SUPPLEMENT TO WCAP-7363

"ETOT, A FORTRAN-IV PROGRAM TO PROCESS DATA FROM THE ENDF/B FILE TO THERMAL LIBRARY FORMAT"

Westinghouse Nuclear Energy Systems

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ENDF-146-SUPP.

Proprietary Class III

SUPPLEMENT TO WCAP-7363

"ETOT, A FORTRAN-IV PROGRAM TO PROCESS DATA FROM THE ENDF/B FILE TO THERMAL LIBRARY FORMAT"

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ABSTRACT

As described in the main report, ETOT is a digital computer program which processes basic nuclear data in the ENDF/B format and produces library data in thermal library format. ETOT is written entirely in ASA Standard FORTRAN and is designed to be computer independent. Along with printed results, the output includes punched cards in the format appropriate to the desired library.

Necessary corrections and changes to ETOT are described in this Supplement. The resulting new version, ETOT-3, successfully reads ENDF/B Version III, achieves a high accuracy and high speed, and is designed for machine independence within the realm of large scientific computers.

CHAPTER 1

INTRODUCTION

In order to permit users of the SOFOCATE[5]*, TEMPEST[6], KATE[7], and THERMØS[9] codes to generate library data from ENDF/B Version III, changes have been made in ETOT. C. L. Beard's programming is adequate for ENDF/B Version II, but with the advent of Version III of ENDF/B, M. Raymund undertook further modifications to produce ETOT-3. This supplement will give details to correct the main report, corresponding to basic changes of ETOT. Further, ETOT has been modified to be able to accept Universal Supergroup System[11] (thermal) files in place of ENDF/B. Details regarding USS input will be given in Chapter 3 of this Supplement. However, for ordinary ETOT-3 runs, the main report is a fully adequate users' guide.

As pointed out in the literature[11,12], ETOT's days are numbered. There will always be possibilities for new versions of ETOT to handle new versions of ENDF/B (ETOT-3 certainly cannot process all of ENDF/B Version I and possibly will fail on some of ENDF/B Version IV). However, the new philosophy of providing central processing of cross sections into "supergroup" files, easily collapsible to all major group-average schemes, will put an end to most ETOT running within 3 or 4 years. Release of ETOT-3 is necessary, however, if present ETOT users are to process ENDF/B-III perfectly.

The chapters of this Supplement are organized corresponding to the chapters of the main report, with the exception of Chapter 6. Chapter 6 will contain remarks concerning the near perfection of ETOT obtained as a by-product of generating a preliminary version of the USS (thermal) library files.

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*The references given in the main report are reproduced here as Ch. 7, with updating and additions ([11] et. seq.).

CHAPTER 2

PROGRAM DESCRIPTION

2.1 GENERAL INFORMATION

The groundwork concerning codes served by ETOT, and concerning symbol definition, is assumed from the main report.

The alterations represented by ETOT-3 require certain modifications to Chapter 2 of the main report. These are limited to the topics: 1) resolved resonances, and 2) capture cross sections.

2.2 RESOLVED RESONANCE TREATMENT

2.2.1 RESOLVED RESONANCE FORMULAE

ETOT will calculate KATE type resonance parameters and/or calculate the microscopic cross sections using the single-level or multi-level Breit-Wigner formula.

The formulae on Page 2-3 of the main report for cross sections from resolved resonance parameters are replaced by the specifications given in Appendix D of Reference 2 (official ENDF/B specification). This Appendix is quoted extensively below. Note that ℓ stands for the angular momentum state, and ETOT-3 will handle the values ℓ=0, 1, and 2.

