
 FLX   1.178E-01
 29    1.334E+00
 FLX   1.054E-01
 30    1.472E+00
 FLX   1.252E-01


GROUP CONSTANTS AT T=3.000E+02 DEG K                          93.706S
FOR MF 3 AND MT  2 ELASTIC

ENRGY  GROUP CONSTANTS AT
GROUP  INFINITE DILUTION

  1    8.096E+00
  2    4.761E+00
  3    4.747E+00
  .
  .
  .
 28    8.632E-01
 29    8.226E-01
 30    8.848E-01


GROUP CONSTANTS AT T=3.000E+02 DEG K                          93.924S
FOR MF 3 AND MT  4 INELASTIC

ENRGY  GROUP CONSTANTS AT
GROUP  INFINITE DILUTION
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```
 24     5.168E-02
 25     2.465E-01
 26     3.311E-01
 27     4.290E-01
 28     4.016E-01
 29     4.300E-01
 30     4.932E-01


GROUP CONSTANTS AT T=3.000E+02 DEG K                                  94.023S
FOR MF 3 AND MT 51 DISCRETE INELASTIC

ENRGY   GROUP CONSTANTS AT
GROUP   INFINITE DILUTION

 24     5.168E-02
 25     2.465E-01
 26     3.199E-01
 27     3.115E-01
 28     2.155E-01
 29     1.850E-01
 30     1.354E-01


GROUP CONSTANTS AT T=3.000E+02 DFG K                                  94.093S
FOR MF 3 AND MT 52 CONTINUED
              LR 23 PARTICLE EMISSION

ENRGY   GROUP CONSTANTS AT
GROUP   INFINITE DILUTION

 26     9.781E-03
 27     4.607E-02
 28     2.983E-02
 29     1.261E-02
 30     7.633E-03


GROUP CONSTANTS AT T=3.000E+02 DEG K                                  94.131S
FOR MF 3 AND MT 53 CONTINUED
              LR 23 PARTICLE EMISSION

ENRGY   GROUP CONSTANTS AT
GROUP   INFINITE DILUTION

 27     5.679E-02
 28     8.611E-02
 29     6.149E-02
 30     4.342E-02



   .
   .
   .
GROUP CONSTANTS AT T=3.000E+02 DEG K                                  94.358S
FOR MF 3 AND MT 64 CONTINUED
              LR 23 PARTICLE EMISSION

ENRGY   GROUP CONSTANTS AT
GROUP   INFINITE DILUTION

 30     6.363E-04


THRESHOLD IS ABOVE HIGHEST ENERGY BOUND FOR MT 65
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THRESHOLD IS ABOVE HIGHEST ENERGY BOUND FOR MT 66

THRESHOLD IS ABOVE HIGHEST ENERGY BOUND FOR MT 67

THRESHOLD IS ABOVE HIGHEST ENERGY BOUND FOR MT 68

GROUP CONSTANTS AT T=3.000E+02 DEG K                          94.382S
FOR MF 3 AND MT 91 CONTINUUM INELASTIC
             LR 23 PARTICLE EMISSION

ENRGY  GROUP CONSTANTS AT
GROUP  INFINITE DILUTION

 26    1.369E-03
 27    1.187E-02
 28    1.924E-02
 29    2.498E-02
 30    3.645E-02

GROUP CONSTANTS AT T=3.000E+02 DEG K                          94.440S
FOR MF 3 AND MT102 N,G

ENRGY  GROUP CONSTANTS AT
GROUP  INFINITE DILUTION

  1    1.270E-02
  2    1.095E-03
  3    6.60E-04
  .
  .
  .
 28    7.142E-05
 29    1.258E-04
 30    1.912E-04

GROUP CONSTANTS AT T=3.000E+02 DEG K                          94.669S
FOR MF 3 AND MT103 (N,P)

ENRGY  GROUP CONSTANTS AT
GROUP  INFINITE DILUTION

 29    1.599E-04
 30    7.549E-03

GROUP CONSTANTS AT T=3.000E+02 DEG K                          94.680S
FOR MF 3 AND MT104 (N,D)

ENRGY  GROUP CONSTANTS AT
GROUP  INFINITE DILUTION

 30    1.808E-02

GROUP CONSTANTS AT T=3.000E+02 DEG K                          94.687S
FOR MF 3 AND MT107 (N,A)

ENRGY  GROUP CONSTANTS AT
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```
GROUP   INFINITE DILUTION

 25     1.503E-02
 26     1.670E-01
 27     1.018E-01
 28     9.626E-02
 29     8.114E-02
 30     6.859E-02


GROUP CONSTANTS AT T=3.000E+02 DEG K                                  94.759S
FOR MF 3 AND MT203 TOTAL H PRODUCTION

ENRGY   GROUP CONSTANTS AT
GROUP   INFINITE DILUTION

 29     1.599E-04
 30     7.549E-03


GROUP CONSTANTS AT T=3.000E+02 DEG K                                  94.770S
FOR MF 3 AND MT204 TOTAL H2 PRODUCTION

ENRGY   GROUP CONSTANTS AT
GROUP   INFINITE DILUTION

 30     1.808E-02


GROUP CONSTANTS AT T=3.000E+02 DEG K                                  94.777S
FOR MF 3 AND MT207 TOTAL HE4 PRODUCTION

ENRGY   GROUP CONSTANTS AT
GROUP   INFINITE DILUTION

 25     1.503E-02
 26     2.004E-01
 27     4.545E-01
 28     6.544E-01
 29     8.160E-01
 30     1.142E+00


GROUP CONSTANTS AT T=3.000E+02 DEG K                                  94.836S
FOR MF 3 AND MT221 FREE THERMAL SCATTERING

ENRGY   GROUP CONSTANTS AT
GROUP   INFINITE DILUTION

  1     8.096E+00
  2     4.761E+00
  3     4.747E+00
  4     4.742E+00


GROUP CONSTANTS AT T=3.000E+02 DEG K                                  94.946S
FOR MF 3 AND MT229 GRAPHITE INELASTIC THERMAL SCATTERING

ENRGY   GROUP CONSTANTS AT
GROUP   INFINITE DILUTION

  1     6.399E-01
  2     2.483E+00
  3     3.760E+00
```

```
  4     4.260E+00

GROUP CONSTANTS AT T=3.000E+02 DEG K                                    95.148S
FOR MF 3 AND MT230 GRAPHITE ELASTIC THERMAL SCATTERING

ENRGY  GROUP CONSTANTS AT
GROUP  INFINITE DILUTION

  1     2.714E+00
  2     2.175E+00
  3     9.166E-01
  4     3.391E-01


GROUP CONSTANTS AT T=3.000E+02 DEG K                                    95.337S
FOR MF 3 AND MT251 MUBAR

ENRGY  GROUP CONSTANTS AT
GROUP  INFINITE DILUTION

  1     5.600E-02
  2     5.604E-02
  3     5.604E-02
  .
  .
  .
 28     5.793E-01
 29     6.259E-01
 30     6.848E-01


GROUP CONSTANTS AT T=3.000E+02 DEG K                                   102.463S
FOR MF 3 AND MT252 XI

ENRGY  GROUP CONSTANTS AT
GROUP  INFINITE DILUTION

  2     1.673E-01
  3     1.592E-01
  .
  .
  .
 28     4.616E-02
 29     3.970E-02
 30     3.951E-02


GROUP CONSTANTS AT T=3.000E+02 DEG K                                   107.237S
FOR MF 3 AND MT253 GAMMA

ENRGY  GROUP CONSTANTS AT
GROUP  INFINITE DILUTION

  2     1.671E-01
  3     1.196E-01
  .
  .
  .
 28     4.407E-02
 29     3.880E-02
 30     4.262E-02
```

GROUP CONSTANTS AT T=3.000E+02 DEG K 112.143S
FOR MF 3 AND MT301 TOTAL HEAT PRODUCTION

ENRGY GROUP	GROUP CONSTANTS AT INFINITE DILUTION
1	1.128E+01
2	1.149E+00
3	1.072E+00
.	
.	
.	
28	2.308E+06
29	2.840E+06
30	3.873E+06

GROUP CONSTANTS AT T=3.000E+02 DEG K 112.549S
FOR MF 6 AND MT 2 ELASTIC

INITL GROUP	FINAL GROUP	GROUP CONSTANTS VS LEGENDRE ORDER 0	1	2	3
1	1	8.091E+00	4.534E-01	1.144E-02	4.182E-05
2	1	7.572E-01	-2.232E-01	-1.689E-02	-4.359E-04
2	2	4.004E+00	4.900E-01	2.363E-02	4.539E-04
.					
.					
.					
30	28	6.865E-02	-1.719E-02	-1.876E-02	1.031E-02
30	29	1.834E-01	1.016E-01	1.937E-02	-7.484E-03
30	30	6.055E-01	5.428E-01	4.372E-01	3.182E-01

GROUP CONSTANTS AT T=3.000E+02 DEG K 123.449S
FOR MF 6 AND MT 51 DISCRETE INELASTIC

INITL GROUP	FINAL GROUP	GROUP CONSTANTS VS LEGENDRE ORDER 0	1	2	3
24	7	2.650E-09	-1.311E-09	-8.178E-12	3.171E-10
24	8	1.222E-08	-5.999E-09	-6.950E-11	1.420E-09
24	9	5.751E-08	-2.796E-08	-4.064E-10	6.263E-09
.					
.					
.					
30	25	9.845E-03	-8.451E-03	6.152E-03	-3.686E-03
30	26	4.082E-02	-7.808E-03	-3.619E-03	-1.275E-03
30	27	7.873E-02	5.860E-02	3.053E-02	8.245E-03
30	28	5.959E-03	5.566E-03	4.841E-03	3.891E-03

GROUP CONSTANTS AT T=3.000E+02 DEG K 128.386S
FOR MF 6 AND MT 52 CONTINUED
LR 23 PARTICLE EMISSION

INITL GROUP	FINAL GROUP	GROUP CONSTANTS VS LEGENDRE ORDER 0	1	2	3
26	8	1.555E-09	-7.688E-10	-3.943E-12	1.834E-10
26	9	7.217E-09	-3.534E-09	-4.068E-11	8.205E-10
26	10	3.421E-08	-1.650E-08	-3.360E-10	3.636E-09
.					
.					

```
 30      24     2.152E-03 -1.461E-03  7.333E-04 -3.335E-04
 30      25     3.424E-03  1.737E-03  3.771E-04  2.235E-04
 30      26     2.057E-03  1.848E-03  1.510E-03  1.150E-03

GROUP CONSTANTS AT T=3.000E+02 DEG K                                  131.561S
FOR MF 6 AND MT 53 CONTINUED
             LR 23 PARTICLE EMISSION

INITL  FINAL  GROUP CONSTANTS VS LEGENDRE ORDER
GROUP  GROUP  0           1           2           3

 27       7    2.360E-09 -1.174E-09 -1.905E-12  2.856E-10
 27       8    1.078E-08 -5.320E-09 -4.813E-11  1.293E-09
 27       9    4.958E-08 -2.419E-08 -4.647E-10  5.805E-09
  .
  .
  .
 30      23    2.763E-03 -1.558E-03  1.204E-04  5.831E-04
 30      24    3.533E-02  1.038E-02 -2.794E-03 -1.265E-03
 30      25    5.313E-03  4.335E-03  2.805E-03  1.320E-03
  .
  .
  .

GROUP CONSTANTS AT T=3.000E+02 DEG K                                  138.116S
FOR MF 6 AND MT 64 CONTINUED
             LR 23 PARTICLE EMISSION

INITL  FINAL  GROUP CONSTANTS VS LEGENDRE ORDER
GROUP  GROUP  0           1           2           3

 30       8    1.481E-09 -7.357E-10 -1.898E-12  1.783E-10
 30       9    6.805E-09 -3.351E-09 -3.229E-11  8.018E-10
 30      10    3.171E-08 -1.541E-08 -3.062E-10  3.594E-09
 30      11    1.501E-07 -7.137E-08 -2.527E-09  1.586E-08
 30      12    7.416E-07 -3.399E-07 -2.039E-08  6.878E-08
 30      13    3.848E-06 -1.655E-06 -1.628E-07  2.743E-07
 30      14    2.167E-05 -8.291E-06 -1.302E-06  8.066E-07
 30      15    1.040E-04 -1.647E-05 -2.358E-05  4.000E-06
 30      16    1.099E-04  2.765E-05 -3.111E-05 -1.994E-05
 30      17    1.763E-04  1.009E-04  1.164E-05 -3.152E-05
 30      18    1.710E-04  1.396E-04  8.962E-05  3.949E-05
 30      19    8.226E-06  7.975E-06  7.491E-06  6.807E-06

THRESHOLD IS ABOVE HIGHEST ENERGY BOUND FOR MT 65

THRESHOLD IS ABOVE HIGHEST ENERGY BOUND FOR MT 66

THRESHOLD IS ABOVE HIGHEST ENERGY BOUND FOR MT 67

THRESHOLD IS ABOVE HIGHEST ENERGY BOUND FOR MT 68

GROUP CONSTANTS AT T=3.000E+02 DEG K                                  138.331S
FOR MF 6 AND MT 91 CONTINUUM INELASTIC
             LR 23 PARTICLE EMISSION
```

INITL GROUP	FINAL GROUP	ISOTROPIC MATRIX VS FINAL GROUP +0	+1	+2	+3		
26	9	2.693E-09	1.989E-08	1.216E-07	8.810E-07	5.537E-06	3.511E-05
26	15	1.827E-04	2.303E-04	3.441E-04	3.511E-04	1.903E-04	2.577E-05
26	21	3.463E-06					
27	8	1.591E-09	1.175E-08	8.680E-08	6.348E-07	4.644E-06	3.304E-05
27	14	2.215E-04	1.241E-03	1.682E-03	2.714E-03	3.122E-03	2.142E-03
27	20	4.740E-04	1.868E-04	4.606E-05	5.244E-06	1.042E-07	
28	8	2.577E-09	1.903E-08	1.406E-07	1.028E-06	7.522E-06	5.352E-05
28	14	3.587E-04	2.010E-03	2.725E-03	4.395E-03	5.056E-03	3.469E-03
28	20	7.677E-04	3.030E-04	8.092E-05	1.325E-05	1.132E-06	
29	8	3.345E-09	2.470E-08	1.825E-07	1.335E-06	9.764E-06	6.947E-05
29	14	4.656E-04	2.608E-03	3.537E-03	5.705E-03	6.563E-03	4.503E-03
29	20	9.964E-04	3.933E-04	1.050E-04	1.720E-05	1.558E-06	
30	8	4.882E-09	3.605E-08	2.663E-07	1.948E-06	1.425E-05	1.014E-04
30	14	6.795E-04	3.806E-03	5.161E-03	8.325E-03	9.577E-03	6.571E-03
30	20	1.454E-03	5.740E-04	1.533E-04	2.510E-05	2.274E-06	1.254E-09

GROUP CONSTANTS AT T=3.000E+02 DEG K 138.711S
FOR MF 6 AND MT221 FREE THERMAL SCATTERING

INITL GROUP	FINAL GROUP	GROUP CONSTANTS VS LEGENDRE ORDER 0	1	2	3
1	1	8.063E+00	2.232E-01	3.138E-02	7.594E-02
1	2	3.241E-02	-1.425E-03	-1.588E-03	-3.647E-04
1	3	1.677E-08	-1.282E-08	7.246E-09	-2.772E-09
2	1	7.423E-01	-1.557E-01	-2.514E-02	-2.682E-03
2	2	3.962E+00	4.477E-01	2.841E-02	7.789E-02
2	3	5.632E-02	8.940E-03	-1.716E-03	-8.155E-04
3	1	8.166E-05	-6.612E-05	4.254E-05	-2.083E-05
3	2	7.281E-01	-1.809E-01	-1.947E-02	2.330E-03
3	3	4.007E+00	4.726E-01	1.381E-02	9.593E-02
3	4	1.153E-02	6.297E-03	2.210E-03	9.408E-04
4	3	7.408E-01	-1.995E-01	-1.954E-02	1.771E-03
4	4	3.999E+00	4.982E-01	2.364E-02	7.423E-02
4	5	1.841E-03	1.514E-03	1.030E-03	5.977E-04

---WARNING FROM BINA---DISC= -3.017OE-14. SET TO ABS VALUE AND CONTINUE.

GROUP CONSTANTS AT T=3.000E+02 DEG K 147.522S
FOR MF 6 AND MT229 GRAPHITE INELASTIC THERMAL SCATTERING

INITL GROUP	FINAL GROUP	GROUP CONSTANTS VS LEGENDRE ORDER 0	1	2	3
1	1	6.259E-01	-9.509E-02	-1.110E-02	-3.864E-03
1	2	1.402E-02	-3.024E-03	-5.689E-04	-1.220E-04
1	3	1.159E-06	-3.364E-07	2.090E-08	-8.742E-09
2	1	4.251E-01	-1.161E-01	-1.290E-02	-4.055E-03
2	2	2.023E+00	-3.631E-01	-1.554E-01	-3.522E-02
2	3	3.446E-02	-3.703E-03	-3.396E-03	-9.096E-04
3	1	1.049E-02	-4.201E-03	6.778E-04	-1.779E-04
3	2	6.057E-01	-1.672E-01	-2.143E-02	-5.394E-03
3	3	3.135E+00	-1.797E-01	-2.928E-01	-1.046E-01
3	4	9.094E-03	2.229E-03	-7.498E-04	-6.540E-04
4	1	3.527E-08	-3.201E-08	2.631E-08	-1.948E-08
4	2	6.161E-05	-5.000E-05	3.255E-05	-1.638E-05
4	3	6.864E-01	-1.951E-01	-2.065E-02	-3.238E-03
4	4	3.571E+00	1.648E-01	-2.419E-01	-1.212E-01
4	5	1.822E-03	1.175E-03	4.590E-04	6.192E-05

```
GROUP CONSTANTS AT T=3.000E+02 DEG K                                    175.128S
FOR MF 6 AND MT230 GRAPHITE ELASTIC THERMAL SCATTERING

INITL  FINAL  GROUP CONSTANTS VS LEGENDRE ORDER
GROUP  GROUP  0           1           2           3

  1      1    2.714E+00 -1.774E+00 -1.156E-01 -3.067E-01
  2      2    2.175E+00  1.537E+00  2.702E-01 -2.418E-02
  3      3    9.166E-01  5.653E-01  2.540E-01  8.639E-02
  4      4    3.391E-01  1.064E-01  7.853E-02  5.067E-02


GROUP CONSTANTS AT T=3.000E+02 DEG K                                    178.936S
FOR MF17 AND MT 51 INELASTIC GAMMA PRODUCTION

INITL  FINAL  GROUP CONSTANTS VS LEGENDRE ORDER
GROUP  GROUP  0           1           2           3

 24      7    5.168E-02  0.          1.388E-02  0.
 25      7    2.465E-01  0.          2.272E-02  0.
 26      7    3.199E-01  0.          4.109E-02  0.
 27      7    3.115E-01  0.          5.306E-02  0.
 28      7    2.155E-01  0.          3.345E-02  0.
 29      7    1.850E-01  0.          2.523E-02  0.
 30      7    1.354E-01  0.          1.647E-02  0.