1. Elastic Scattering Cross Section

$$\sigma_{n,n}(E) = \sum_{\ell=0}^{NLS} \sigma_{n,n}^{\ell}(E),$$

where

$$\sigma_{n,n}^{\ell}(E) = (2\ell+1)\frac{4\pi}{k^2}\sin^2\varphi_\ell + \frac{\pi}{k^2}\sum_J g_J \sum_{r=1}^{NR_J} \frac{\Gamma_{nr}^2\cos 2\varphi_\ell - 2\Gamma_{nr}\left(\Gamma_{\gamma r}+\Gamma_{fr}\right)\sin^2\varphi_\ell + 2(E-E_r')\Gamma_{nr}\sin 2\varphi_\ell}{(E-E_r')^2 + \frac{1}{4}\Gamma_r^2}$$

2. Radiative Capture Cross Section

$$\sigma_{n,\gamma}(E) = \sum_{\ell=0}^{NLS} \sigma_{n,\gamma}^{\ell}(E)$$

where

$$\sigma_{n,\gamma}^{\ell}(E) = \frac{\pi}{k^2}\sum_J g_J \sum_{r=1}^{NR_J} \frac{\Gamma_{nr}\Gamma_{\gamma r}}{(E-E_r')^2 + \frac{1}{4}\Gamma_r^2}$$

3. Fission Cross Section

$$\sigma_{n,f}(E) = \sum_{\ell=0}^{NLS} \sigma_{n,f}^{\ell}(E) ,$$

where

$$\sigma_{n,f}^{\ell}(E) = \frac{\pi}{k^2} \sum_{J} g_J \sum_{r=1}^{NR_J} \frac{\Gamma_{nr}\Gamma_{fr}}{(E-E_r')^2 + \frac{1}{4}\Gamma_r^2} ,$$

where

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

I is the spin of the target nucleus and J is the spin of the compound nucleus for the resonance state.

I = SPI, as given in File 2 data for each isotope

The summation on ℓ extends over all ℓ-states described. There will be NLS terms in the summation.

NLS is given in File 2 for each isotope

The summation on J extends over all possible J-states for a particular ℓ-state. NR_J is the number of resonances for a given pair of ℓ and J values.

$$NRS = \sum_{J} NR_J$$

NRS is given in File 2 for each ℓ-value

$\Gamma_{nr}(|E_r|) \equiv GN_r$ is the neutron width, for the r^{th} resonance for a particular value of ℓ, evaluated at the resonance energy E_r. For bound levels, the absolute value $|E_r|$ is used.

$$\Gamma_{nr} = \frac{P_\ell(E)\ \Gamma_{nr}(|E_r|)}{P_\ell(|E_r|)}$$

$\Gamma_r = \Gamma_{nr}(E) + \Gamma_{\gamma r} + \Gamma_{fr}$ is the total width.

The following quantities are given in File 2 for each resonance:

E_r = ER, the resonance energy

J = AJ, the spin of the resonance state

$\Gamma_{nr}(|E_r|)$ = GN, the neutron width

$\Gamma_{\gamma r}$ = GG, the radiation width

Γ_{fr} = GF, the fission width

$$E_r' = E_r + \frac{S_\ell(|E_r|) - S_\ell(E)}{2P_\ell(|E_r|)}\ \Gamma_{nr}(|E_r|)$$

$$k = 2.196771\ \frac{AWRI}{AWRI + 1.0}\ \times 10^{-3}\ \sqrt{E}\ ,$$

where k is the neutron wave number and AWRI is the ratio of the mass of the particular isotope to that of the neutron.

AWRI given in File 2 data for each isotope

E is the incident neutron energy (Laboratory system);

S_ℓ is the shift factor,

$$S_0 = 0$$

$$S_1 = -\frac{1}{1 + \rho^2}$$

$$S_2 = -\frac{18 + 3\rho^2}{9 + 3\rho^2 + \rho^4}$$

P_ℓ is the penetration factor,

$$P_0 = \rho$$

$$P_1 = \frac{\rho^3}{1+\rho^2}$$

$$P_2 = \frac{\rho^5}{9+3\rho^2+\rho^4}$$

where $\rho = ka$ and "a" is the channel radius (in units of 10^{-12} cm) and is defined as

$$a = [1.23(AWRI)^{1/3} + 0.8] \times 10^{-1} \ ;$$

φ_ℓ is the phase shift,

$$\varphi_0 = \hat{\rho}$$

$$\varphi_1 = \hat{\rho} - \tan^{-1}\hat{\rho}$$

$$\varphi_2 = \hat{\rho} - \tan^{-1}\frac{3\hat{\rho}}{3-\hat{\rho}^2} \ ,$$

where $\hat{\rho} = k\hat{a}$ and $\hat{a}$ is the effective scattering radius.

$\hat{a} = AP$, as given in File 2 data

This considerable change in formulae is not justified for typical low-energy ETOT processing, but the change was made to achieve near perfection (4-digit accuracy) in comparison of ETOT results with standard results up to 3 eV.

The MLBW calculation specified in Reference 2 is used in ETOT-3 for ENDF/B resolved resonance data which calls for this form. Quoting again from Appendix D of Reference 2:

Multilevel Breit-Wigner Formula: LRU=1, LRF=2

The equations are exactly the same as above, except that a level-level interference term is included in the equation for elastic scattering:

$$\frac{\pi}{k^2}\sum_J g_J \sum_{r=2}^{NR_J}\sum_{s=1}^{r-1} \frac{2\Gamma_{nr}\Gamma_{ns}\left|(E-E_r')(E-E_s') + \frac{1}{4}\Gamma_r\Gamma_s\right|}{\left|(E-E_r')^2 + \frac{1}{4}\Gamma_r^2\right|\left|(E-E_s')^2 + \frac{1}{4}\Gamma_s^2\right|}$$

It is crucial to notice that any term in the sum above is omitted if the J value assigned to resonance s differs from the J value assigned to resonance r. This is not a deficiency in the specifications in Reference 2, but merely a caution, since the classes "NR_J" are not always segregated in ETOT.

ETOT-3 lacks provisions for Reich-Moore and for Adler-Adler formalisms. The only ENDF/B Version-III material excluded by these shortcomings is U^{233}, Mat 1110, for cross sections above 0.79 eV.

2.2.2 KATE RESONANCE PARAMETERS

Some corrections to the main report are required, and certain corrections were made in ETOT for KATE parameters. Certain questions concerning energy dependence of Γ_n are still unresolved. However, a faithful description of actual computing will be given. The author has never used the ETOT option for KATE parameters.

The KATE resonance parameters are denoted* by E_o, Γ_n^o, Γ_a, K_1, K_2, and K_3. If KATE resonance parameters are desired, ETOT will find the IRES largest resonances that are both within the thermal library range and within the ENDF/B defined resonance region. The resonances are compared as to their total peak cross section given by

$$\alpha_o = \frac{(2.6037 \times 10^6)}{|E_o|} \frac{\Gamma_n(|E_o|)_g}{\Gamma} \left(\frac{AWR + 1.0}{AWR}\right)^2$$

The IRES largest resonances are converted into KATE parameters if the background cross sections are 1/v. The background is composed of the remaining resonances (usually epithermal) and the smooth cross sections from ENDF/B File 3.

The single-level Breit-Wigner formula, when written using the KATE parameters, is given by:

*In the KATE report (ref. 9), Γ_n^o is denoted by n and Γ_a is denoted by γ.

$$\sqrt{E}\ \sigma_a = \frac{K_1\gamma}{(\Gamma_a + \Gamma_n^o E^{1/2})^2 + 4(E - E_o)^2}$$

$$\sqrt{E}\ \sigma_f = \frac{K_2\gamma}{(\Gamma_a + \Gamma_n^o E^{1/2})^2 + 4(E - E_o)^2}$$

$$\sigma_s = \frac{K_3\gamma}{(\Gamma_a + \Gamma_n^o E^{1/2})^2 + 4(E - E_o)^2}$$

(These formulae are only explanatory; they are not the basic cross-section formulae of ETOT-3.)

where

$$\Gamma_a = \Gamma_\gamma + \Gamma_f$$

$$\Gamma_n^o = \frac{\Gamma_n(|E_o|)}{\sqrt{|E_o|}}$$

$$K_1 = \frac{(2.6037 \times 10^6)}{\sqrt{|E_o|}}\ \Gamma_n(|E_o|)\ g\left(\frac{AWR + 1.0}{AWR}\right)^2$$

$$K_2 = \frac{(2.6037 \times 10^6)}{\sqrt{|E_o|}}\ \Gamma_n(|E_o|)\ g\ \frac{\Gamma_f}{\Gamma_\gamma + \Gamma_f}\ \left(\frac{AWR + 1.0}{AWR}\right)^2$$

$$K_3 = \frac{(2.6037 \times 10^6)}{|E_o|}\ \Gamma_n(|E_o|)\ g\ \frac{\Gamma_n(|E_o|)}{\Gamma_\gamma + \Gamma_f}\ \left(\frac{AWR + 1.0}{AWR}\right)^2$$

(An erroneous use of $1/(\Gamma_n + \Gamma_f)$ in K_2 has been reprogrammed as $1/(\Gamma_\gamma + \Gamma_f)$.)