GROUP CONSTANTS AT T=3.000E+02 DEG K                                    179.405S
FOR MF16 AND MT102 CAPTURE GAMMA PRODUCTION

INITL  FINAL  ISOTROPIC MATRIX VS FINAL GROUP
GROUP  GROUP  +0          +1          +2          +3

  1      4    4.065E-03  0.          4.065E-03  8.638E-03
  2      4    3.504E-04  0.          3.504E-04  7.446E-04
  3      4    2.122E-04  0.          2.122E-04  4.509E-04
  .
  .
  .
 29      6    4.025E-05  0.          0.          0.          0.          0.
 29     12    1.258E-04
 30      6    6.118E-05  0.          0.          0.          0.          0.
 30     12    1.452E-04

                                                                        180.723S
*******************************************************************************

MODER...CHANGE THE MODE OF AN ENDF/B TAPE OR NJOY OUTPUT TAPE           180.749S

INPUT UNIT (+ FOR CODED, - FOR BB) ...          -23
OUTPUT UNIT (+ FOR CODED, - FOR BB) ..           25

TAPE LABEL
------------------------------------
 PENDF TAPE FOR C FROM ENDF/B TAPE 511
                                                                        190.553S
*******************************************************************************


PENDF TAPE FOR C FROM ENDF/B TAPE 511                                  1 0  0    0
 6.00000+ 3 1.18969+ 1          0           0           0          01306 1451    1
 0.00000+ 0 0.00000+ 0          0           0           0          01306 1451    2
```

```
PENDF TAPE FOR C FROM ENDF/B TAPE 511                                   1 0  0    0
 6.00000+ 3 1.18969+ 1          0          0          0          01306 1451    1
 0.00000+ 0 0.00000+ 0          0          0          0          01306 1451    2
 3.00000+ 2 5.00000- 3          0          0          3          391306 1451   3
6-C-NAT FROM TAPE 511                                                1306 1451   4
PROCESSED BY THE NJOY NUCLEAR DATA PROCESSING SYSTEM                 1306 1451   5
SEE ORIGINAL ENDF/B-V TAPE FOR DETAILS OF EVALUATION                 1306 1451   6
                                   1        451         43          01306 1451    7
                                   2        151          4          01306 1451    8
                                   3          1        292          01306 1451    9
                                   3          2        292          01306 1451   10
                                   3          4        139          01306 1451   11
                                   3         51        139          01306 1451   12
                                   3         52         82          01306 1451   13
                                   3         53         56          01306 1451   14
                                   3         54         49          01306 1451   15
                                   3         55         46          01306 1451   16
                                   3         56         42          01306 1451   17
                                   3         57         39          01306 1451   18
                                   3         58         36          01306 1451   19
                                   3         59         33          01306 1451   20
                                   3         60         30          01306 1451   21
                                   3         61         25          01306 1451   22
                                   3         62         21          01306 1451   23
                                   3         63         19          01306 1451   24
                                   3         64         17          01306 1451   25
                                   3         65         14          01306 1451   26
                                   3         66         12          01306 1451   27
                                   3         67         10          01306 1451   28
                                   3         68          8          01306 1451   29
                                   3         91         91          01306 1451   30
                                   3        102        292          01306 1451   31
                                   3        103         30          01306 1451   32
                                   3        104         21          01306 1451   33
                                   3        107        118          01306 1451   34
                                   3        203         30          01306 1451   35
                                   3        204         21          01306 1451   36
                                   3        207        118          01306 1451   37
                                   3        221         32          01306 1451   38
                                   3        229        209          01306 1451   39
                                   3        230        209          01306 1451   40
                                   3        301        292          01306 1451   41
                                   3        444        292          01306 1451   42
                                   6        221       4010          01306 1451   43
                                   6        229       4644          01306 1451   44
                                   6        230          2          01306 1451   45
                                                                     1306 1  0    46
                                                                     1306 0  0    47
 6.00000+ 3 1.18969+ 1          0          0          1          01306 2151    48
 6.00000+ 3 0.00000+ 0          0          0          1          01306 2151    49
 1.00000- 5 2.00000+ 7          0          0          0          01306 2151    50
 0.00000+ 0 6.14112- 1          0          0          0          01306 2151    51
                                                                     1306 2  0    52
                                                                     1306 0  0    53
 6.00000+ 3 1.18969+ 1          0         99          0          01306 3  1    54
 3.00000+ 2 0.00000+ 0          0          0          1          8661306 3  1    55
       866          2                                                1306 3  1    56
 1.000000-5 7.911976+1 1.193350-5 7.244845+1 1.386710-5 6.722771+11306 3  1    57
 1.580070-5 6.299862+1 1.773430-5 5.948262+1 2.160150-5 5.392759+11306 3  1    58
 2.546870-5 4.969414+1 2.933590-5 4.633020+1 3.320310-5 4.357423+11306 3  1    59
 4.093750-5 3.928872+1 4.867180-5 3.607434+1 5.640620-5 3.354913+11306 3  1    60
  .
  .
  .
 6.00000+ 3 1.18969+ 1          0          0          0          01306 3229 2238
 3.00000+ 2 0.00000+ 0          0          0          1          6181306 3229 2239
       618          2                                                1306 3229 2240
```

```
1.000000-5 3.051823+0 4.555443-4 4.733945-1 4.555535-4 4.733903-11306 3229 2241
1.822177-3 2.423495-1 1.822214-3 2.423479-1 2.391635-3 2.228712-11306 3229 2242
2.961056-3 2.107348-1 4.099899-3 1.979619-1 4.099981-3 1.979613-11306 3229 2243
4.515467-3 1.957387-1 4.515557-3 1.957384-1 4.971011-3 1.941680-11306 3229 2244
 .
 .
 .
6.00000+ 3 1.18969+ 1          0          0          0          01306 3230 2448
3.00000+ 2 0.00000+ 0          0          0          1        6181306 3230 2449
       618          2                                              1306 3230 2450
1.000000-5 0.000000+0 4.555443-4 0.000000+0 4.555535-4 0.000000+01306 3230 2451
1.822177-3 0.000000+0 1.822214-3 7.392451+0 2.391635-3 5.632392+01306 3230 2452
2.961056-3 4.549263+0 4.099899-3 3.285599+0 4.099981-3 3.285534+01306 3230 2453
4.515467-3 2.983219+0 4.515557-3 3.330007+0 4.971011-3 3.024905+01306 3230 2454
4.971110-3 4.819179+0 6.337644-3 3.780059+0 6.337771-3 4.190413+01306 3230 2455
 .
 .
 .
6.00000+ 3 1.18969+ 1          0          0          0          01306 3301 2658
3.00000+ 2 0.00000+ 0          0          0          1        8661306 3301 2659
       866          2                                              1306 3301 2660
1.000010-5 1.513444+2 1.193350-5 1.385512+2 1.386710-5 1.285330+21306 3301 2661
1.580070-5 1.204165+2 1.773430-5 1.136650+2 2.160150-5 1.029944+21306 3301 2662
2.546870-5 9.485684+1 2.933590-5 8.838563+1 3.320310-5 8.308118+11306 3301 2663
4.093750-5 7.482474+1 4.867180-5 6.862420+1 5.640620-5 6.374702+11306 3301 2664
6.414060-5 5.978092+1 7.187500-5 5.647769+1 8.734350-5 5.123677+11306 3301 2665
 .
 .
 .
6.00000+ 3 1.18969+ 1          0          0          0          01306 3444 2951
3.00000+ 2 0.00000+ 0          0          0          1        8661306 3444 2952
       866          2                                              1306 3444 2953
1.000010-5 1.142386+2 1.193350-5 1.045362+2 1.386710-5 9.697747+11306 3444 2954
1.580070-5 9.085359+1 1.773430-5 8.575963+1 2.160150-5 7.770867+11306 3444 2955
2.546870-5 7.156891+1 2.933590-5 6.668641+1 3.320310-5 6.268422+11306 3444 2956
4.093750-5 5.645475+1 4.867180-5 5.177646+1 5.640620-5 4.809663+11306 3444 2957
 .
 .
 .
6.00000+ 3 1.18969+ 1          0          5          0          01306 6229 7256
3.00000+ 2 0.00000+ 0          0          0          1         521306 6229 7257
        52          2                                              1306 6229 7258
0.00000+ 0 1.00000- 5          0          0        450         101306 6229 7259
0.000000+0 0.000000+0 0.000000+0 0.000000+0 0.000000+0 0.000000+01306 6229 7260
0.000000+0 0.000000+0 0.000000+0 0.000000+0 1.081430-4 0.000000+01306 6229 7261
0.000000+0 0.000000+0 0.000000+0 0.000000+0 0.000000+0 0.000000+01306 6229 7262
0.000000+0 0.000000+0 2.091463-4 1.114684-1-9.050929-1-7.089504-11306 6229 7263
-5.020376-1-2.821791-1-4.633196-2 2.100009-1 4.940009-1 8.185834-11306 6229 7264
4.111530-4 2.668334-1-8.984247-1-6.896068-1-4.713482-1-2.421188-11306 6229 7265
 .
 .
 .
6.00000+ 3 1.18969+ 1          0          7          0          01306 623011901
6.00000+ 3 1.18969+ 1          0          0          0        3141306 623011902
                                                                1306 6  011903
 .
 .
 .
```

II. EXAMPLE 2, CCCC CROSS SECTION LIBRARY

MOUNT ENDF/B-IV TAPE 404 ON UNIT 20.

```
 0
 4
 *MODER*
 20 -21
 *RECONR*
 -21 -22
 *PENDF TAPE FOR PU-238 FROM ENDF/B-IV TAPE 404*/
 1050 3 0
 .005 0 6 /
 *94-PU-238 FROM ENDF/B TAPE T404*/
 *PROCESSED BY THE NJOY NUCLEAR DATA PROCESSING SYSTEM*/
 *SEE ORIGINAL ENDF/B-IV TAPE FOR DETAILS OF EVALUATION*/
 0/
 *BROADR*
 -22 -23
 1050 3 0 1 0 .002 1.E6
 300. 900. 2100.
 0/
 *UNRESR*
 -21 -23 -22
 1050 3 7 1
 300 900 2100
 1.E10 1.E5 1.E4 1000. 100. 10. 1
 0/
 *GROUPR*
 -21 -22 0 -25
 1050 5 0 4 3 3 7 1
 *94-PU-238*/
 300. 900. 2100.
 1.E10 1.E5 1.E4 1000. 100. 10. 1
 .1 0.025 0.8208E06 1.4E06
 3 1 *TOTAL*/
 3 2 *ELASTIC*/
 3 16 *N2N*/
 3 17 *N3N*/
 3 18 *FISSION*/
 3 102 *CAPTURE*/
 3 251 *MUBAR*/
 3 252 *XI*/
 3 253 *GAMMA*/
 3 259 *1/V*/
 6 2 *ELASTIC*/
 6 16 *N2N*/
 6 17 *N,3N*/
 6 18 *FISSION*/
 6 51 *DISCRETE INELASTIC*/
 6 -59 *CONTINUED*/
 6 91 *CONTINUUM INELASTIC*/
 0/
 3 1 *TOTAL*/
 3 2 *ELASTIC*/
 3 18 *FISSION*/
 3 102 *CAPTURE*/
 6 2 *ELASTIC*/
 0/
 3 1 *TOTAL*/
 3 2 *ELASTIC*/
 3 18 *FISSION*/
 3 102 *CAPTURE*/
 6 2 *ELASTIC*/
 0/
 0/
 *CCCCR*
 -25 21 22 0
 1 1 *T2LANL NJOY*/
```

```
*CCCCR TESTS OCT,1981*/
50 0 1 4 1
*PU238* *PU238* *ENDFB4* * 1050 * 1050 10.89
1 0 50 -1
0 2.3821E02 3.3003E-11 1.7461E-12 0. 1.E10 0.0
3 6
300 900 2100
1.E5 1.E4 1000. 100. 10. 1
*STOP*
1**********************************************************************
*                                    *                   *            *
*   $$   $$       $$   $$$$$   $$   $$   *               *  VERS.10/81  *
*   $$$  $$       $$  $$$$$$$   $$ $$    *  NUCLEAR      *  RAN AT LANL *
*   $$$$ $$       $$  $$   $$    $$$$     *  CROSS SECTION *  ON MACH. U  *
*   $$ $$$$  $$  $$  $$   $$     $$      *  PROCESSING   *  ON 11/06/81 *
*   $$  $$$  $$$$$$$ $$$$$$$     $$      *  SYSTEM       *  AT 18:33:09 *
*   $$   $$   $$$$$   $$$$$      $$      *               *              *
*                                    *                   *            *
**********************************************************************

MODER...CHANGE THE MODE OF AN ENDF/B TAPE OR NJOY OUTPUT TAPE          .629S

INPUT UNIT (+ FOR CODED, - FOR BB) ...          20
OUTPUT UNIT (+ FOR CODED, - FOR BB) ...        -21

TAPE LABEL
---------------------------------------
  ENDF/B-IV TAPE 404 (REV. 3)                          1-SEPT-76
                                                                  7.962S
**********************************************************************

RECONR...RECONSTRUCT POINTWISE CROSS SECTIONS IN PENDF FORMAT          8.002S

UNIT FOR ENDF/B TAPE ..................        -21
UNIT FOR PENDF TAPE ...................        -22

LABEL FOR PENDF TAPE
---------------------------------------
 PENDF TAPE FOR PU-238 FROM ENDF/B-IV TAPE 404

TAPE LABEL
---------------------------------------
  ENDF/B-IV TAPE 404 (REV. 3)                          1-SEPT-76

MATERIAL TO BE PROCESSED ..............       1050
RECONSTRUCTION TOLERANCE ..............       .005
RECONSTRUCTION TEMPERATURE ............         0.K
NO. SIGNIFICANT FIGURES ...............          6
RESONANCE-INTEGRAL-CHECK TOLERANCE ....       .100
MAX RESONANCE-INTEGRAL ERROR ..........  5.000E-07

DESCRIPTIVE CARDS FOR PENDF TAPE
---------------------------------------
  94-PU-238 FROM ENDF/B TAPE T404
  PROCESSED BY THE NJOY NUCLEAR DATA PROCESSING SYSTEM
  SEE ORIGINAL ENDF/B-IV TAPE FOR DETAILS OF EVALUATION


PROCESSING MAT    1050
---------------------------------------
  94-PU-238 AI          EVAL-MAY67 ALTER AND DUNFORD


POINTS IN INITIAL UNIONIZED GRID =   111
```

```
POINTS ADDED BY LINEARIZATION = 338                                    10.002S

             ESTIMATED MAXIMUM ERROR DUE TO
             RESONANCE INTEGRAL CHECK (ERRMAX,ERRINT)
             AND SIGNIFICANT FIGURE TRUNCATION (NDIGIT)

   UPPER       ELASTIC     PERCENT ERROR     CAPTURE     PERCENT ERROR
   ENERGY      INTEGRAL   RES-INT SIG-FIG    INTEGRAL   RES-INT SIG-FIG
 1.00E+00
 3.17E+00     1.11E+01    0.000   0.000      3.62E+01    0.000   0.000
 1.04E+01     1.16E+01    0.000   0.000      7.49E+00    0.000   0.000
 3.92E+01     1.65E+01     .000    .000      3.68E+01     .000    .000
 1.24E+02     2.23E+01     .000    .000      2.19E+01     .000    .000
 2.00E+02     1.61E+01     .000    .000      7.93E+00     .000    .000
 1.00E+04     1.07E+02    0.000    .000      1.96E+01    0.000    .000

POINTS ADDED BY RESONANCE RECONSTRUCTION =  2703
POINTS AFFECTED BY RESONANCE INTEGRAL CHECK =   547
POINTS AFFECTED BY SIGNIFICANT FIGURE REDUCTION =    73
POINTS REMOVED BY BACKTHINNING =   569
FINAL NUMBER OF RESONANCE POINTS =  2753
                                                                       20.454S
**************************************************************************

BROADR...DOPPLER BROADENING OF ENDF/B DATA                             20.493S

UNIT FOR INPUT PENDF TAPE .....          -22
UNIT FOR OUTPUT PENDF TAPE .....         -23
MATERIAL TO BE PROCESSED .....          1050
NUMBER OF FINAL TEMPERATURES .....         3
RESTART (0 NO, 1 YES) .....                0
BOOTSTRAP (0 NO, 1 YES) .....              1
STARTING MATERIAL TEMPERATURE .....      0.K
THINNING TOLERANCE .....                .002
MAX. ENERGY .....                   1.00E+06
FINAL TEMPERATURES .....            3.00E+02
                                    9.00E+02
                                    2.10E+03
                                                                       22.968S
BROADENED MAT1050 FROM  0.          TO  3.0000E+02 K
        POINTS IN=  3136  POINTS OUT=  2323
        MT   2  18 102
                                                                       36.196S
BROADENED MAT1050 FROM  3.0000E+02 TO  9.0000E+02 K
        POINTS IN=  2323  POINTS OUT=  2067
        MT   2  18 102
                                                                       41.772S
BROADENED MAT1050 FROM  9.0000E+02 TO  2.1000E+03 K
        POINTS IN=  2067  POINTS OUT=  1822
        MT   2  18 102
                                                                       46.423S
**************************************************************************

UNRESR...CALCULATION OF UNRESOLVED RESONANCE CROSS SECTIONS            46.460S

UNIT FOR INPUT ENDF/B TAPE .....         -21
UNIT FOR INPUT PENDF TAPE .....          -23
UNIT FOR OUTPUT PENDF TAPE .....         -22
TEMPERATURES .....                  3.00E+02
                                    9.00E+02
                                    2.10E+03
SIGMA ZERO VALUES .....             1.00E+10
                                    1.00E+05
                                    1.00E+04
```

```
                                        1.00E+03
                                        1.00E+02
                                        1.00E+01
                                        1.00E+00
PRINT OPTION (0 MIN., 1 MAX.) ........          1