Since the resonance region usually will not cover the library energy mesh, the tails of the resonances which are put into KATE parameters must be subtracted from the smooth cross sections outside of the resonance region. Also, the scattering cross section does not incl e the interference term so it must be added to the smooth cross section for these resonances. This corresponds to the sine terms of the equation for $\sigma_{n,n}$ in Section 2.2.1.

2.3 SMOOTH CROSS SECTIONS

The information required for the thermal codes includes the capture, fission, and scattering cross sections, as well as the fission neutron yield and the average cosine of scattering. These values can be calculated as group-averaged values or point values depending on the input option IAV.

2.3.1 SCATTERING

In the thermal range, the scattering cross section is taken as the elastic cross section which is obtained from ENDF/B File 3, MT=2. Where the resolved-resonance-energy region extends into the thermal range, the contribution from resonance parameters to the scattering is added. This is, of course, modified by the statement at the end of Section 2.2.2 above, when KATE parameters are being generated.

2.3.2 CAPTURE

The basic smooth capture is taken as σ_γ, but if any other "capture-like" cross section is non-zero, it is added to the capture cross section. If a material index is given in File 1, ETOT will see if the (n,γ) cross section is tabulated. If it is not, and σ_a is given, it will calculate σ_c by $\sigma_c = \sigma_a - \sigma_f$. σ_a is obtained from ENDF/B File 3, MT-27, and σ_γ is is obtained from ENDF/B File 3, MT=102.

Again, proper resonance contributions are added when the thermal group or point structure overlaps the resolved-resonance-energy region.

In order to accommodate the Universal Supergroup System (thermal) as input data to ETOT-3 in place of ENDF/B, an arrangement was made to recognize File 3, MT=101 data. This is called "parasitic absorption (redundant)..." in Reference 2, p. B-3. ETOT-3 takes in MT=101, if present, as capture information, but replaces by any other "smooth capture" MT sections found in File 3 of the incoming library data for the material being processed.

2.3.3 FISSION

The fission cross section is taken from ENDF/B File 3, MT=18. Once more, it is pertinent to remark that applicable resolved-resonance-generated cross sections are added to File-3 quantities to give final results.

CHAPTER 3

EXECUTION INFORMATION AND OUTPUT DESCRIPTION

This chapter is written to replace many sections of Chapter 3 of the main report which contained errors and should be updated in order to correspond with ETOT-3. "Input Description" and "Available Options" are covered completely and, likewise, "Sample Input" and "Sample Output." A vertical black bar will be placed in the margin, for Sections 3.3 and 3.4, to indicate changes or corrections.

3.1 LIMITATIONS

The limitations stated in the main report still hold. The additional limitation required is concerned with graphical output. This feature did not function in the ETOT version first deposited at the Argonne Code Center and has not been worked on since that time (January, 1972).

3.2 NOTE ON USS DATA

As pointed out in Reference 11, a preliminary version of the Universal Supergroup System (thermal) is available from the National Neutron Cross Section Center (Brookhaven National Laboratory). ETOT-3 will accept the non-kernel portion of this data just as if ENDF/B-III data were used. Tape i.d. numbers are the same, but all MAT numbers on the USS tapes are reduced to 2 or 3 digits to avoid confusion with the ENDF/B library itself.

Because the "one-dimensional" sections are essentially "File 3" formats, all materials from the USS library are processed by ETOT-3 with the high speed of a "no-resolved resonances" material. (Along these lines, a user may wish to remove large blocks of coding to produce a small ETOT version for USS processing only.)