MAT = 1050     TEMP =  3.00E+02                                          46.953S
ENERGY =  2.0000E+02
  6.538E+01  6.442E+01  5.780E+01  3.715E+01  2.018E+01  1.492E+01  1.402E+01
  4.484E+01  4.414E+01  3.937E+01  2.559E+01  1.569E+01  1.292E+01  1.246E+01
  3.582E+00  3.537E+00  3.211E+00  2.004E+00  7.677E-01  3.314E-01  2.553E-01
  1.687E+01  1.666E+01  1.513E+01  9.466E+00  3.633E+00  1.570E+00  1.211E+00
  6.538E+01  6.349E+01  5.185E+01  2.683E+01  1.520E+01  1.284E+01  1.248E+01
ENERGY =  5.0000E+02
  4.541E+01  4.516E+01  4.318E+01  3.351E+01  2.037E+01  1.506E+01  1.409E+01
  3.430E+01  3.411E+01  3.256E+01  2.530E+01  1.636E+01  1.314E+01  1.258E+01
  3.114E+00  3.099E+00  2.975E+00  2.285E+00  1.088E+00  4.963E-01  3.811E-01
  7.852E+00  7.815E+00  7.507E+00  5.789E+00  2.783E+00  1.282E+00  9.880E-01
  4.541E+01  4.492E+01  4.119E+01  2.713E+01  1.562E+01  1.284E+01  1.243E+01
ENERGY =  6.4000E+02
  4.143E+01  4.126E+01  3.985E+01  3.226E+01  2.037E+01  1.511E+01  1.413E+01
  3.210E+01  3.196E+01  3.084E+01  2.497E+01  1.654E+01  1.322E+01  1.263E+01
  2.734E+00  2.723E+00  2.638E+00  2.119E+00  1.079E+00  5.065E-01  3.899E-01
  6.434E+00  6.410E+00  6.214E+00  5.012E+00  2.584E+00  1.229E+00  9.509E-01
  4.143E+01  4.109E+01  3.841E+01  2.690E+01  1.577E+01  1.286E+01  1.243E+01
ENERGY =  8.1920E+02
  3.791E+01  3.779E+01  3.680E+01  3.094E+01  2.034E+01  1.518E+01  1.418E+01
  3.004E+01  2.995E+01  2.914E+01  2.449E+01  1.670E+01  1.330E+01  1.268E+01
  2.423E+00  2.416E+00  2.357E+00  1.970E+00  1.075E+00  5.221E-01  4.040E-01
  5.261E+00  5.246E+00  5.122E+00  4.298E+00  2.379E+00  1.176E+00  9.159E-01
  3.791E+01  3.767E+01  3.577E+01  2.652E+01  1.594E+01  1.290E+01  1.244E+01
    .
    .
    .
ENERGY =  1.0000E+04
  1.893E+01  1.893E+01  1.891E+01  1.871E+01  1.749E+01  1.546E+01  1.474E+01
  1.623E+01  1.623E+01  1.621E+01  1.603E+01  1.498E+01  1.330E+01  1.274E+01
  1.364E+00  1.364E+00  1.362E+00  1.345E+00  1.232E+00  9.902E-01  8.829E-01
  7.047E-01  7.047E-01  7.039E-01  6.967E-01  6.481E-01  5.404E-01  4.901E-01
  1.893E+01  1.893E+01  1.888E+01  1.848E+01  1.642E+01  1.381E+01  1.304E+01
GENERATED CROSS SECTIONS AT  15 POINTS                                  56.434S

MAT = 1050     TEMP =  9.00E+02                                          56.434S
ENERGY =  2.0000E+02
  6.538E+01  6.472E+01  5.986E+01  4.128E+01  2.214E+01  1.557E+01  1.445E+01
  4.484E+01  4.435E+01  4.079E+01  2.805E+01  1.660E+01  1.317E+01  1.261E+01
  3.582E+00  3.552E+00  3.323E+00  2.294E+00  9.477E-01  4.000E-01  3.019E-01
  1.687E+01  1.673E+01  1.566E+01  1.085E+01  4.503E+00  1.906E+00  1.440E+00
  6.538E+01  6.408E+01  5.525E+01  3.068E+01  1.597E+01  1.296E+01  1.254E+01
    .
    .
    .
ENERGY =  1.0000E+04
  1.893E+01  1.893E+01  1.892E+01  1.879E+01  1.798E+01  1.636E+01  1.570E+01
  1.623E+01  1.623E+01  1.622E+01  1.611E+01  1.539E+01  1.399E+01  1.345E+01
  1.364E+00  1.364E+00  1.363E+00  1.354E+00  1.292E+00  1.135E+00  1.055E+00
  7.047E-01  7.047E-01  7.043E-01  7.008E-01  6.749E-01  6.077E-01  5.714E-01
  1.893E+01  1.893E+01  1.890E+01  1.865E+01  1.718E+01  1.476E+01  1.386E+01
GENERATED CROSS SECTIONS AT  15 POINTS                                  64.451S

MAT = 1050     TEMP =  2.10E+03                                          64.451S
ENERGY =  2.0000E+02
  6.538E+01  6.491E+01  6.128E+01  4.503E+01  2.448E+01  1.649E+01  1.509E+01
  4.484E+01  4.449E+01  4.180E+01  3.041E+01  1.777E+01  1.355E+01  1.287E+01
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  3.582E+00  3.561E+00  3.396E+00  2.537E+00  1.150E+00  4.925E-01  3.683E-01
  1.687E+01  1.677E+01  1.600E+01  1.200E+01  5.473E+00  2.354E+00  1.763E+00
  6.538E+01  6.445E+01  5.771E+01  3.469E+01  1.713E+01  1.320E+01  1.268E+01
    .
    .
    .
ENERGY =  1.0000E+04
  1.893E+01  1.893E+01  1.892E+01  1.885E+01  1.833E+01  1.719E+01  1.671E+01
  1.623E+01  1.623E+01  1.623E+01  1.616E+01  1.568E+01  1.464E+01  1.421E+01
  1.364E+00  1.364E+00  1.364E+00  1.360E+00  1.331E+00  1.258E+00  1.220E+00
  7.047E-01  7.048E-01  7.046E-01  7.031E-01  6.923E-01  6.633E-01  6.469E-01
  1.893E+01  1.893E+01  1.891E+01  1.876E+01  1.777E+01  1.583E+01  1.497E+01
GENERATED CROSS SECTIONS AT  15 POINTS                                  72.288S

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GROUPR...COMPUTE SELF-SHIELDED GROUP-AVERAGED CROSS-SECTIONS            72.345S

UNIT FOR ENDF/B TAPE ..................          -21
UNIT FOR PENDF TAPE ...................          -22
UNIT FOR INPUT GOUT TAPE ..............            0
UNIT FOR OUTPUT GOUT TAPE .............          -25
MAT TO BE PROCESSED ...................         1050
NEUTRON GROUP STRUCTURE OPTION ........            5
GAMMA GROUP OPTION ....................            0
WEIGHT FUNCTION OPTION ................            4
LEGENDRE ORDER ........................            3
PRINT OPTION (0 MIN, 1 MAX) ...........            1

RUN TITLE
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     94-PU-238

TEMPERATURES (KELVIN) .................   3.00E+02
                                          9.00E+02
                                          2.10E+03
SIGMA ZEROES ..........................   INFINITY
                                          1.00E+05
                                          1.00E+04
                                          1.00E+03
                                          1.00E+02
                                          1.00E+01
                                          1.00E+00

NEUTRON GROUP STRUCTURE.....RRD 50 GROUP
    1.    1.0000E-05 -   6.8256E-01
    2     6.8256E-01 -   1.1254E+00
    3     1.1254E+00 -   1.8554E+00
    .
    .
    .
   48     3.6788E+06 -   6.0653E+06
   49     6.0653E+06 -   1.0000E+07
   50     1.0000E+07 -   1.9971E+07

WEIGHT FUNCTION.....THERMAL + 1/E + FISSION
THERMAL BREAKPOINT AND TEMPERATURE     1.0000E-01  2.5000E-02
FISSION BREAKPOINT AND TEMPERATURE     8.2080E+05  1.4000E+06

PROCESSING MAT   1050
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 94-PU-238 FROM ENDF/B TAPE T404

GROUP CONSTANTS AT T=3.000E+02 DEG K                                    76.269S
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FOR MF 3 AND MT 1 TOTAL

ENRGY GROUP	LGEND ORDER	GROUP CONSTANTS VS SIGMA ZERO INFINITY	1.000E+05	1.000E+04	1.000E+03	1.000E+02	1.000E+01	1.000E+00
1	0	3.688E+02	3.677E+02	3.594E+02	3.125E+02	2.184E+02	1.663E+02	1.570E+02
FLUX	0	5.021E+00	5.003E+00	4.847E+00	3.826E+00	1.577E+00	2.848E-01	3.179E-02
1	1	3.688E+02	3.667E+02	3.506E+02	2.686E+02	1.318E+02	8.010E+01	7.300E+01
FLUX	1	5.021E+00	4.985E+00	4.683E+00	3.016E+00	6.803E-01	3.161E-02	4.295E-04
2	0	2.476E+01	2.476E+01	2.475E+01	2.472E+01	2.440E+01	2.330E+01	2.265E+01
FLUX	0	5.002E-01	5.000E-01	4.989E-01	4.881E-01	4.021E-01	1.502E-01	2.116E-02
2	1	2.476E+01	2.476E+01	2.475E+01	2.467E+01	2.402E+01	2.172E+01	2.035E+01
FLUX	1	5.002E-01	4.999E-01	4.977E-01	4.763E-01	3.242E-01	4.735E-02	9.912E-04
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50	0	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.879E+00
FLUX	0	9.012E-03	9.012E-03	9.007E-03	8.959E-03	8.512E-03	5.675E-03	1.310E-03
50	1	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.879E+00
FLUX	1	9.012E-03	9.011E-03	9.002E-03	8.907E-03	8.039E-03	3.574E-03	1.904E-04

GROUP CONSTANTS AT T=3.000E+02 DEG K 79.923S
FOR MF 3 AND MT 2 ELASTIC

ENRGY GROUP	GROUP CONSTANTS VS SIGMA ZERO INFINITY	1.000E+05	1.000E+04	1.000E+03	1.000E+02	1.000E+01	1.000E+00
1	1.922E+01	1.921E+01	1.918E+01	1.893E+01	1.817E+01	1.760E+01	1.748E+01
2	1.378E+01	1.378E+01	1.378E+01	1.377E+01	1.369E+01	1.342E+01	1.325E+01
3	9.597E+00	9.597E+00	9.597E+00	9.597E+00	9.597E+00	9.595E+00	9.594E+00
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48	3.654E+00	3.654E+00	3.654E+00	3.654E+00	3.654E+00	3.654E+00	3.653E+00
49	3.115E+00	3.115E+00	3.115E+00	3.115E+00	3.114E+00	3.111E+00	3.106E+00
50	2.719E+00	2.719E+00	2.719E+00	2.719E+00	2.719E+00	2.719E+00	2.719E+00

GROUP CONSTANTS AT T=3.000E+02 DEG K 81.883S
FOR MF 3 AND MT 16 N2N

ENRGY GROUP	GROUP CONSTANTS AT INFINITE DILUTION
49	2.279E-02
50	1.109E-01

GROUP CONSTANTS AT T=3.000E+02 DEG K 82.759S
FOR MF 3 AND MT 17 N3N

ENRGY GROUP	GROUP CONSTANTS AT INFINITE DILUTION
50	2.902E-03

GROUP CONSTANTS AT T=3.000E+02 DEG K 83.374S
FOR MF 3 AND MT 18 FISSION

ENRGY GROUP	GROUP CONSTANTS VS SIGMA ZERO INFINITY	1.000E+05	1.000E+04	1.000E+03	1.000E+02	1.000E+01	1.000E+00

1	1.010E+01	1.007E+01	9.830E+00	8.478E+00	5.772E+00	4.277E+00	4.009E+00
2	2.991E-01	2.991E-01	2.990E-01	2.982E-01	2.917E-01	2.698E-01	2.568E-01
3	2.819E-02	2.819E-02	2.819E-02	2.819E-02	2.817E-02	2.810E-02	2.804E-02
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48	2.612E+00	2.612E+00	2.612E+00	2.612E+00	2.612E+00	2.612E+00	2.612E+00
49	2.605E+00	2.605E+00	2.605E+00	2.605E+00	2.604E+00	2.604E+00	2.602E+00
50	2.470E+00	2.470E+00	2.470E+00	2.470E+00	2.470E+00	2.470E+00	2.470E+00

GROUP CONSTANTS AT T=3.000E+02 DEG K 85.213S
FOR MF 3 AND MT102 CAPTURE

ENRGY GROUP	GROUP CONSTANTS VS SIGMA ZERO INFINITY	1.000E+05	1.000E+04	1.000E+03	1.000E+02	1.000E+01	1.000E+00
1	3.394E+02	3.384E+02	3.304E+02	2.851E+02	1.945E+02	1.445E+02	1.355E+02
2	1.068E+01	1.068E+01	1.068E+01	1.065E+01	1.042E+01	9.615E+00	9.139E+00
3	6.354E-01	6.353E-01	6.353E-01	6.353E-01	6.347E-01	6.320E-01	6.296E-01
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48	1.087E-02	1.087E-02	1.087E-02	1.087E-02	1.087E-02	1.086E-02	1.085E-02
49	7.328E-03	7.328E-03	7.328E-03	7.328E-03	7.327E-03	7.317E-03	7.303E-03
50	5.584E-03	5.584E-03	5.584E-03	5.584E-03	5.584E-03	5.584E-03	5.585E-03

GROUP CONSTANTS AT T=3.000E+02 DEG K 87.195S
FOR MF 3 AND MT251 MUBAR

ENRGY GROUP	GROUP CONSTANTS AT INFINITE DILUTION
1	2.823E-03
2	2.823E-03
3	2.823E-03
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48	8.522E-01
49	8.829E-01
50	8.714E-01

GROUP CONSTANTS AT T=3.000E+02 DEG K 91.153S
FOR MF 3 AND MT252 XI

ENRGY GROUP	GROUP CONSTANTS AT INFINITE DILUTION
2	1.391E-02
3	8.964E-03
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.	
48	2.278E-03
49	3.907E-03
50	6.814E-04

GROUP CONSTANTS AT T=3.000E+02 DEG K 94.320S
FOR MF 3 AND MT253 GAMMA

ENRGY GROUP CONSTANTS AT
GROUP INFINITE DILUTION

2	2.644E-01
3	3.961E-02
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48	5.238E-02
49	2.461E-01
50	1.066E-02

GROUP CONSTANTS AT T=3.000E+02 DEG K 97.083S
FOR MF 3 AND MT259 1/V

ENRGY GROUP CONSTANTS AT
GROUP INFINITE DILUTION

1	3.184E-04
2	7.731E-05
3	6.021E-05
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48	3.393E-08
49	2.693E-08
50	2.142E-08

GROUP CONSTANTS AT T=3.000E+02 DEG K 98.183S
FOR MF 6 AND MT 2 ELASTIC

INITL GROUP	FINAL GROUP	LGEND ORDER	GROUP CONSTANTS VS SIGMA ZERO INFINITY	1.000E+05	1.000E+04	1.000E+03	1.000E+02	1.000E+01	1.000E+00
1	1	0	1.922E+01	1.921E+01	1.918E+01	1.893E+01	1.817E+01	1.760E+01	1.748E+01
1	1	1	5.425E-02	5.423E-02	5.403E-02	5.265E-02	4.889E-02	4.666E-02	4.627E-02
1	1	2	6.891E-05	6.887E-05	6.849E-05	6.597E-05	6.015E-05	5.762E-05	5.723E-05
1	1	3	0.	0.	0.	0.	0.	0.	0.
2	1	0	2.565E-01	2.565E-01	2.563E-01	2.544E-01	2.392E-01	1.969E-01	1.763E-01
2	1	1	-8.499E-02	-8.498E-02	-8.484E-02	-8.358E-02	-7.379E-02	-4.788E-02	-3.646E-02
2	1	2	-3.068E-04	-3.066E-04	-3.047E-04	-2.867E-04	-1.666E-04	3.438E-06	2.300E-05
2	1	3	-1.296E-06	-1.291E-06	-1.241E-06	-7.816E-07	1.434E-06	1.144E-06	4.647E-07
2	2	0	1.352E+01	1.352E+01	1.352E+01	1.351E+01	1.345E+01	1.322E+01	1.307E+01
2	2	1	1.239E-01	1.239E-01	1.237E-01	1.224E-01	1.122E-01	8.462E-02	7.219E-02
2	2	2	3.562E-04	3.560E-04	3.541E-04	3.360E-04	2.150E-04	4.177E-05	2.038E-05
2	2	3	1.296E-06	1.291E-06	1.241E-06	7.816E-07	-1.434E-06	-1.144E-06	-4.647E-07
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50	49	0	9.862E-02	9.862E-02	9.862E-02	9.861E-02	9.860E-02	9.848E-02	9.831E-02
50	49	1	8.107E-02	8.107E-02	8.107E-02	8.107E-02	8.104E-02	8.085E-02	8.056E-02
50	49	2	7.195E-02	7.195E-02	7.195E-02	7.194E-02	7.190E-02	7.166E-02	7.127E-02
50	49	3	6.249E-02	6.249E-02	6.249E-02	6.249E-02	6.244E-02	6.216E-02	6.170E-02
50	50	0	2.621E+00	2.621E+00	2.621E+00	2.621E+00	2.621E+00	2.620E+00	2.620E+00
50	50	1	2.288E+00	2.288E+00	2.288E+00	2.288E+00	2.288E+00	2.288E+00	2.288E+00
50	50	2	1.983E+00	1.983E+00	1.983E+00	1.983E+00	1.983E+00	1.983E+00	1.982E+00
50	50	3	1.721E+00	1.721E+00	1.721E+00	1.721E+00	1.721E+00	1.721E+00	1.720E+00

GROUP CONSTANTS AT T=3.000E+02 DEG K 106.530S
FOR MF 6 AND MT 16 N2N

INITL GROUP	FINAL GROUP	ISOTROPIC MATRIX VS FINAL GROUP +0	+1	+2	+3		
49	10	1.393E-09	3.784E-09	1.028E-08	2.790E-08	2.860E-08	4.708E-08
49	16	7.749E-08	1.275E-07	2.096E-07	3.443E-07	5.650E-07	9.261E-07
49	22	1.516E-06	2.475E-06	4.033E-06	6.553E-06	1.061E-05	1.710E-05
49	28	2.744E-05	4.377E-05	6.942E-05	1.094E-04	1.703E-04	2.623E-04
49	34	4.056E-04	6.185E-04	9.266E-04	1.362E-03	1.952E-03	2.709E-03
49	40	3.610E-03	4.566E-03	5.411E-03	5.900E-03	1.075E-02	5.532E-03
49	46	1.071E-03	3.635E-05				
50	10	1.995E-09	5.423E-09	1.474E-08	4.006E-08	4.110E-08	6.774E-08
50	16	1.117E-07	1.840E-07	3.032E-07	4.996E-07	8.229E-07	1.355E-06
50	22	2.231E-06	3.672E-06	6.039E-06	9.927E-06	1.630E-05	2.674E-05
50	28	4.380E-05	7.162E-05	1.168E-04	1.900E-04	3.077E-04	4.960E-04
50	34	7.944E-04	1.262E-03	1.983E-03	3.075E-03	4.685E-03	6.983E-03
50	40	1.012E-02	1.413E-02	1.885E-02	2.370E-02	5.701E-02	5.008E-02
50	46	2.329E-02	4.350E-03	2.214E-04	2.778E-06	6.290E-09	

GROUP CONSTANTS AT T=3.000E+02 DEG K 107.332S
FOR MF 6 AND MT 17 N,3N

INITL GROUP	FINAL GROUP	ISOTROPIC MATRIX VS FINAL GROUP +0	+1	+2	+3		
50	12	1.249E-09	3.394E-09	3.48 E-09	5.737E-09	9.454E-09	1.558E-08
50	18	2.566E-08	4.226E-08	6.957E-08	1.145E-07	1.883E-07	3.095E-07
50	24	5.084E-07	8.340E-07	1.366E-06	2.234E-06	3.645E-06	5.929E-06
50	30	9.609E-06	1.550E-05	2.474E-05	3.899E-05	6.151E-05	9.583E-05
50	36	1.470E-04	2.210E-04	3.239E-04	4.594E-04	6.261E-04	8.110E-04
50	42	9.852E-04	1.105E-03	2.127E-03	1.253E-03	3.468E-04	3.811E-05
50	48	1.227E-06	2.685E-09				

GROUP CONSTANTS AT T=3.000E+02 DEG K 107.948S
FOR MF 6 AND MT 18 FISSION

INITL GROUP	FINAL GROUP	ISOTROPIC MATRIX VS FINAL GROUP +0	+1	+2	+3		
1	1	1.502E-07	4.860E-08	6.913E-08	1.032E-07	1.634E-07	2.756E-07
1	7	4.942E-07	9.327E-07	1.831E-06	3.697E-06	7.600E-06	1.581E-05
1	13	3.313E-05	2.843E-05	4.127E-05	5.995E-05	8.711E-05	1.266E-04
1	19	1.841E-04	2.676E-04	3.392E-04	5.659E-04	8.229E-04	1.196E-03
1	25	1.739E-03	2.528E-03	3.673E-03	5.335E-03	7.746E-03	1.124E-02
1	31	1.629E-02	2.359E-02	3.412E-02	4.926E-02	7.097E-02	1.019E-01
1	37	1.459E-01	2.079E-01	2.944E-01	4.137E-01	5.756E-01	7.909E-01
1	43	1.069E+00	3.240E+00	4.981E+00	6.252E+00	5.656E+00	3.043E+00
1	49	7.278E-01	5.046E-02				
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50	1	5.479E-08	1.772E-08	2.521E-08	3.764E-08	5.958E-08	1.005E-07
50	7	1.802E-07	3.402E-07	6.678E-07	1.348E-06	2.772E-06	5.765E-06
50	13	1.208E-05	1.037E-05	1.505E-05	2.186E-05	3.177E-05	4.617E-05
50	19	6.713E-05	9.760E-05	1.419E-04	2.064E-04	3.001E-04	4.363E-04
50	25	6.343E-04	9.219E-04	1.340E-03	1.946E-03	2.825E-03	4.098E-03
50	31	5.941E-03	8.604E-03	1.244E-02	1.797E-02	2.588E-02	3.718E-02
50	37	5.321E-02	7.581E-02	1.074E-01	1.509E-01	2.099E-01	2.884E-01
50	43	3.899E-01	1.182E+00	1.817E+00	2.280E+00	2.063E+00	1.110E+00
50	49	2.654E-01	1.840E-02				

GROUP CONSTANTS AT T=3.000E+02 DEG K 111.474S

FOR MF 6 AND MT 51 DISCRETE INELASTIC

INITL GROUP	FINAL GROUP	GROUP CONSTANTS VS LEGENDRE ORDER 0	1	2	3
34	7	6.049E-09	-4.087E-09	1.650E-09	-1.675E-10
34	8	6.705E-08	-2.319E-08	-1.058E-10	6.584E-10
34	9	3.394E-07	-4.658E-08	-2.401E-09	-1.767E-10
34	10	1.198E-06	-8.683E-08	-3.170E-09	-2.305E-10
34	11	3.712E-06	-1.681E-07	-4.294E-09	-2.274E-10
34	12	1.083E-05	-3.358E-07	-6.115E-09	-2.057E-10
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49	49	6.838E-01	1.102E-02	8.335E-05	3.840E-08
50	49	4.998E-02	-7.339E-03	-1.952E-03	1.240E-03
50	50	5.148E-01	8.936E-03	1.954E-03	-1.240E-03

GROUP CONSTANTS AT T=3.000E+02 DEG K 112.670S
FOR MF 6 AND MT 52 CONTINUED

INITL GROUP	FINAL GROUP	GROUP CONSTANTS VS LEGENDRE ORDER 0	1	2	3
39	23	6.203E-08	-1.156E-08	5.300E-10	1.642E-11
39	24	2.830E-07	-8.121E-09	-6.178E-10	-1.351E-11
39	25	5.311E-07	-7.251E-09	-4.973E-11	-5.492E-13
39	26	9.425E-07	-9.902E-09	-5.765E-11	-5.285E-13
39	27	1.630E-06	-1.364E-08	-1.660E-11	-3.910E-11
39	28	3.371E-06	-7.323E-08	1.004E-09	5.536E-11
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47	47	1.420E-02	1.654E-04	7.193E-07	-1.605E-10
48	47	5.958E-04	-1.926E-05	-1.048E-06	-8.418E-11
48	48	1.401E-04	2.138E-05	1.050E-06	8.418E-11

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GROUP CONSTANTS AT T=3.000E+02 DEG K 121.078S
FOR MF 6 AND MT 59 CONTINUED

INITL GROUP	FINAL GROUP	GROUP CONSTANTS VS LEGENDRE ORDER 0	1	2	3
45	31	4.304E-09	-3.570E-09	2.402E-09	-1.230E-09
45	32	1.957E-06	-2.728E-07	6.661E-09	1.462E-09
45	33	8.935E-06	-3.852E-07	-3.297E-09	-4.346E-11
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47	46	9.251E-03	5.328E-05	-2.240E-07	-3.366E-10
47	47	1.441E-03	5.122E-05	5.729E-07	6.328E-10
48	47	6.231E-04	2.082E-06	3.130E-09	2.416E-15

GROUP CONSTANTS AT T=3.000E+02 DEG K 122.630S
FOR MF 6 AND MT 91 CONTINUUM INELASTIC

INITL GROUP	FINAL GROUP	GROUP CONSTANTS VS LEGENDRE ORDER 0	1	2	3

45	12	2.470E-09	6.972E-12	7.411E-15	0.
45	13	6.713E-09	1.894E-11	2.014E-14	0.
45	14	6.886E-09	1.943E-11	2.066E-14	0.
45	15	1.135E-08	3.203E-11	3.405E-14	0.
45	16	1.870E-08	5.278E-11	5.611E-14	0.
45	17	3.082E-08	8.696E-11	9.245E-14	0.
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50	48	1.018E-04	2.872E-07	3.054E-10	0.
50	49	3.252E-06	9.176E-09	9.755E-12	0.
50	50	5.733E-09	1.618E-11	1.720E-14	0.

GROUP CONSTANTS AT T=9.000E+02 DEG K 127.737S
FOR MF 3 AND MT 1 TOTAL

ENRGY GROUP	LGEND ORDER	GROUP CONSTANTS VS SIGMA ZERO INFINITY	1.000E+05	1.000E+04	1.000E+03	1.000E+02	1.000E+01	1.000E+00
1	0	3.690E+02	3.679E+02	3.596E+02	3.127E+02	2.186E+02	1.665E+02	1.571E+02
FLUX	0	5.021E+00	5.003E+00	4.847E+00	3.825E+00	1.576E+00	2.845E-01	3.176E-02
1	1	3.690E+02	3.669E+02	3.508E+02	2.687E+02	1.319E+02	8.019E+01	7.310E+01
FLUX	1	5.021E+00	4.985E+00	4.683E+00	3.015E+00	6.797E-01	3.155E-02	4.286E-04
2	0	2.485E+01	2.485E+01	2.485E+01	2.481E+01	2.451E+01	2.352E+01	2.294E+01
FLUX	0	5.002E-01	5.000E-01	4.989E-01	4.881E-01	4.017E-01	1.492E-01	2.089E-02
2	1	2.485E+01	2.485E+01	2.484E+01	2.477E+01	2.417E+01	2.210E+01	2.088E+01
FLUX	1	5.002E-01	4.999E-01	4.977E-01	4.763E-01	3.235E-01	4.649E-02	9.552E-04
3	0	1.032E+01	1.032E+01	1.032E+01	1.032E+01	1.031E+01	1.031E+01	1.030E+01
FLUX	0	5.001E-01	5.001E-01	4.996E-01	4.950E-01	4.534E-01	2.463E-01	4.426E-02
3	1	1.032E+01	1.032E+01	1.032E+01	1.032E+01	1.031E+01	1.030E+01	1.029E+01
FLUX	1	5.001E-01	5.000E-01	4.991E-01	4.900E-01	4.110E-01	1.213E-01	3.922E-03
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50	0	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.879E+00
FLUX	0	9.012E-03	9.012E-03	9.007E-03	8.959E-03	8.512E-03	5.675E-03	1.310E-03
50	1	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.879E+00
FLUX	1	9.012E-03	9.011E-03	9.002E-03	8.907E-03	8.039E-03	3.574E-03	1.904E-04

GROUP CONSTANTS AT T=9.000E+02 DEG K 131.012S
FOR MF 3 AND MT 2 ELASTIC

ENRGY GROUP	GROUP CONSTANTS VS SIGMA ZERO INFINITY	1.000E+05	1.000E+04	1.000E+03	1.000E+02	1.000E+01	1.000E+00
1	1.927E+01	1.927E+01	1.923E+01	1.897E+01	1.820E+01	1.762E+01	1.750E+01
2	1.380E+01	1.380E+01	1.379E+01	1.379E+01	1.372E+01	1.347E+01	1.333E+01
3	9.615E+00	9.615E+00	9.615E+00	9.615E+00	9.614E+00	9.612E+00	9.610E+00
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48	3.654E+00	3.654E+00	3.654E+00	3.654E+00	3.654E+00	3.654E+00	3.653E+00
49	3.115E+00	3.115E+00	3.115E+00	3.115E+00	3.114E+00	3.111E+00	3.106E+00
50	2.719E+00	2.719E+00	2.719E+00	2.719E+00	2.719E+00	2.719E+00	2.719E+00

GROUP CONSTANTS AT T=9.000E+02 DEG K 133.413S
FOR MF 3 AND MT 18 FISSION

ENRGY GROUP	GROUP CONSTANTS VS SIGMA ZERO INFINITY	1.000E+05	1.000E+04	1.000E+03	1.000E+02	1.000E+01	1.000E+00

1	1.011E+01	1.008E+01	9.834E+00	8.482E+00	5.775E+00	4.281E+00	4.013E+00
2	3.010E-01	3.010E-01	3.009E-01	3.002E-01	2.942E-01	2.742E-01	2.626E-01
3	2.916E-02	2.916E-02	2.916E-02	2.916E-02	2.913E-02	2.902E-02	2.892E-02
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48	2.612E+00	2.612E+00	2.612E+00	2.612E+00	2.612E+00	2.612E+00	2.612E+00
49	2.605E+00	2.605E+00	2.605E+00	2.605E+00	2.604E+00	2.604E+00	2.602E+00
50	2.470E+00	2.470E+00	2.470E+00	2.470E+00	2.470E+00	2.470E+00	2.470E+00

GROUP CONSTANTS AT T=9.000E+02 DEG K 135.595S
FOR MF 3 AND MT102 CAPTURE

ENRGY GROUP CONSTANTS VS SIGMA ZERO

GROUP	INFINITY	1.000E+05	1.000E+04	1.000E+03	1.000E+02	1.000E+01	1.000E+00
1	3.396E+02	3.386E+02	3.305E+02	2.852E+02	1.946E+02	1.446E+02	1.356E+02
2	1.075E+01	1.075E+01	1.075E+01	1.072E+01	1.050E+01	9.775E+00	9.352E+00
3	6.717E-01	6.717E-01	6.717E-01	6.716E-01	6.707E-01	6.664E-01	6.627E-01
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48	1.087E-02	1.087E-02	1.087E-02	1.087E-02	1.087E-02	1.086E-02	1.085E-02
49	7.328E-03	7.328E-03	7.328E-03	7.328E-03	7.327E-03	7.317E-03	7.303E-03
50	5.584E-03	5.584E-03	5.584E-03	5.584E-03	5.584E-03	5.584E-03	5.585E-03

GROUP CONSTANTS AT T=9.000E+02 DEG K 137.878S
FOR MF 6 AND MT 2 ELASTIC

INITL FINAL LGEND GROUP CONSTANTS VS SIGMA ZERO

GROUP	GROUP	ORDER	INFINITY	1.000E+05	1.000E+04	1.000E+03	1.000E+02	1.000E+01	1.000E+00
1	1	0	1.927E+01	1.927E+01	1.923E+01	1.897E+01	1.820E+01	1.762E+01	1.750E+01
1	1	1	5.441E-02	5.438E-02	5.417E-02	5.274E-02	4.892E-02	4.668E-02	4.629E-02
1	1	2	6.912E-05	6.907E-05	6.867E-05	6.606E-05	6.017E-05	5.763E-05	5.724E-05
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50	50	0	2.621E+00	2.621E+00	2.621E+00	2.621E+00	2.621E+00	2.620E+00	2.620E+00
50	50	1	2.288E+00	2.288E+00	2.288E+00	2.288E+00	2.288E+00	2.288E+00	2.288E+00
50	50	2	1.983E+00	1.983E+00	1.983E+00	1.983E+00	1.983E+00	1.983E+00	1.982E+00
50	50	3	1.721E+00	1.721E+00	1.721E+00	1.721E+00	1.721E+00	1.721E+00	1.720E+00

GROUP CONSTANTS AT T=2.100E+03 DEG K 149.334S
FOR MF 3 AND MT 1 TOTAL

ENRGY LGEND GROUP CONSTANTS VS SIGMA ZERO

GROUP	ORDER	INFINITY	1.000E+05	1.000E+04	1.000E+03	1.000E+02	1.000E+01	1.000E+00
1	0	3.688E+02	3.678E+02	3.594E+02	3.126E+02	2.186E+02	1.666E+02	1.573E+02
FLUX	0	5.021E+00	5.003E+00	4.847E+00	3.826E+00	1.576E+00	2.843E-01	3.173E-02
1	1	3.688E+02	3.667E+02	3.507E+02	2.687E+02	1.320E+02	8.031E+01	7.321E+01
FLUX	1	5.021E+00	4.985E+00	4.683E+00	3.015E+00	6.793E-01	3.148E-02	4.276E-04
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50	0	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.879E+00
FLUX	0	9.012E-03	9.012E-03	9.007E-03	8.959E-03	8.512E-03	5.675E-03	1.310E-03
50	1	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.880E+00	5.879E+00
FLUX	1	9.012E-03	9.011E-03	9.002E-03	8.907E-03	8.039E-03	3.574E-03	1.904E-04

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GROUP CONSTANTS AT T=2.100E+03 DEG K 157.48S
FOR MF 6 AND MT 2 ELASTIC

INITL GROUP	FINAL GROUP	LGEND ORDER	GROUP CONSTANTS VS SIGMA ZERO INFINITY	1.000E+05	1.000E+04	1.000E+03	1.000E+02	1.000E+01	1.000E+00
1	1	0	1.939E+01	1.938E+01	1.934E+01	1.905E+01	1.825E+01	1.765E+01	1.753E+01
1	1	1	5.473E-02	5.470E-02	5.445E-02	5.292E-02	4.899E-02	4.671E-02	4.632E-02
1	1	2	6.952E-05	6.946E-05	6.901E-05	6.624E-05	6.022E-05	5.765E-05	5.727E-05
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50	50	1	2.288E+00	2.288E+00	2.288E+00	2.288E+00	2.288E+00	2.288E+00	2.288E+00
50	50	2	1.983E+00	1.983E+00	1.983E+00	1.983E+00	1.983E+00	1.983E+00	1.982E+00
50	50	3	1.721E+00	1.721E+00	1.721E+00	1.721E+00	1.721E+00	1.721E+00	1.720E+00

165.157S

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CCCCR...PRODUCE CCCC FORMAT OUTPUT FILES 165.194S

INPUT GENDF UNIT ..... -25
OUTPUT ISOTXS UNIT 21
OUTPUT BRKOXS UNIT 22
OUTPUT DLAYXS UNIT 0

FILE ISOTXS -- VERSION 1 -- UNIT 21
USER IDENTIFICATIONT2LANL NJOY

FILE CONTROL PARAMETERS

NGROUP	NUMBER OF ENERGY GROUPS IN SET	50
NISO	NUMBER OF ISOTOPES IN SET	1
MAXUP	MAXIMUM NUMBER OF UPSCATTER GROUPS	0
MAXDN	MAXIMUM NUMBER OF DOWNSCATTER GROUPS	50
MAXORD	MAXIMUM SCATTERING ORDER	4
ICHIST	SET FISSION SPECTRUM FLAG ICHIST=1 SET VECTOR =NGROUP, SET MATRIX	0
NSCMAX	MAXIMUM NUMBER OF BLOCKS OF SCATTERING DATA	4
NSBLOK	BLOCKING CONTROL FOR SCATTERING DATA	1

CCCCR TESTS OCT,1981

ISOTOPE	NAME
1	PU238

GROUP	NEUTRON VELOCITY (CM/SEC)	UPPER ENERGY (EV)
1	4.667684E+09	1.997108E+07
2	3.712734E+09	1.000000E+07
3	2.947111E+09	6.065307E+06
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48	1.660850E+06	1.855391E+00

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   49          1.293479E+06          1.125352E+00
   50          3.140241E+05          6.825603E-01
                                     1.000021E-05

NUMBER OF RECORDS TO BE SKIPPED

    ISOTOPE  NUMBER
       1        0

ISOTOPE  1

ISOTOPE CONTROL PARAMETERS

 HABSID  ABSOLUTE ISOTOPE LABEL                                  PU238
 HIDENT  LIBRARY IDENTIFIER                                     ENDFB4
 HMAT    ISOTOPE IDENTIFICATION                                  1050
 AMASS   GRAM ATOMIC WEIGHT                                  2.38210E+02
 EFISS   THERMAL ENERGY/FISSION (W*SEC/FISS)                 3.30030E-11
 ECAPT   THERMAL ENERGY/CAPTURE (W*SEC/CAPT)                 1.74610E-12
 TEMP    ISOTOPE TEMPERATURE (DEG K)                         0.
 SIGPOT  AVE. POTENTIAL SCATTERING (BARNS/ATOM)              1.00000E+10
 ADENS   REFERENCE ATOM DENSITY (A/B*CM)                     0.
 KBR     ISOTOPE CLASSIFICATION                                       0
 ICHI    FISSION SPECTRUM FLAG (O/1/N=SET CHI/VECTOR/MATRIX)          1
 IFIS    (N,F) X-SEC FLAG (O/1=NO/YES)                                1
 IALF    (N,A) X-SEC FLAG (O/1=NO/YES)                                0
 INP     (N,P) X-SEC FLAG (O/1=NO/YES)                                0
 IN2N    (N,2N) X-SEC FLAG (O/1=NO/YES)                               1
 IND     (N,D) X-SEC FLAG (O/1=NO/YES)                                0
 INT     (N,T) X-SEC FLAG (O/1=NO/YES)                                0
 LTOT    NUMBER OF TOTAL X-SEC MOMENTS                                1
 LTRN    NUMBER OF TRANSPORT X-SEC MOMENTS                            1
 ISTRPD  NUMBER OF TRANSPORT X-SEC DIRECTIONS                         0

BLOCK     TYPE     IDENT    ORDERS

    1    INELAS     200        4
    2    ELASTC     100        4
    3       N2N     300        1
    4     TOTAL       0        4

SCATTERING BANDWIDTH AND IN-GROUP SCATTERING POSITION

GROUP/BLOCK       1    2    3    4    1    2    3    4
    1             1    1    1    1    1    1    1    1
    2             2    2    2    2    1    1    1    1
    3             3    2    3    3    1    1    1    1
   ..
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    .
   48             0    2    0    2    1    1    1    1
   49             0    2    0    2    1    1    1    1
   50             0    2    0    2    1    1    1    1

PRINCIPAL CROSS-SECTIONS

GROUP     STRPL        STOTPL        SNGAM         SFIS        SNUTOT        CHISO         SN2N
  1   3.508785E+00 5.879757E+00 5.583553E-03 2.469865E+00 4.101729E+00 1.816369E-03 1.109183E-01
  2   3.835912E+00 6.588224E+00 7.328427E-03 2.604587E+00 3.605884E+00 2.619729E-02 2.278995E-02
  3   4.199807E+00 7.316763E+00 1.086872E-02 2.611864E+00 3.292566E+00 1.095327E-01 0.
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 48   1.023363E+01 1.026073E+01 6.353501E-01 2.818899E-02 2.750000E+00 2.486807E-09 0.
 49   2.471991E+01 2.475880E+01 1.068274E+01 2.990718E-01 2.750000E+00 1.748206E-09 0.
 50   3.687034E+02 3.687577E+02 3.394378E+02 1.010177E+01 2.750000E+00 5.404519E-09 0.
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MATRIX ** INELAS **