The USS files, of course, cannot provide any KATE resonance parameters. There should be no difference in this respect from an ENDF/B material containing no resolved resonances. For the rest of this chapter, regular ENDF/B processing is assumed.

3.3 INPUT DESCRIPTION

In the following input list, the various items are described and the columns to be used for each item designated. Standard FORTRAN input is used. For added convenience the actual program formats and symbols are also listed. The various options are more fully described in the next section.

Card No. 1 (20A4)

Item	Columns	Name	Description
1	1-80	LABEL	General output label

Card No. 2 (9I5, 3X, 2E12.5)

Item	Columns	Name	Description
1	1-5	INALL	0=only cards Number 1-3 are read in 1=all input cards are read
2	6-10	MCODE	Program for which the library is intended =1 KATE =2 THERMOS =3 ARK =4 TEMPEST =5 LASER
3	11-15	NMAT	Number of materials
4	16-20	IREW	0=ENDF/B tape is not rewound by ETOT 1=ENDF/B tape is rewound by ETOT
5	21-25	IPUN	0=no punched output 1=punched output
6	26-30	IAPX	0=do not try to fit cross sections to 1/v 1=try to fit cross sections to 1/v
7	31-35	IRES	Number of resonances which are to be output by resonance parameters

Card No. 2 (9I5, 3X, 2E12.5) (Cont'd)

Item	Columns	Name	Description
8	36-40	IXL	Not in use
9	41-45	LEGO	Not in use
10	49-60	EPSLON	Maximum relative deviation for 1/v fit
11	61-72	TEMP	Temperature for Maxwellian distribution

Card No. 3 (4(2I5, 1X, A4)) or (12I5)

Item	Columns	Name	Description
1	1-5	MATNOS	ENDF/B tape material number
2	6-10	MATIDS	Principle thermal material number
3	12-15	MAT2ID	Secondary thermal material identification number. Alphanumeric (A4) for MCODE=1, 3 & 4 and numeric for MCODE= 2 or 5.

The above set is repeated NMAT times with four sets per card.

Card No. 4(5I5, 23X, 2E12.5) (If INALL=1)

Item	Columns	Name	Description
1	1-5	IAV	If=0, cross sections will be group averaged If=1, cross sections will be point values
2	6-10	IEU	Group structure option
3	11-15	IW	Type of weighting function
4	16-20	MAXG	Number of groups
5	21-25	IGRAPH	Graphing option, graphs made if > 0 (Not yet used on CDC-7600 computer)
6	49-60	EPSMIN	Minimum error for combining two TAB1 functions
7	61-72	EPSMAX	Maximum error for combining two TAB1 functions

Card No. 5(4I5) (If INALL=1)

Item	Columns	Name	Description
1	1-5	NDFB	ENDF/B tape unit
2	6-10	IDTAP	ENDF/B tape ID
3	11-15	MODE	Mode of ENDF/B tape =1 binary (Not yet tried on CDC-7600 computer) =2 BCD
4	16-20	LTAPE	Library tape unit (Not yet used on CDC-7600 computer) If=0, no library written

Card No. 6

This is actually a card set and is necessary only if IW=3. The set consists of the desired weighting function as tabulated points plus the interpolation tables defining the interpolation scheme to be used with the tabulated points. The weighting function must be given from low to high in energy. The format of the card set is a standard ENDF/B TAB 1 record.

Card No. 6.1 (44X, 2I11)

Item	Columns	Name	Description
1	45-55	N1	Number of interpolation ranges
2	56-66	N2	Number of weighting function points

Card No. 6.2 - ... (6I11)

Item	Columns	Name	Description
1	1-11	NBT(1)	Last point number in 1st interpolation range
2	12-22	JNT(1)	Interpolation scheme for 1st range
3	23-33	NBT(2)	Last point number in 2nd interpolation range
4	34-44	JNT(2)	Interpolation scheme for 2nd range

:
:
etc.