FINAL GROUP	INITL GROUP	XSEC VS LEGENDRE ORDER ORDER 0	ORDER 1	ORDER 2	ORDER 3
1	1	5.148E-01	8.936E-03	1.954E-03	-1.240E-03
2	2	6.838E-01	1.102E-02	8.335E-05	3.840E-08
	1	4.998E-02	-7.339E-03	-1.952E-03	1.240E-03
3	3	7.830E-01	8.773E-03	3.410E-05	7.016E-09
	2	5.210E-02	-8.934E-03	-8.070E-05	-3.840E-08
	1	1.030E-04	2.872E-07	3.054E-10	0.
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41	17	1.198E-06	-8.683E-08	-3.170E-09	-2.305E-10
	5	2.396E-09	6.762E-12	7.188E-15	0.
	4	1.693E-09	4.779E-12	5.080E-15	0.
	3	1.763E-09	4.974E-12	5.288E-15	0.
42	17	3.394E-07	-4.658E-08	-2.401E-09	-1.767E-10
43	17	6.705E-08	-2.319E-08	-1.058E-10	6.584E-10
44	17	6.049E-09	-4.087E-09	1.650E-09	-1.675E-10

MATRIX ** ELASTC **

FINAL GROUP	INITL GROUP	XSEC VS LEGENDRE ORDER ORDER 0	ORDER 1	ORDER 2	ORDER 3
1	1	2.621E+00	2.288E+00	1.983E+00	1.721E+00
2	2	3.101E+00	2.747E+00	2.440E+00	2.089E+00
	1	9.862E-02	8.107E-02	7.195E-02	6.249E-02
3	3	3.638E+00	3.111E+00	2.685E+00	2.185E+00
	2	1.389E-02	3.195E-03	4.247E-03	1.441E-03
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50	50	1.922E+01	5.425E-02	6.891E-05	0.
	49	2.565E-01	-8.499E-02	-3.068E-04	-1.296E-06

MATRIX ** N2N **

FINAL GROUP	INITL GROUP	XSEC VS INITL GROUP -0	-1	-2	-3
1	1	6.290E-09			
2	1	2.778E-06			
3	1	2.214E-04			
4	2	3.635E-05	4.350E-03		
5	2	1.071E-03	2.329E-02		
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39	2	1.028E-08	1.474E-08		
40	2	3.784E-09	5.423E-09		
41	2	1.393E-09	1.995E-09		

MATRIX ** TOTAL **

FINAL GROUP	INITL GROUP	XSEC VS LEGENDRE ORDER ORDER 0	ORDER 1	ORDER 2	ORDER 3

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   1       1      3.135E+00   2.297E+00   1.985E+00   1.720E+00
   2       2      3.785E+00   2.758E+00   2.440E+00   2.089E+00
           1      1.486E-01   7.373E-02   7.000E-02   6.373E-02
   3       3      4.421E+00   3.120E+00   2.685E+00   2.185E+00
           2      6.599E-02  -5.739E-03   4.966E-03   1.440E-03
           1      3.244E-04   2.872E-07   3.054E-10   0.
    .
    .
    .
  49      49      1.352E+01   1.239E-01   3.562E-04   1.296E-06
          48      1.720E-01  -5.678E-02  -3.417E-04   1.393E-07
  50      50      1.922E+01   5.425E-02   6.891E-05   0.
          49      2.565E-01  -8.499E-02  -3.068E-04  -1.296E-06


1***FILE BRKOXS -- VERSION  1 -- UNIT 22***
 **USER IDENTIFICATION**T2LANL     NJOY

 FILE CONTROL PARAMETERS

  NGROUP     NUMBER OF ENERGY GROUPS IN SET                    50
  NISOSH     NUMBER OF ISOTOPES WITH SELF-
               SHIELDING FACTORS                                1
  NSIGPT     TOTAL NUMBER OF VALUES OF VARIABLE X
               WHICH ARE GIVEN.  NSIGPT IS EQUAL TO
               THE SUM FROM 1 TO NISOSH OF NTABP(I)             6
  NTEMPT     TOTAL NUMBER OF VALUES OF VARIABLE TB
               WHICH ARE GIVEN.  NTEMPT IS EQUAL TO
             THE SUM FROM 1 TO NISOSH OF NTABT(I)               3
  NREACT     NUMBER OF REACTIONS                               6
  IBLK       BLOCKING OPTION                                   0

     ISOTOPE     NAME
        1        PU238

 LN(SIGPO)/LN(10) VALUES FOR ALL ISOTOPES
     ISOTOPE       1ST VALUE       2ND VALUE                  . . .
         1     5.00000E+00     4.00000E+00     3.00000E+00     2.00000E+00     1.00000E+00     0.

 TEMPERATURES (DEG C) FOR ALL ISOTOPES

 ISOTOPE       1ST VALUE       2ND VALUE                  . . .
         1     2.68400E+01     6.26840E+02     1.82684E+03

 MAXIMUM ENERGY BOUND
   GROUP J
         1   1.99711E+07
         2   1.00000E+07
         3   6.06531E+06
             .
             .
             .
        48   1.85539E+00
        49   1.12535E+00
        50   6.82560E-01

 MINIMUM ENERGY BOUND OF SET

                 1.00002E-05

 F-FACTOR START AND STOP GROUPS
 AND NUMBER OF SIGO AND TEMPERATURE VALUES

 ISOTOPE            JBFH            JBFL           NTABF           NTABT
       1               1              50               6               3
```

TOTAL SELF-SHIELDING FACTORS ISOTOPE 1

GROUP	1		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	1.00000E+00	1.00000E+00	1.00000E+00
2	1.00000E+00	1.00000E+00	1.00000E+00
3	9.99999E-01	9.99999E-01	9.99999E-01
4	9.99994E-01	9.99994E-01	9.99994E-01
5	9.99957E-01	9.99957E-01	9.99957E-01
6	9.99903E-01	9.99903E-01	9.99903E-01
GROUP	2		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	1.00000E+00	1.00000E+00	1.00000E+00
2	9.99997E-01	9.99997E-01	9.99997E-01
3	9.99969E-01	9.99969E-01	9.99969E-01
4	9.99702E-01	9.99702E-01	9.99702E-01
5	9.98061E-01	9.98061E-01	9.98061E-01
6	9.95676E-01	9.95676E-01	9.95676E-01

.
.
.

GROUP	50		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.94392E-01	9.94954E-01	9.94545E-01
2	9.50729E-01	9.51253E-01	9.50906E-01
3	7.28257E-01	7.28645E-01	7.28597E-01
4	3.57339E-01	3.57631E-01	3.57933E-01
5	2.17207E-01	2.17473E-01	2.17792E-01
6	1.97971E-01	1.98227E-01	1.98536E-01

CAPTURE SELF-SHIELDING FACTORS ISOTOPE 1

GROUP	1		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	1.00000E+00	1.00000E+00	1.00000E+00
2	1.00000E+00	1.00000E+00	1.00000E+00
3	1.00000E+00	1.00000E+00	1.00000E+00
4	1.00001E+00	1.00001E+00	1.00001E+00
5	1.00008E+00	1.00008E+00	1.00008E+00
6	1.00017E+00	1.00017E+00	1.00017E+00
GROUP	2		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	1.00000E+00	1.00000E+00	1.00000E+00
2	9.99997E-01	9.99997E-01	9.99997E-01
3	9.99974E-01	9.99974E-01	9.99974E-01
4	9.99753E-01	9.99753E-01	9.99753E-01
5	9.98403E-01	9.98403E-01	9.98403E-01
6	9.96466E-01	9.96466E-01	9.96466E-01

.
.
.

GROUP	50		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	9.97040E-01	9.97475E-01	9.96721E-01
2	9.73241E-01	9.73662E-01	9.72957E-01
3	8.39920E-01	8.40290E-01	8.39841E-01
4	5.73007E-01	5.73354E-01	5.73336E-01
5	4.25570E-01	4.25969E-01	4.26188E-01
6	3.99121E-01	3.99534E-01	3.99798E-01

FISSION SELF-SHIELDING FACTORS ISOTOPE 1

GROUP	1		
SIGO	TEMP 1	TEMP 2	TEMP 3
1	1.00000E+00	1.00000E+00	1.00000E+00
2	1.00000E+00	1.00000E+00	1.00000E+00
3	1.00000E+00	1.00000E+00	1.00000E+00

```
          4       1.00000E+00   1.00000E+00   1.00000E+00
          5       1.00000E+00   1.00000E+00   1.00000E+00
          6       1.00001E+00   1.00001E+00   1.00001E+00
       GROUP      2
       SIGO       TEMP     1    TEMP     2    TEMP     3
          1       1.00000E+00   1.00000E+00   1.00000E+00
          2       9.99999E-01   9.99999E-01   9.99999E-01
          3       9.99993E-01   9.99993E-01   9.99993E-01
          4       9.99937E-01   9.99937E-01   9.99937E-01
          5       9.99589E-01   9.99589E-01   9.99589E-01
          6       9.99088E-01   9.99088E-01   9.99088E-01
       .
       .
       .
       GROUP     50
       SIGO       TEMP     1    TEMP     2    TEMP     3
          1       9.97027E-01   9.97451E-01   9.96669E-01
          2       9.73128E-01   9.73539E-01   9.72809E-01
          3       8.39276E-01   8.39638E-01   8.39169E-01
          4       5.71351E-01   5.71694E-01   5.71665E-01
          5       4.23412E-01   4.23808E-01   4.24021E-01
          6       3.96881E-01   3.97292E-01   3.97550E-01

TRANSPORT SELF-SHIELDING FACTORS              ISOTOPE  1
       GROUP      1
       SIGO       TEMP     1    TEMP     2    TEMP     3
          1       1.00000E+00   1.00000E+00   1.00000E+00
          2       1.00000E+00   1.00000E+00   1.00000E+00
          3       1.00000E+00   1.00000E+00   1.00000E+00
          4       1.00001E+00   1.00001E+00   1.00001E+00
          5       1.00005E+00   1.00005E+00   1.00005E+00
          6       1.00010E+00   1.00010E+00   1.00010E+00
       GROUP      2
       SIGO       TEMP     1    TEMP     2    TEMP     3
          1       1.00000E+00   1.00000E+00   1.00000E+00
          2       9.99998E-01   9.99998E-01   9.99998E-01
          3       9.99979E-01   9.99979E-01   9.99979E-01
          4       9.99798E-01   9.99798E-01   9.99798E-01
          5       9.98686E-01   9.98686E-01   9.98686E-01
          6       9.97078E-01   9.97078E-01   9.97078E-01
       .
       .
       .
       GROUP     50
       SIGO       TEMP     1    TEMP     2    TEMP     3
          1       9.94391E-01   9.94953E-01   9.94543E-01
          2       9.50723E-01   9.51246E-01   9.50899E-01
          3       7.28222E-01   7.28609E-01   7.28561E-01
          4       3.57259E-01   3.57551E-01   3.57853E-01
          5       2.17112E-01   2.17378E-01   2.17698E-01
          6       1.97875E-01   1.98131E-01   1.98439E-01

ELASTIC SELF-SHIELDING FACTORS                ISOTOPE  1
       GROUP      1
       SIGO       TEMP     1    TEMP     2    TEMP     3
          1       1.00000E+00   1.00000E+00   1.00000E+00
          2       1.00000E+00   1.00000E+00   1.00000E+00
          3       9.99999E-01   9.99999E-01   9.99999E-01
          4       9.99990E-01   9.99990E-01   9.99990E-01
          5       9.99932E-01   9.99932E-01   9.99932E-01
          6       9.99846E-01   9.99846E-01   9.99846E-01
       GROUP      2
       SIGO       TEMP     1    TEMP     2    TEMP     3
          1       1.00000E+00   1.00000E+00   1.00000E+00
```

```
          2      9.99998E-01  9.99998E-01  9.99998E-01
          3      9.99979E-01  9.99979E-01  9 99979E-01
          4      9.99802E-01  9.99802E-01  9.99802E-01
          5      9.98713E-01  9.98713E-01  9.98713E-01
          6      9.97146E-01  9.97146E-01  9.97146E-01
       .
       .
       .
       GROUP    50
       SIGO      TEMP    1    TEMP    2    TEMP    3
          1      9.99781E-01  1.00271E+00  1.00851E+00
          2      9.97927E-01  1.00071E+00  1.00623E+00
          3      9.84846E-01  9.86992E-01  9.91264E-01
          4      9.45681E-01  9.46953E-01  9.49488E-01
          5      9.15673E-01  9.16588E-01  9.18391E-01
          6      9.09501E-01  9.10359E-01  9.12043E-01

REMOVAL SELF-SHIELDING FACTORS          ISOTOPE  1
       GROUP     1
       SIGO      TEMP    1    TEMP    2    TEMP    3
          1      1.00000E+00  1.00000E+00  1.00000E+00
          2      9.99998E-01  9.99998E-01  9.99998E-01
          3      9.99979E-01  9.99979E-01  9.99979E-01
          4      9.99800E-01  9.99800E-01  9.99800E-01
          5      9.98663E-01  9.98663E-01  9.98663E-01
          6      9.96896E-01  9.96896E-01  9.96896E-01
       GROUP     2
       SIGO      TEMP    1    TEMP    2    TEMP    3
          1      9.99996E-01  9.99996E-01  9.99996E-01
          2      9.99958E-01  9.99958E-01  9.99958E-01
          3      9.99578E-01  9.99578E-01  9.99578E-01
          4      9.96018E-01  9.96018E-01  9.96018E-01
          5      9.74638E-01  9.74638E-01  9.74638E-01
          6      9.45192E-01  9.45192E-01  9.45192E-01
       .
       .
       .
       GROUP    50
       SIGO      TEMP    1    TEMP    2    TEMP    3
          1      1.00000E+00  1.00000E+00  1.00000E+00
          2      1.00000E+00  1.00000E+00  1.00000E+00
          3      1.00000E+00  1.00000E+00  1.00000E+00
          4      1.00000E+00  1.00000E+00  1.00000E+00
          5      1.00000E+00  1.00000E+00  1.00000E+00
          6      1.00000E+00  1.00000E+00  1.00000E+00

GROUP          XSPO          XSIN          XSE          XSMU          XSED          XSXI
    1 1.089000E+01 5.800316E-01 2.719157E+00 8.713564E-01 9.861667E-02 6.814144E-04
    2 1.089000E+01 8.413039E-01 3.114775E+00 8.828668E-01 1.388818E-02 3.907121E-03
    3 1.089000E+01 1.039804E+00 3.654240E+00 8.521630E-01 1.664873E-02 2.278001E-03
    4 1.089000E+01 9.595992E-01 3.767679E+00 7.600857E-01 2.036892E-02 2.703112E-03
    5 1.089000E+01 8.053699E-01 3.950636E+00 6.621020E-01 2.501423E-02 3.165847E-03
    6 1.089000E+01 6.943349E-01 4.412761E+00 5.619092E-01 3.262864E-02 3.697078E-03
    .
    .
    .
   48 1.089000E+01 0.           9.597100E+00 2.822861E-03 1.720488E-01 8.963583E-03
   49 1.089000E+01 0.           1.377694E+01 2.822861E-03 2.565092E-01 1.391099E-02
   50 1.089000E+01 0.           1.921812E+01 2.822861E-03 0.           0.
                                                                    169.752S
*************************************************************************
```

III. EXAMPLE 3, PHOTON INTERACTION PROCESSING

```
MOUNT FILE 23 PART OF DLC7E ON UNIT 20.

MOUNT FILE 27 PART OF DLC7E ON UNIT 22.

 0
 4
 *RECONR*
 20 21
 *PENDF TAPE FOR PHOTON INTERACTION CROSS SECTIONS FROM DLC7E*/
 1 1 0
 .001 0 6 /
 *1-HYDROGEN*/
 92 1 0
 .001 0. 6 /
 *92-URANIUM*/
 0/
 *GAMINR*
 22 21 0 23
 1 3 3 4 1
 *12 GROUP PHOTON INTERACTION LIBRARY*/
 -1 0/
 92
 -1 0/
 0/
 *DTFR*
 23 24 0
 1 0 0
 5 12 4 5 16 1 0
 *PHEAT*
 1 621 1
 0/
 *H* 1 1 0./
 *U* 92 1 0./
 0/
 *MATXSR*
 0 23 25
 1 1 *T2LASL NJOY*/
 1 1 1
 *12-GROUP PHOTON INTERACTION LIBRARY*/
 *GAMA*
 12
 *GSCAT*/
 1 1 3 2
 1
 1
 *H* 1 1 1
 *U* 1 1 92
 *STOP*
1*************************************************************************
 *                                    *                  *               *
 *   $$   $$       $$   $$$$$   $$    $$   *                *  VERS.10/81   *
 *   $$$  $$       $$  $$$$$$$   $$  $$    *  NUCLEAR       *  RAN AT LANL  *
 *   $$$$ $$       $$  $$   $$    $$$$     *  CROSS SECTION *  ON MACH. U  *
 *   $$ $$$$  $$   $$  $$   $$     $$      *  PROCESSING    *  ON 11/06/81  *
 *   $$  $$$  $$$$$$$  $$$$$$$     $$      *  SYSTEM        *  AT 18:59:14  *
 *   $$   $$   $$$$$    $$$$$      $$      *                *               *
 *                                    *                  *               *
 *************************************************************************

 RECONR...RECONSTRUCT POINTWISE CROSS SECTIONS IN PENDF FORMAT          .768S

 UNIT FOR ENDF/B TAPE ..................        20
 UNIT FOR PENDF TAPE ...................        21

 LABEL FOR PENDF TAPE
 ----------------------------------------
```

```
 PENDF TAPE FOR PHOTON INTERACTION CROSS SECTIONS FROM DLC7E

TAPE LABEL
------------------------------------
 DLC-7E PHOTON INTERACTION LIBRARY IN ENDF FORMAT - DATAFOR FILE 23

MATERIAL TO BE PROCESSED .............          1
RECONSTRUCTION TOLERANCE .............       .001
RECONSTRUCTION TEMPERATURE ...........        0.K
NO. SIGNIFICANT FIGURES ..............          6
RESONANCE-INTEGRAL-CHECK TOLERANCE ...       .020
MAX RESONANCE-INTEGRAL ERROR .........  1.000E-07

DESCRIPTIVE CARDS FOR PENDF TAPE
------------------------------------
  1-HYDROGEN


PROCESSING MAT      1
------------------------------------
         PHOTON INTERACTION DATA FOR    1 H


MAT HAS NO FILE 2.

MAT HAS NO RESONANCE PARAMETERS

POINTS IN INITIAL UNIONIZED GRID =   40
POINTS ADDED BY LINEARIZATION = 263                                  2.028S

MATERIAL TO BE PROCESSED .............         92
RECONSTRUCTION TOLERANCE .............       .001
RECONSTRUCTION TEMPERATURE ...........        0.K
NO. SIGNIFICANT FIGURES ..............          6
RESONANCE-INTEGRAL-CHECK TOLERANCE ...       .020
MAX RESONANCE-INTEGRAL ERROR .........  1.000E-07

DESCRIPTIVE CARDS FOR PENDF TAPE
------------------------------------
  92-URANIUM


PROCESSING MAT     92
------------------------------------
         PHOTON INTERACTION DATA FOR   92 U


MAT HAS NO FILE 2.

MAT HAS NO RESONANCE PARAMETERS

POINTS IN INITIAL UNIONIZED GRID =   60
POINTS ADDED BY LINEARIZATION = 493                                  7.041S
                                                                     9.138S
********************************************************************************

GAMINR...PRODUCE PHOTON INTERACTION CROSS SECTIONS                    9.169S

UNIT FOR ENDF/B TAPE .................        22
UNIT FOR PENDF TAPE ..................        21
UNIT FOR INPUT GAMOUT TAPE ...........         0
UNIT FOR OUTPUT GAMOUT TAPE ..........        23
MAT TO BE PROCESSED ..................         1
GAMMA GROUP OPTION ...................         3
```

```
WEIGHT FUNCTION OPTION ..............          3
LEGENDRE ORDER ......................          4
PRINT OPTION (0 MIN, 1 MAX) .........          1

RUN TITLE
-------------------------------------
     12 GROUP PHOTON INTERACTION LIBRARY


GAMMA GROUP STRUCTURE......LASL 12 GROUP
    1    1.0000E+04 -   1.0000E+05
    2    1.0000E+05 -   5.0000E+05
    3    5.0000E+05 -   1.0000E+06
    4    1.0000E+06 -   2.0000E+06
    5    2.0000E+06 -   3.0000E+06
    6    3.0000E+06 -   4.0000E+06
    7    4.0000E+06 -   5.0000E+06
    8    5.0000E+06 -   6.0000E+06
    9    6.0000E+06 -   7.0000E+06
   10    7.0000E+06 -   8.0000E+06
   11    8.0000E+06 -   9.0000E+06
   12    9.0000E+06 -   2.0000E+07

WEIGHT FUNCTION......1/E WITH ROLLOFFS

PROCESSING MAT      1
-------------------------------------
 1-HYDROGEN

GROUP CONSTANTS                                                    9.2945
FOR MF23 AND MT501 TOTL

GAMMA   SIGMA
GROUP   (BARNS)
  1     5.256E-01
  2     3.914E-01
  3     2.493E-01
  4     1.777E-01
  5     1.307E-01
  6     1.063E-01
  7     9.072E-02
  8     7.978E-02
  9     7.160E-02
 10     6.532E-02
 11     6.032E-02
 12     4.996E-02

GROUP CONSTANTS                                                    9.3845
FOR MF23 AND MT502 COHT

GAMMA   SIGMA
GROUP   (BARNS)
  1     1.235E-03
  2     1.386E-04
  3     1.004E-05
  4     2.510E-06
  5     7.934E-07
  6     3.919E-07
  7     2.337E-07
  8     1.553E-07
  9     1.109E-07
 10     8.311E-08
 11     6.451E-08
 12     3.677E-08
```

GROUP CONSTANTS 9.472S
FOR MF26 AND MT502 COHT

INITL GROUP	FINAL GROUP	CROSS SECTIONS VS LEGENDRE ORDER				
1	1	1.235E-03	1.220E-03	1.193E-03	1.158E-03	1.117E-03
2	2	1.386E-04	1.386E-04	1.384E-04	1.381E-04	1.377E-04
3	3	1.004E-05	1.004E-05	1.004E-05	1.004E-05	1.004E-05
4	4	2.510E-06	2.510E-06	2.510E-06	2.510E-06	2.510E-06
5	5	7.934E-07	7.934E-07	7.934E-07	7.934E-07	7.934E-07
6	6	3.919E-07	3.919E-07	3.919E-07	3.919E-07	3.919E-07
7	7	2.337E-07	2.337E-07	2.337E-07	2.337E-07	2.337E-07
8	8	1.553E-07	1.553E-07	1.553E-07	1.553E-07	1.553E-07
9	9	1.109E-07	1.109E-07	1.109E-07	1.109E-07	1.109E-07
10	10	8.311E-08	8.311E-08	8.311E-08	8.311E-08	8.311E-08
11	11	6.451E-08	6.451E-08	6.451E-08	6.451E-08	6.451E-08
12	12	3.677E-08	3.677E-08	3.677E-08	3.677E-08	3.677E-08

GROUP CONSTANTS 12.778S
FOR MF23 AND MT504 INCH

GAMMA GROUP	SIGMA (BARNS)
1	5.243E-01
2	3.912E-01
3	2.493E-01
4	1.777E-01
5	1.304E-01
6	1.055E-01
7	8.952E-02
8	7.818E-02
9	6.965E-02
10	6.300E-02
11	5.762E-02
12	4.622E-02

GROUP CONSTANTS 12.873S
FOR MF26 AND MT504 INCH

INITL GROUP	FINAL GROUP	CROSS SECTIONS VS LEGENDRE ORDER				
1	1	5.243E-01	4.719E-02	5.465E-02	4.790E-03	-6.011E-04
1	XSEC	5.243E-01				
1	HEAT	4.488E+03				
2	1	5.769E-02	-1.966E-02	3.794E-03	-2.102E-03	-3.024E-04
2	2	3.335E-01	9.507E-02	4.679E-02	1.466E-02	3.093E-03
2	XSEC	3.912E-01				
.						
.						
.						
12	10	2.167E-03	2.121E-03	2.031E-03	1.899E-03	1.731E-03
12	11	2.101E-03	2.073E-03	2.019E-03	1.940E-03	1.837E-03
12	12	4.112E-03	4.082E-03	4.023E-03	3.935E-03	3.821E-03
12	XSEC	4.622E-02				
12	HEAT	3.711E+05				

GROUP CONSTANTS 24.730S
FOR MF23 AND MT516 PAIR

GAMMA GROUP	SIGMA (BARNS)
4	4.641E-05
5	3.308E-04

6	7.523E-04
7	1.201E-03
8	1.558E-03
9	1.950E-03
10	2.318E-03
11	2.704E-03
12	3.740E-03

GROUP CONSTANTS 24.764S
FOR MF26 AND MT516 PAIR

INITL GROUP	FINAL GROUP	CROSS SECTIONS VS LEGENDRE ORDER
4	3	9.282E-05
4	HEAT	3.329E+01
5	3	6.615E-04
5	HEAT	5.089E+02
.		
.		
.		
12	3	7.481E-03
12	HEAT	4.213E+04

GROUP CONSTANTS 24.817S
FOR MF23 AND MT602 ABST

GAMMA GROUP	SIGMA (BARNS)	HEATING (EV-BARNS)
1	1.926E-05	6.331E-01
2	3.243E-07	4.569E-02
3	3.915E-09	2.507E-03
4	6.579E-10	8.847E-04
5	2.559E-10	6.184E-04
6	1.590E-10	5.475E-04
7	1.152E-10	5.131E-04
8	9.006E-11	4.920E-04
9	7.424E-11	4.803E-04
10	6.294E-11	4.703E-04
11	5.445E-11	4.614E-04
12	3.937E-11	4.480E-04

GROUP CONSTANTS 24.907S
FOR MF23 AND MT621 HEAT

GAMMA GROUP	HEATING (EV-BARNS)
1	4.489E+03
2	2.282E+04
3	7.050E+04
4	1.240E+05
5	1.784E+05
6	2.190E+05
7	2.519E+05
8	2.799E+05
9	3.046E+05
10	3.274E+05
11	3.488E+05
12	4.133E+05

PROCESSING MAT 92

92-URANIUM

GROUP CONSTANTS 24.925S

FOR MF23 AND MT501 TOTL

GAMMA GROUP	SIGMA (BARNS)
1	2.768E+03
2	5.452E+02
3	4.882E+01
4	2.345E+01
5	1.781E+01
6	1.718E+01
7	1.735E+01
8	1.766E+01
9	1.800E+01
10	1.849E+01
11	1.909E+01
12	2.103E+01

GROUP CONSTANTS 25.080S
FOR MF23 AND MT502 COHT

GAMMA GROUP	SIGMA (BARNS)
1	1.844E+02
2	2.953E+01
3	2.623E+00
4	6.803E-01
5	2.188E-01
6	1.085E-01
7	6.483E-02
8	4.313E-02
9	3.079E-02
10	2.306E-02
11	1.793E-02
12	1.021E-02

GROUP CONSTANTS 25.232S
FOR MF26 AND MT502 COHT

INITL GROUP	FINAL GROUP	CROSS SECTIONS VS LEGENDRE ORDER				
1	1	1.844E+02	1.292E+02	9.996E+01	7.350E+01	5.558E+01
2	2	2.953E+01	2.541E+01	2.232E+01	1.922E+01	1.664E+01
3	3	2.623E+00	2.495E+00	2.374E+00	2.255E+00	2.151E+00
4	4	6.803E-01	6.664E-01	6.477E-01	6.275E-01	6.081E-01
5	5	2.188E-01	2.170E-01	2.142E-01	2.107E-01	2.069E-01
6	6	1.085E-01	1.080E-01	1.072E-01	1.062E-01	1.049E-01
7	7	6.483E-02	6.466E-02	6.435E-02	6.393E-02	6.343E-02
8	8	4.313E-02	4.305E-02	4.291E-02	4.271E-02	4.247E-02
9	9	3.079E-02	3.075E-02	3.067E-02	3.057E-02	3.044E-02
10	10	2.306E-02	2.304E-02	2.300E-02	2.293E-02	2.286E-02
11	11	1.793E-02	1.792E-02	1.789E-02	1.785E-02	1.781E-02
12	12	1.021E-02	1.021E-02	1.020E-02	1.019E-02	1.017E-02

GROUP CONSTANTS 35.879S
FOR MF23 AND MT504 INCH

GAMMA GROUP	SIGMA (BARNS)
1	3.676E+01
2	3.280E+01
3	2.252E+01
4	1.623E+01
5	1.196E+01
6	9.688E+00

```
  7     8.222E+00
  8     7.183E+00
  9     6.401E+00
 10     5.788E+00
 11     5.296E+00
 12     4.247E+00

GROUP CONSTANTS                                                          36.037S
FOR MF26 AND MT504 INCH

INITL  FINAL  CROSS SECTIONS VS
GROUP  GROUP  LEGENDRE ORDER
  1      1    3.676E+01 -3.149E-02  2.240E+00 -8.225E-01 -6.794E-01
  1   XSEC    3.676E+01
  1   HEAT    3.561E+05
  2      1    4.864E+00 -1.777E+00  3.398E-01 -1.769E-01 -1.700E-02
  2      2    2.794E+01  6.794E+00  2.958E+00  4.526E-01 -3.175E-01
  2   XSEC    3.280E+01
  .
  .
  .
 12     12    3.872E-01  3.845E-01  3.790E-01  3.710E-01  3.605E-01
 12   XSEC    4.247E+00
 12   HEAT    3.400E+07

GROUP CONSTANTS                                                          71.497S
FOR MF23 AND MT516 PAIR

GAMMA  SIGMA
GROUP  (BARNS)
  4    6.051E-01
  5    3.491E+00
  6    6.143E+00
  7    8.217E+00
  8    9.796E+00
  9    1.105E+01
 10    1.225E+01
 11    1.341E+01
 12    1.652E+01

GROUP CONSTANTS                                                          71.569S
FOR MF26 AND MT516 PAIR

INITL  FINAL  CROSS SECTIONS VS
GROUP  GROUP  LEGENDRE ORDER
  4      3    1.210E+00
  4   HEAT    4.503E+05
  5      3    6.982E+00
  5   HEAT    5.276E+06
  .
  .
  .
 12      3    3.303E+01
 12   HEAT    1.842E+08

GROUP CONSTANTS                                                          71.674S
FOR MF23 AND MT602 ABST

GAMMA  SIGMA       HEATING
GROUP  (BARNS)     (EV-BARNS)
  1    2.547E+03   1.289E+08
  2    4.829E+02   8.101E+07
  3    2.368E+01   1.570E+07
  4    5.937E+00   7.955E+06
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  5     2.140E+00  5.164E+06
  6     1.244E+00  4.278E+06
  7     8.503E-01  3.786E+06
  8     6.398E-01  3.496E+06
  9     5.150E-01  3.331E+06
 10     4.276E-01  3.196E+06
 11     3.637E-01  3.083E+06
 12     2.563E-01  2.916E+06

GROUP CONSTANTS                                                    71.826S
FOR MF23 AND MT621 HEAT

GAMMA   HEATING
GROUP   (EV-BARNS)
  1     1.293E+08
  2     8.305E+07
  3     2.208E+07
  4     1.969E+07
  5     2.673E+07
  6     3.945E+07
  7     5.509E+07
  8     7.236E+07
  9     9.081E+07
 10     1.112E+08
 11     1.335E+08
 12     2.211E+08
                                                                   71.748S
********************************************************************************

DTFR...PRODUCE DTF FORMAT FROM GROUPR OUTPUT                       71.791S

INPUT GENDF UNIT ......................          23
OUTPUT UNIT ...........................          24
INPUT PENDF UNIT ......................           0
PRINT OPTION (0 MIN, 1 MAX) ...........           1
FILM OPTION (NONE, 1/PLOT, 4/PLOT ) ...           0
EDIT OPTION (0 TABLE, 1 SEP.)..........           0
NUMBER OF NEUTRON TABLES ..............           5
NUMBER OF NEUTRON GROUPS ..............          12
POSITION OF TOTAL .....................           4
POSITION OF IN-GROUP ..................           5
TABLE LENGTH ..........................          16
EDIT CROSS SECTIONS ................... NAME   POSITION REACTION MULTIPLICITY
                                       PHEAT     1       621         1
NUMBER OF PHOTON TABLES ...............           0


MAT=   1  ISO=H       SIGZERO NO= 1  TEMP= 0.
IL= 1 TABLE 12 GP 16 POS. MAT=     1 IZ= 1 TEMP= 0.
 4.1326E+05 -3.7403E-03  0.          4.9959E-02  4.1123E-03  0.
 0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          3.4884E+05 -2.7037E-03
 0.          6.0321E-02  1.6197E-03  2.1009E-03  0.          0.
 0.          0.          0.          0.          0.          0.
 0.          0.          3.2740E+05 -2.3184E-03  0.          6.5317E-02
 2.0663E-03  3.5675E-03  2.1674E-03  0.          0.          0.
 0.          0.          0.          0.          0.          0.
 3.0461E+05 -1.9501E-03  0.          7.1605E-02  2.7252E-03  4.5910E-03
 3.6311E-03  2.2838E-03  0.          0.          0.          0.
 0.          0.          0.          0.          2.7991E+05 -1.5979E-03
 0.          7.9779E-02  3.7626E-03  6.1295E-03  4.7009E-03  3.7957E-03
 2.4778E-03  0.          0.          0.          0.          0.
 0.          0.          2.5188E+05 -1.2009E-03  0.          9.0717E-02
```

```
  5.5276E-03  8.6030E-03  6.3377E-03  5.0001E-03  4.1302E-03  2.8022E-03
  0.          0.          0.          0.          0.          0.
  2.1901E+05 -7.5223E-04  0.          1.0629E-01  8.9122E-03  1.2960E-02
  9.0525E-03  6.9481E-03  5.6558E-03  4.7847E-03  3.3717E-03  0.
  0.          0.          0.          0.          1.7844E+05 -3.3080E-04
  0.          1.3071E-01  1.6756E-02  2.1796E-02  1.4155E-02  1.0549E-02
  8.4713E-03  7.1196E-03  6.1633E-03  4.4949E-03  0.          0.
  0.          0.          1.2397E+05 -4.6426E-05  0.          1.7774E-01
  4.3226E-02  4.4858E-02  2.6576E-02  1.9396E-02  1.5488E-02  1.2980E-02
  1.1216E-02  9.8948E-03  7.4090E-03  0.          0.          0.
  7.0497E+04 -7.3820E-08  0.          2.4930E-01  8.1577E-02  6.7262E-02
  3.2719E-02  2.4173E-02  2.0211E-02  1.7934E-02  1.6494E-02  1.5644E-02
  1.5187E-02  1.4867E-02  0.          0.          2.2817E+04  3.2150E-07
  0.          3.9136E-01  3.3367E-01  1.6772E-01  6.7295E-02  3.6706E-02
  2.5581E-02  1.9669E-02  1.5988E-02  1.3469E-02  1.1641E-02  1.0250E-02
  7.6122E-03  0.          4.4889E+03  5.8176E-05  0.          5.2555E-01
  5.2550E-01  5.7690E-02  0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
IL= 2 TABLE 12 GP 16 POS, MAT=     1 IZ= 1 TEMP= 0.
  0.          0.          0.          0.          4.0823E-03  0.
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
   .
   .
   .
 -9.7256E-03 -7.8220E-03 -6.5324E-03 -5.6042E-03 -4.9071E-03 -4.3633E-03
 -3.2954E-03  0.          0.          0.          0.          0.
  4.8415E-02 -1.9662E-02  0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
IL= 3 TABLE 12 GP 16 POS, MAT=     1 IZ= 1 TEMP= 0.
  0.          0.          0.          0.          4.0229E-03  0.
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
   .
   .
   .
 -6.7256E-04  0.          0.          0.          0.          0.
  5.5845E-02  3.7941E-03  0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
IL= 4 TABLE 12 GP 16 POS, MAT=     1 IZ= 1 TEMP= 0.
  0.          0.          0.          0.          3.9352E-03  0.
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
   .
   .
   .
  1.1390E-03  0.          0.          0.          0.          0.
  5.9479E-03 -2.1019E-03  0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
IL= 5 TABLE 12 GP 16 POS, MAT=     1 IZ= 1 TEMP= 0.
  0.          0.          0.          0.          3.8207E-03  0.
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
   .
   .
   .
  2.4938E-04  0.          0.          0.          0.          0.
  5.1587E-04 -3.0239E-04  0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.


MAT=  92  ISO=U       SIGZERO NO= 1  TEMP= 0.
IL= 1 TABLE 12 GP 16 POS, MAT=    92 IZ= 1 TEMP= 0.
  2.2110E+08 -1.6259E+01  0.          2.1029E+01  3.9740E-01  0.
```

```
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          1.3350E+08 -1.3044E+01
   .
   .
   .
  6.9779E-01  0.          1.2926E+08  2.5467E+03  0.          2.7679E+03
  2.2116E+02  4.8636E+00  0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
   .
   .
   .
IL= 5 TABLE 12 GP 16 POS, MAT=   92 IZ= 1 TEMP= 0.
  0.          0.          0.          0.          3.7071E-01  0.
  0.          0.          0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
   .
   .
   .
  2.2866E-02  0.          0.          0.          0.          0.
  5.4900E+01 -1.6996E-02  0.          0.          0.          0.
  0.          0.          0.          0.          0.          0.
                                                                    75.088S
********************************************************************************

MATXSR...PRODUCE A MATXS FORMAT OUTPUT FILE                         75.128S

INPUT GENDF UNIT ..................          0
INPUT GAMOUT UNIT .................         23
OUTPUT MATXS UNIT .................         25
PRINT OPTION (0 MIN, 1 MAX) .......          1
FILE VERSION NUMBER ...............          1
USER ID ........................... T2LASL NJOY
NPART ..............................      1
NTYPE ..............................      1
NHOLL ..............................      1

SET IDENTIFICATION
------------------
     12-GROUP PHOTON INTERACTION LIBRARY

NAMES OF PARTICLES ................ GAMA
NO. GROUPS FOR EACH PARTICLE .....    12
NAMES OF DATA TYPES ............... GSCAT

FOR DATA TYPE   1
-----------------
IFOPT ..............................      1
NSBLK ..............................      1
MAX. LEGENDRE ORDER ................      3
NO. MATERIALS ......................      2
IINP ...............................      1
IOUTP ..............................      1

     MATERIAL   MAX.    MAX.
       NAME     TEMPS   SIGZ      IMAT
     --------   -----   ----      -----
      H           1       1         1
      U           1       1        92
1
                                                                    76.499S
```

```
****************************************
*** FILE  MATXS          ***************
*** VERS    1            ***************
*** USER  T2LASL NJOY    ***************
****************************************
```

FILE CONTROL PARAMETERS

NPART	NUMBER OF PARTICLES FOR WHICH GROUP STRUCTURES ARE GIVEN	1
NTYPE	NUMBER OF DATA TYPES PRESENT IN SET	1
NHOLL	NUMBER OF WORDS IN SET HOLLERITH IDENTIFICATION RECORD	12

FILE DESCRIPTION

12-GROUP PHOTON INTERACTION LIBRARY

FILE DATA

PARTICLE	NAME	NGRP
1	GAMA	12

DATA TYPE	NAME	NMAT	NINP	NING	NOUTP	NOUTG	LOCT
1	GSCAT	2	1	12	1	12	0

GROUP STRUCTURES

PARTICLE 1

GROUP	MAXIMUM ENERGY
1	2.00000E+07
2	9.00000E+06
3	8.00000E+06
4	7.00000E+06
5	6.00000E+06
6	5.00000E+06
7	4.00000E+06
8	3.00000E+06
9	2.00000E+06
10	1.00000E+06
11	5.00000E+05
12	1.00000E+05
EMIN	1.00000E+04

```
****************************************
*** DATA TYPE  1 ****** GSCAT  ********
****************************************
```

DATA TYPE CONTROL

MATERIAL	HMATNM	TEMP	SIGZ	LOCA
1	H	0.	1.00E+10	0
2	U	0.	1.00E+10	7

INCIDENT PARTICLES	1
OUTGOING PARTICLES	1
NSBLK	1

*** GSCAT *** MATERIAL 1 ***********
****

MATERIAL CONTROL

HMAT	H
AMASS	9.992E-01
TEMP	0.
SIGZ	1.000E+10
IMAC	1
N1DR	7
N1DB	1
N2DB	3

VECTOR CONTROL

REACTION	REACTION ID	BLOCK	FIRST GROUP	LAST GROUP
1	GWTO	1	1	12
2	GTOTO	1	1	12
3	GCOH	1	9	12
4	GINCH	1	1	12
5	GPAIR	1	1	9
6	GABS	1	12	12
7	GHEAT	1	1	12

VECTOR BLOCK 1

GROUP	GWTO	GTOTO	GCOH	GINCH	GPAIR	GABS	GHEAT
1	3.855E+04	4.996E-02		4.622E-02	3.740E-03		4.133E+05
2	1.178E+04	6.032E-02		5.762E-02	2.704E-03		3.488E+05
3	1.336E+04	6.532E-02		6.300E-02	2.318E-03		3.274E+05
4	1.542E+04	7.160E-02		6.965E-02	1.950E-03		3.046E+05
5	1.824E+04	7.978E-02		7.818E-02	1.598E-03		2.799E+05
6	2.232E+04	9.072E-02		8.952E-02	1.201E-03		2.519E+05
7	2.878E+04	1.063E-01		1.055E-01	7.523E-04		2.190E+05
8	4.056E+04	1.307E-01		1.304E-01	3.308E-04		1.784E+05
9	6.934E+04	1.777E-01	2.510E-06	1.777E-01	4.641E-05		1.240E+05
10	6.934E+04	2.493E-01	1.004E-05	2.493E-01			7.050E+04
11	1.610E+05	3.914E-01	1.386E-04	3.912E-01			2.282E+04
12	3.331E+04	5.256E-01	1.235E-03	5.243E-01		1.926E-05	4.489E+03

MATRIX ** GCOH **

FINAL GROUP	INITL GROUP	XSEC VS LEGENDRE ORDER ORDER 0	ORDER 1	ORDER 2	ORDER 3
9	9	2.510E-06	2.510E-06	2.510E-06	2.510E-06
10	10	1.004E-05	1.004E-05	1.004E-05	1.004E-05
11	11	1.386E-04	1.386E-04	1.384E-04	1.381E-04
12	12	1.235E-03	1.220E-03	1.193E-03	1.158E-03

MATRIX ** GINCH **

FINAL GROUP	INITL GROUP	XSEC VS LEGENDRE ORDER ORDER 0	ORDER 1	ORDER 2	ORDER 3
1	1	4.112E-03	4.082E-03	4.023E-03	3.935E-03
2	2	1.620E-03	1.616E-03	1.608E-03	1.597E-03
	1	2.101E-03	2.073E-03	2.019E-03	1.940E-03
3	3	2.066E-03	2.060E-03	2.047E-03	2.029E-03
	2	3.568E-03	3.540E-03	3.484E-03	3.401E-03
	1	2.167E-03	2.121E-03	2.031E-03	1.899E-03

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.
.

	1	7.612E-03	-3.295E-03	-6.726E-04	1.139E-03
12	12	5.243E-01	4.719E-02	5.465E-02	4.790E-03
	11	5.769E-02	-1.966E-02	3.794E-03	-2.102E-03

MATRIX ** GPAIR **

FINAL GROUP	INITL GROUP	XSEC VS INITL GROUP -0	-1	-2	-3	-4
10	9	9.282E-05	6.615E-04	1.505E-03	2.402E-03	3.196E-03
	4	3.900E-03	4.637E-03	5.407E-03	7.481E-03	

*** GSCAT *** MATERIAL 2 **********
****

MATERIAL CONTROL

HMAT	U
AMASS	2.360E+02
TEMP	0.
SIGZ	1.000E+10
IMAC	1
N1DR	7
N1DB	1
N2DB	3

VECTOR CONTROL

REACTION	REACTION ID	BLOCK	FIRST GROUP	LAST GROUP
1	GWTO	1	1	12
2	GTOTO	1	1	12
3	GCOH	1	1	12
4	GINCH	1	1	12
5	GPAIR	1	1	9
6	GABS	1	1	12
7	GHEAT	1	1	12

VECTOR BLOCK 1

GROUP	GWTO	GTOTO	GCOH	GINCH	GPAIR	GABS	GHEAT
1	3.848E+04	2.103E+01	1.021E-02	4.247E+00	1.652E+01	2.563E-01	2.211E+08
2	1.178E+04	1.909E+01	1.793E-02	5.296E+00	1.341E+01	3.637E-01	1.335E+08
3	1.335E+04	1.849E+01	2.306E-02	5.788E+00	1.225E+01	4.276E-01	1.112E+08
4	1.542E+04	1.800E+01	3.079E-02	6.401E+00	1.105E+01	5.150E-01	9.081E+07
5	1.823E+04	1.766E+01	4.313E-02	7.183E+00	9.796E+00	6.398E-01	7.236E+07
6	2.232E+04	1.735E+01	6.483E-02	8.222E+00	8.217E+00	8.503E-01	5.509E+07
7	2.877E+04	1.718E+01	1.085E-01	9.688E+00	6.143E+00	1.244E+00	3.945E+07
8	4.055E+04	1.781E+01	2.188E-01	1.196E+01	3.491E+00	2.140E+00	2.673E+07
9	6.932E+04	2.345E+01	6.803E-01	1.623E+01	6.051E-01	5.937E+00	1.969E+07
10	6.932E+04	4.882E+01	2.623E+00	2.252E+01		2.368E+01	2.208E+07
11	1.610E+05	5.452E+02	2.953E+01	3.280E+01		4.829E+02	8.305E+07
12	3.330E+04	2.768E+03	1.844E+02	3.676E+01		2.547E+03	1.293E+08

MATRIX ** GCOH **

FINAL GROUP	INITL GROUP	XSEC VS LEGENDRE ORDER ORDER 0	ORDER 1	ORDER 2	ORDER 3

```
    1       1      1.021E-02   1.021E-02   1.020E-02   1.019E-02
    2       2      1.793E-02   1.792E-02   1.789E-02   1.785E-02
    3       3      2.306E-02   2.304E-02   2.300E-02   2.293E-02
    4       4      3.079E-02   3.075E-02   3.067E-02   3.057E-02
    5       5      4.313E-02   4.305E-02   4.291E-02   4.271E-02
    6       6      6.483E-02   6.466E-02   6.435E-02   6.393E-02
    7       7      1.085E-01   1.080E-01   1.072E-01   1.062E-01
    8       8      2.188E-01   2.170E-01   2.142E-01   2.107E-01
    9       9      6.803E-01   6.664E-01   6.477E-01   6.275E-01
   10      10      2.623E+00   2.495E+00   2.374E+00   2.255E+00
   11      11      2.953E+01   2.541E+01   2.232E+01   1.922E+01
   12      12      1.844E+02   1.292E+02   9.996E+01   7.350E+01

MATRIX ** GINCH  **

 FINAL   INITL     XSEC VS LEGENDRE ORDER
 GROUP   GROUP      ORDER 0      ORDER 1      ORDER 2      ORDER 3
 -----   -----   ----------------------------------------------------
    1       1      3.872E-01   3.845E-01   3.790E-01   3.710E-01
    2       2      1.511E-01   1.507E-01   1.500E-01   1.490E-01
            1      1.926E-01   1.901E-01   1.851E-01   1.778E-01
    3       3      1.926E-01   1.920E-01   1.909E-01   1.892E-01
            2      3.274E-01   3.248E-01   3.197E-01   3.122E-01
            1      1.987E-01   1.945E-01   1.862E-01   1.742E-01
    .
    .
    .
            1      6.978E-01  -3.021E-01  -6.166E-02   1.044E-01
   12      12      3.676E+01  -3.149E-02   2.240E+00  -8.225E-01
           11      4.864E+00  -1.777E+00   3.398E-01  -1.769E-01

MATRIX ** GPAIR  **

 FINAL   INITL     XSEC VS INITL GROUP
 GROUP   GROUP       -0          -1          -2          -3          -4
 -----   -----   ----------------------------------------------------------
   10       9      1.210E+00   6.982E+00   1.229E+01   1.643E+01   1.959E+01
            4      2.210E+01   2.450E+01   2.682E+01   3.303E+01


INDEX OF MATXS FILE                                                  76.602S

****************************************
*** FILE  MATXS          ***************
*** USER  T2LASL NJOY    ***************
*** VERS     1           ***************
****************************************

FILE DESCRIPTION

 12-GROUP PHOTON INTERACTION LIBRARY

DATA TYPES ON FILE

            NAME       LOCT
            ----       ----
    1     GSCAT           0


****************************************
*** DATA TYPE   1 ****** GSCAT  ********
****************************************
```

```
MATERIALS ON FILE FOR THIS DATA TYPE

          NAME       TEMP       SIGZ     LOCA
          ----       ----       ----     ----
    1     H          0.         1.00E+10    0
    2     U          0.         1.00E+10    7

VECTOR REACTION TYPES ON FILE BY MATERIAL

               1          2
          ------     ------
    1     GWTO       GWTO
    2     GTOTO      GTOTO
    3     GCOH       GCOH
    4     GINCH      GINCH
    5     GPAIR      GPAIR
    6     GABS       GABS
    7     GHEAT      GHEAT

MATRIX REACTION TYPES ON FILE BY MATERIAL

               1          2
          ------     ------
    1     GCOH       GCOH
    2     GINCH      GINCH
    3     GPAIR      GPAIR

INDEX COMPLETE                                                          76.635S
                                                                        76.671S
*****************************************************************************
```

IV. EXAMPLE 4, TEST OF COVARIANCE PROCESSING.

MOUNT ENDF/-V TAPE 511 ON UNIT 20.

```
 0
 5
 *MODER*
 20 -21
 *RECONR*
 -21 -22
 *U-235 10% PENDF FOR ERRORR TEST PROBLEM FROM T511*/
 1395 0 0
 .10 0. 6 0 .1
 0/
 *ERRORR*
 -21 -22 0 23 0
 1395 19 1 1
 3 0 0
 0 33
 1
 1.E0 1.E3
 *GROUPR*
 -21 -22 0 24
 1395 3 0 3 0 1 1 1
 *U-235 MULTIGROUP NUBAR CALCULATION*/
 0.
 1.E10
 3 452 *TOTAL NUBAR*/
 0/
 0/
 *ERRORR*
 -21 0 24 25 23
 1395 1 1 1
```

```
0 31
7
1.E0 1.E1 1.E2 1.E3 1.E4 1.E5 1.E6 1.E7
*STOP*
1**********************************************************************************
*                                                *                *               *
*   $$   $$       $$   $$$$$   $$    $$  *                *  VERS.10/81   *
*   $$$  $$       $$  $$$$$$$  $$  $$    *  NUCLEAR       *  RAN AT LANL  *
*   $$$$ $$       $$  $$   $$    $$$$     *  CROSS SECTION *  ON MACH. T  *
*   $$ $$$$  $$   $$  $$   $$     $$      *  PROCESSING    *  ON 11/06/81  *
*   $$  $$$  $$$$$$$  $$$$$$$     $$      *  SYSTEM        *  AT 19:25:12  *
*   $$   $$   $$$$$    $$$$$      $$      *                *               *
*                                                *                *               *
**********************************************************************************

MODER...CHANGE THE MODE OF AN ENDF/B TAPE OR NJOY OUTPUT TAPE                .633S

INPUT UNIT (+ FOR CODED, - FOR BB) ...          20
OUTPUT UNIT (+ FOR CODED, - FOR BB) ..         -21

TAPE LABEL
---------------------------------------
 ENDF/B-V TAPE 511 (STANDARDS MATERIALS)
                                                                          11.456S
**********************************************************************************

RECONR...RECONSTRUCT POINTWISE CROSS SECTIONS IN PENDF FORMAT               11.507S

UNIT FOR ENDF/B TAPE .................          -21
UNIT FOR PENDF TAPE ..................          -22

LABEL FOR PENDF TAPE
---------------------------------------
 U-235 10% PENDF FOR ERROR TEST PROBLEM FROM T511

TAPE LABEL
---------------------------------------
 ENDF/B-V TAPE 511 (STANDARDS MATERIALS)

MATERIAL TO BE PROCESSED .............        1395
RECONSTRUCTION TOLERANCE .............        .100
RECONSTRUCTION TEMPERATURE ...........         0.K
NO. SIGNIFICANT FIGURES ..............           6
RESONANCE-INTEGRAL-CHECK TOLERANCE ...       2.000
MAX RESONANCE-INTEGRAL ERROR .........   1.000E-01

DESCRIPTIVE CARDS FOR PENDF TAPE
---------------------------------------
  PENDF TAPE PREPARED BY THE NJOY NUCLEAR DATA PROCESSING SYSTEM


PROCESSING MAT   1395
---------------------------------------
  92-U -235OBNL         EVAL-APR77 M.R.BHAT


POINTS IN INITIAL UNIONIZED GRID = 1662
POINTS ADDED BY LINEARIZATION =  15                                          16.618S

              ESTIMATED MAXIMUM ERROR DUE TO
              RESONANCE INTEGRAL CHECK (ERRMAX,ERRINT)
              AND SIGNIFICANT FIGURE TRUNCATION (NDIGIT)

   UPPER      ELASTIC    PERCENT ERROR    CAPTURE    PERCENT ERROR
```

```
   ENERGY      INTEGRAL  RES-INT SIG-FIG   INTEGRAL  RES-INT SIG-FIG
 1.00E+00
 3.18E+00     1.48E+01     .002   0.000    1.12E+01     .428   0.000
 1.01E+01     1.29E+01     .337   0.000    3.25E+01    1.315   0.000
 3.20E+01     1.38E+01    1.008   0.000    4.23E+01    3.409   0.000
 8.20E+01     1.26E+01    1.925   0.000    2.31E+01    8.113   0.000
 2.50E+04     6.90E+01     .002   0.000    2.69E+01     .029   0.000

POINTS ADDED BY RESONANCE RECONSTRUCTION =    149
POINTS AFFECTED BY RESONANCE INTEGRAL CHECK =    347
POINTS AFFECTED BY SIGNIFICANT FIGURE REDUCTION =      0
POINTS REMOVED BY BACKTHINNING =     48
FINAL NUMBER OF RESONANCE POINTS =    941
                                                                        33.081S
************************************************************************************

ERRORR...PRODUCE CROSS SECTION COVARIANCES.                             33.115S

UNIT FOR ENDF/B TAPE ..................          -21
UNIT FOR PENDF TAPE ...................          -22
UNIT FOR INPUT GENDF TAPE .............            0
UNIT FOR OUTPUT COVARIANCE TAPE .......           23
UNIT FOR INPUT COVARIANCE TAPE ........            0
MATERIAL TO BE PROCESSED ..............         1395
NEUTRON GROUP OPTION ..................           19
PRINT OPTION (0 MIN, 1 MAX) ...........            1
REL. COV. OPTION (0 ABS, 1 REL) .......            1
GROUP AVERAGING WEIGHT OPTION .........            3
GROUP AV. PRINT OPTION (0 MIN, 1 MAX)              0
TEMPERATURE ...........................           0.
READ OPTION (0 CALC, 1 READ  2 COMBO)              0
ENDF COVARIANCE FILE TO BE PROCESSED              33

NOTE TO USER.  COVARIANCES OF THE STANDARD REACTION MTS= 18 WITH THE
REACTION (MAT=1342,MT= 18) WILL NOT BE CALCULATED.  LTY=3.

NOTE TO USER.  COVARIANCES OF THE STANDARD REACTION MTS= 18 WITH THE
REACTION (MAT=1361,MT= 18) WILL NOT BE CALCULATED.  LTY=3.

NOTE TO USER.  COVARIANCES OF THE STANDARD REACTION MTS= 18 WITH THE
REACTION (MAT=1399,MT= 18) WILL NOT BE CALCULATED.  LTY=3.

NOTE TO USER.  COVARIANCES OF THE STANDARD REACTION MTS= 18 WITH THE
REACTION (MAT=1399,MT=102) WILL NOT BE CALCULATED.  LTY=3.

COMPUTING MULTIGROUP CROSS SECTIONS                                     35.044S
                                                                      REPACKING

UNION STRUCTURE (= USER STRUCTURE) HAS   9 GROUPS

     1       1.00000E+00 - 1.80000E+00
     2       1.80000E+00 - 5.00000E+00
     3       5.00000E+00 - 1.00000E+01
     4       1.00000E+01 - 2.00000E+01
     5       2.00000E+01 - 4.00000E+01
     6       4.00000E+01 - 8.00000E+01
     7       8.00000E+01 - 2.00000E+02
     8       2.00000E+02 - 4.00000E+02
     9       4.00000E+02 - 1.00000E+03

WEIGHT FUNCTION.....1/E FOR ALL L

GROUP AVERAGING COMPLETED                                               36.057S
```

REPACKING

COVARIANCES CALCULATED FOR 2 REACTIONS AND 9 GROUPS 36.894S

TABLE OF MULTIGROUP CROSS SECTIONS

GROUP NO.	LOWER ENERGY	CROSS SECTION MT 18	MT102
1	1.0000E+00	4.1646E+01	1.0751E+01
2	1.8000E+00	1.6744E+01	1.3156E+01
3	5.0000E+00	5.2733E+01	3.5074E+01
4	1.0000E+01	5.2362E+01	4.4286E+01
5	2.0000E+01	4.9641E+01	3.0819E+01
6	4.0000E+01	4.1728E+01	1.9486E+01
7	8.0000E+01	2.1709E+01	1.2707E+01
8	2.0000E+02	1.7192E+01	8.1314E+00
9	4.0000E+02	1.1587E+01	4.7376E+00

RELATIVE COVARIANCE (MT 18 , IG , MT 18 , IGP) 37.416S

IG	IGP	+0	+1	+2			
1	1	5.000E-04	4.000E-04	4.001E-04	4.001E-04	3.999E-04	4.000E-04
1	7	4.000E-04	4.000E-04	4.000E-04			
2	1	4.000E-04	5.000E-04	4.001E-04	4.001E-04	3.999E-04	4.000E-04
2	7	4.000E-04	4.000E-04	4.000E-04			
3	1	4.001E-04	4.001E-04	7.001E-04	6.001E-04	5.998E-04	5.998E-04
3	7	5.998E-04	5.998E-04	5.998E-04			
4	1	4.001E-04	4.001E-04	6.001E-04	7.001E-04	5.998E-04	5.998E-04
4	7	5.998E-04	5.998E-04	5.998E-04			
5	1	3.999E-04	3.999E-04	5.998E-04	5.998E-04	7.998E-04	7.001E-04
5	7	7.001E-04	7.001E-04	7.001E-04			
6	1	4.000E-04	4.000E-04	5.998E-04	5.998E-04	7.001E-04	9.998E-04
6	7	8.999E-04	8.999E-04	8.999E-04			
7	1	4.000E-04	4.000E-04	5.998E-04	5.998E-04	7.001E-04	8.999E-04
7	7	9.998E-04	8.999E-04	8.999E-04			
8	1	4.000E-04	4.000E-04	5.998E-04	5.998E-04	7.001E-04	8.999E-04
8	7	8.999E-04	9.998E-04	8.999E-04			
9	1	4.000E-04	4.000E-04	5.998E-04	5.998E-04	7.001E-04	8.999E-04
9	7	8.999E-04	8.999E-04	9.998E-04			

RELATIVE COVARIANCE (MT 18 , IG , MT102 , IGP) 37.441S

ZERO

RELATIVE COVARIANCE (MT102 , IG , MT102 , IGP) 37.450S

IG	IGP	+0	+1	+2			
1	1	1.690E-02	1.440E-02	1.440E-02	1.440E-02	1.440E-02	1.440E-02
1	7	2.500E-03	2.500E-03	2.500E-03			
2	1	1.440E-02	1.690E-02	1.440E-02	1.440E-02	1.440E-02	1.440E-02
.							
.							
.							
8	7	5.000E-03	6.400E-03	5.000E-03			
9	1	2.500E-03	2.500E-03	2.500E-03	2.500E-03	2.500E-03	2.500E-03
9	7	5.000E-03	5.000E-03	6.400E-03			

37.574S

****

GROUPR...COMPUTE SELF-SHIELDED GROUP-AVERAGED CROSS-SECTIONS 37.608S

```
UNIT FOR ENDF/B TAPE ..................          -21
UNIT FOR PENDF TAPE ...................          -22
UNIT FOR INPUT GOUT TAPE ..............            0
UNIT FOR OUTPUT GOUT TAPE .............           24
MAT TO BE PROCESSED ...................         1395
NEUTRON GROUP STRUCTURE OPTION ........            3
GAMMA GROUP OPTION ....................            0
WEIGHT FUNCTION OPTION ................            3
LEGENDRE ORDER ........................            0
PRINT OPTION (0 MIN, 1 MAX) ...........            1

RUN TITLE
-------------------------------------
     U-235 MULTIGROUP NUBAR CALCULATION

TEMPERATURES (KELVIN) .................         ZERO
SIGMA ZEROES ..........................     INFINITY

NEUTRON GROUP STRUCTURE......LASL 30 GROUP
    1     1.3900E-04 -    1.5200E-01
    2     1.5200E-01 -    4.1400E-01
    3     4.1400E-01 -    1.1300E+00
    .
    .
    .
   28     1.2000E+07 -    1.3500E+07
   29     1.3500E+07 -    1.5000E+07
   30     1.5000E+07 -    1.7000E+07

WEIGHT FUNCTION.......1/E FOR ALL L

PROCESSING MAT    1395
-------------------------------------
 PENDF TAPE PREPARED BY THE NJOY NUCLEAR DATA PROCESSING SYSTEM

GROUP CONSTANTS AT T=ZERO DEG K                                    40.791S
FOR MF 3 AND MT452 TOTAL NUBAR

ENRGY  GROUP CONSTANTS AT
GROUP  INFINITE DILUTION

  1     2.437E+00
  2     2.437E+00
  3     2.437E+00
  .
  .
  .
 28     4.221E+00
 29     4.433E+00
 30     4.678E+00

                                                                   41.379S
*******************************************************************************

ERRORR...PRODUCE CROSS SECTION COVARIANCES                         41.426S

UNIT FOR ENDF/B TAPE ..................          -21
UNIT FOR PENDF TAPE ...................            0
UNIT FOR INPUT GENDF TAPE .............           24
UNIT FOR OUTPUT COVARIANCE TAPE .......           25
UNIT FOR INPUT COVARIANCE TAPE ........           23
MATERIAL TO BE PROCESSED ..............         1395
NEUTRON GROUP OPTION ..................            1
PRINT OPTION (0 MIN, 1 MAX) ...........            1
```

```
REL. COV. OPTION (0 ABS, 1 REL) .....          1
READ OPTION (0 CALC, 1 READ, 2 COMBO)          0
ENDF COVARIANCE FILE TO BE PROCESSED .        31

NEUTRON GROUP STRUCTURE.....READ IN

     1       1.00000E+00 - 1.00000E+01
     2       1.00000E+01 - 1.00000E+02
     3       1.00000E+02 - 1.00000E+03
     4       1.00000E+03 - 1.00000E+04
     5       1.00000E+04 - 1.00000E+05
     6       1.00000E+05 - 1.00000E+06
     7       1.00000E+06 - 1.00000E+07
                                                              REPACKING

UNION STRUCTURE HAS  15 GROUPS

     1       1.00000E+00 - 1.00000E+01
     2       1.00000E+01 - 1.00000E+02
     3       1.00000E+02 - 1.00000E+03
     4       1.00000E+03 - 1.00000E+04
     5       1.00000E+04 - 1.00000E+05
     6       1.00000E+05 - 2.00000E+05
     7       2.00000E+05 - 5.00000E+05
     8       5.00000E+05 - 1.00000E+06
     9       1.00000E+06 - 1.50000E+06
    10       1.50000E+06 - 2.00000E+06
    11       2.00000E+06 - 3.00000E+06
    12       3.00000E+06 - 4.00000E+06
    13       4.00000E+06 - 6.00000E+06
    14       6.00000E+06 - 8.00000E+06
    15       8.00000E+06 - 1.00000E+07
                                                              REPACKING

COVARIANCES CALCULATED FOR  1 REACTIONS AND  15 GROUPS                 44.558S

TABLE OF MULTIGROUP CROSS SECTIONS

GROUP    LOWER      CROSS SECTION
 NO.     ENERGY     MT452
-----    ------     -----
   1  1.0000E+00  2.4367E+00
   2  1.0000E+01  2.4367E+00
   3  1.0000E+02  2.4367E+00
   4  1.0000E+03  2.4367E+00
   5  1.0000E+04  2.4382E+00
   6  1.0000E+05  2.4707E+00
   7  1.0000E+06  2.9171E+00

RELATIVE COVARIANCE ( MT452 , IG , MT452 , IGP )                       44.999S

 IG   IGP          +0          +1          +2
---   ---        ----        ----        ----
  1     1  4.815E-05  4.815E-05  4.536E-05  4.536E-05  4.536E-05  4.111E-05
  1     7  2.775E-05
  2     1  4.815E-05  4.815E-05  4.536E-05  4.536E-05  4.536E-05  4.111E-05
  2     7  2.775E-05
  3     1  4.536E-05  4.536E-05  4.298E-05  4.298E-05  4.298E-05  3.934E-05
  3     7  2.784E-05
  4     1  4.536E-05  4.536E-05  4.298E-05  4.298E-05  4.298E-05  3.934E-05
  4     7  2.784E-05
  5     1  4.536E-05  4.536E-05  4.298E-05  4.298E-05  4.298E-05  3.934E-05
  5     7  2.784E-05
  6     1  4.111E-05  4.111E-05  3.934E-05  3.934E-05  3.934E-05  3.672E-05
  6     7  2.806E-05
  7     1  2.775E-05  2.775E-05  2.784E-05  2.784E-05  2.784E-05  2.806E-05
  7     7  3.145E-05
                                                                       45.091S
********************************************************************************
```

APPENDIX D

PREPROCESSING PROGRAM FOR IBM/CDC CODE CONVERSION

This program requires approximately 15 seconds of CDC-7600 central-processor time to convert the entire code system.

```
      PROGRAM CCC (TAPE1,TAPE2,TAPE3)
C     ******************************************************************
C     CODE CONVERSION CONTROLLER.
C     CONVERT A FORTRAN PROGRAM FROM CDC TO IBM AND BACK.
C     IMACH=1, IF AN IBM VERSION IS DESIRED,
C           2, IF A CDC VERSION IS DESIRED.
C     ******************************************************************
      DIMENSION IA(23)
      DATA IC /1HC/, IB /1H /, IBB /2H  /, IIBM /2HIB/, ICDC /2HCD/
      NIN=1
      NOUT=2
      NSYSO=3
      IIB=0
      ICD=0
C
C     IBM DESIRED.
      IMACH=1
C
C     READ AND WRITE MACHINE-INDEPENDENT LINES.
  100 READ (NIN,10) (IA(I),I=1,23)
      IF (EOF(NIN)) 230,110
  110 IF (IA(1).NE.IC) GO TO 120
      IF (IA(2).EQ.IBB) GO TO 120
      IF (IA(2).EQ.IIBM) GO TO 130
      IF (IA(2).EQ.ICDC) GO TO 180
  120 WRITE (NOUT,10) (IA(I),I=1,23)
      GO TO 100
C
C     READ AND WRITE IBM LINES.
  130 IIB=IIB+1
      GO TO 170
  140 READ (NIN,10) (IA(I),I=1,23)
      IF (EOF(NIN)) 230,150
  150 IF (IA(2).EQ.IIBM) GO TO 120
      IF (IMACH.NE.1) GO TO 160
      IA(1)=IB
      GO TO 170
  160 IA(1)=IC
  170 WRITE (NOUT,10) (IA(I),I=1,23)
      GO TO 140
C
C     READ AND WRITE CDC LINES.
  180 ICD=ICD+1
      GO TO 220
  190 READ (NIN,10) (IA(I),I=1,23)
      IF (EOF(NIN)) 230,200
  200 IF (IA(2).EQ.ICDC) GO TO 120
      IF (IMACH.NE.2) GO TO 210
      IA(1)=IB
      GO TO 220
  210 IA(1)=IC
  220 WRITE (NOUT,10) (IA(I),I=1,23)
      GO TO 190
C
C     CCC FINISHED.
  230 WRITE (NSYSO,20) IIB,ICD
      STOP
C
   10 FORMAT (A1,A2,20A4,A3)
   20 FORMAT (//I5,22H IBM BLOCKS PROCESSED.,
     1         /I5,22H CDC BLOCKS PROCESSED.,
     2        //26H CODE CONVERSION COMPLETE.)
      END
```


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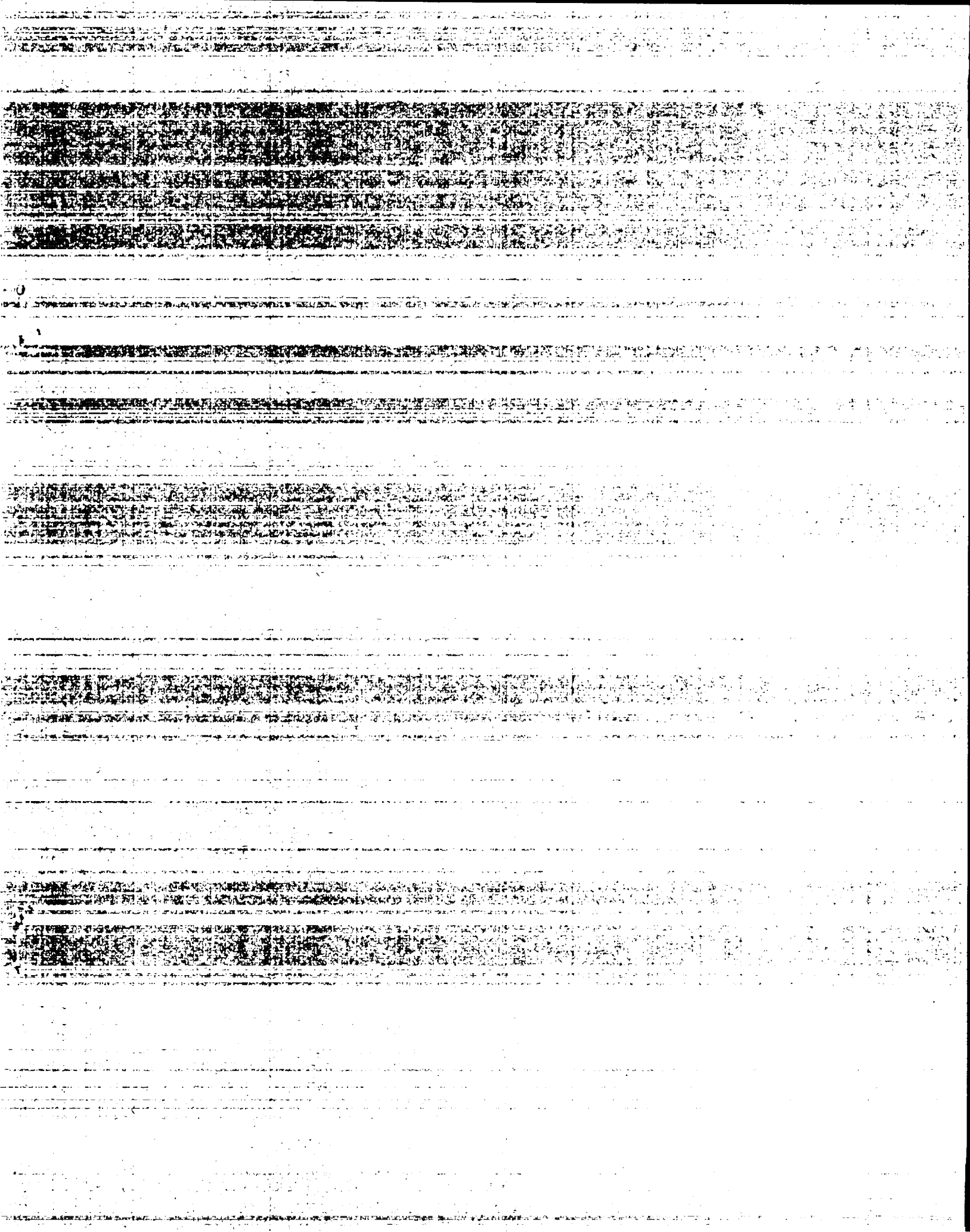

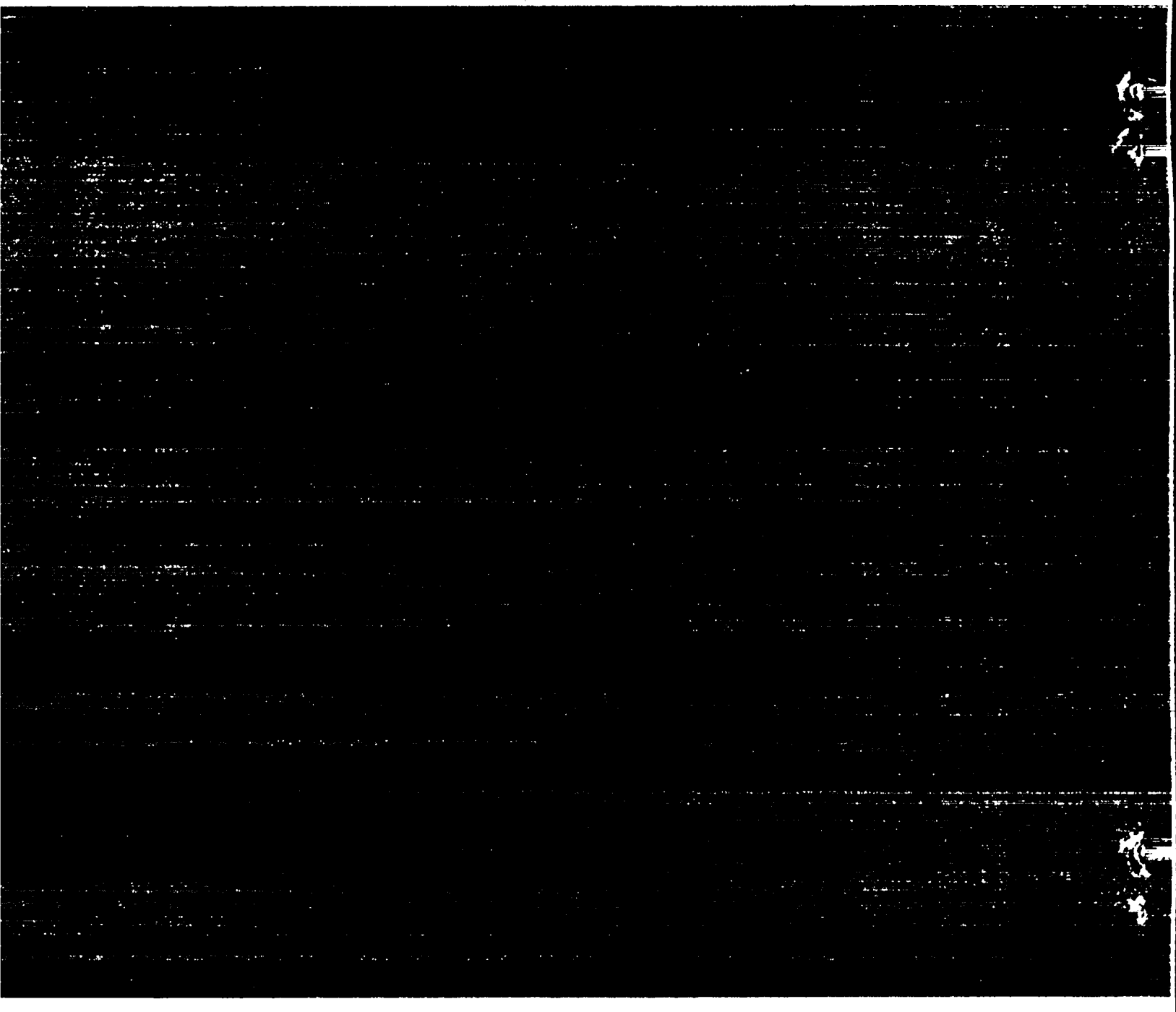

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