Card No. 6.2 - ... (6I11) (Cont'd)

Item	Columns	Name	Description
2*N1-1		NBT(N1)	Last point number in N1 interpolation range
2*N1		JNT(N1)	Interpolation scheme for the N1 range

Card No. 6.3 - ... (6E11.4)

Item	Columns	Name	Description
1	1-11	BLOK3(1)	First energy point ($\leq$ lowest energy in group structure)
2	12-22	BLOK4(1)	Weight at this energy
⋮			
etc. using N2/3 cards			
⋮			
2*N2-1		BLOK3(N2)	Last energy point ($\geq$ highest energy in group structure)
2*N2		BLOK4(N2)	Weight at this energy

Card No. 7

This is actually a card set and is necessary only if INALL=1 and IEU=1,2,3,6,7 or 8. If IEU=1, the set is the energy breakpoints from low to high energy. If IEU=2, the set is the speed breakpoints of the structure given from low to high velocity. If IEU=3, the set is the energy points from low to high energy. If IEU=6, the set is the description of the energy point mesh in terms of the increments and endpoints. If IEU=7, the set is the speed points from low to high in energy. If IEU=8, the set is the description of the speed point mesh in terms of the increments and endpoints. An example best clarifies the increment input. If the input consists of XX(1)=0.0, XX(2)=.005, XX(3)=.1, XX(4)=.05, XX(5)=1.5, the energy array would begin at 0.0, step .005 for each point until .1 and then step .05 until 1.5. See Section 3.4.8 for further explanation. (Energy increment input has not yet been used on the CDC-7600 computer.)

An energy point or a group breakpoint of zero is allowed.

Card No. 7.1 (6E11.4)

Item	Columns	Name	Description
1	1-11	XX(1)	
2	12-22	XX(2)	
⋮			
etc. using (MAXG+1)/6 cards			
⋮			
MAXG		XX(MAXG)	
MAXG1		XX(MAXG1)	

Note: (MAXG+1)/6 cards must be used, even if blanks must be used.

3.4 AVAILABLE OPTIONS

3.4.1 READ INPUT OPTION (INALL)

This option is designed to facilitate stacked cases where several materials are to be processed in about the same way. Complete input is necessary only with the first case (INALL=1) and subsequent cases need only the first few cards (INALL=0).

3.4.2 THERMAL CODE OPTION (MCODE)

Since actual processing is the same, this merely controls the punched output formats. The available options are:

1	KATE
2	THERMOS
3	ARK
4	TEMPEST
5	LASER

3.4.3 TAPE REWIND OPTION (IREW)

This is to provide running efficiency by a single pass over the ENDF/B tape during a stack of cases. The first case should request a tape rewind (IREW=1), but subsequent cases should not.

3.4.4 PUNCH OPTION (IPUN)

This option merely selects whether or not the results should be punched out on cards.

3.4.5 1/V APPROXIMATION OPTION (IAPX)

This is an option to signal that the cross section is to be tested for a 1/v fit within a relative error of EPSLON.

3.4.6 RESONANCE PARAMETER OPTION (IRES)

This corresponds to the maximum number of resonances which will be given as resonance parameters if the remaining cross section is 1/v. If the remaining cross section is not 1/v, no resonances will be specified by parameters (not yet tried on the CDC-7600 computer).

3.4.7 AVERAGE OPTION (IAV)

This option determines whether the cross sections will be group averaged (IAV=0) or point values (IAV=1).

3.4.8 ENERGY STRUCTURE OPTION (IEU)

This option permits the standard thermal structures to be internally generated or allows the structure to be input in a variety of ways. (Not all choices have been tried in ETOT-3.)

IEU=1	Input energy breakpoints
IEU=2	Input speed breakpoints
IEU=3	Input energy points
IEU=4	Standard LEOPARD 172 points
IEU=5	Standard LEOPARD 309 points
IEU=6	Energy increment input
IEU=7	Speed points input
IEU=8	Speed increment input
IEU=9	LASER standard 35 points
IEU=10	TEMPEST and KATE standard 246 points
IEU=11	THERMOS standard 30 points

The speeds as input are in fractions of 2200 m/sec and the energies are in electron volts. The increment inputs are a shortened form by which the structures can be given. The first number is the initial value, the second is the increment, the third is the final value for this increment and the initial value for the next increment, etc. For example

0.0,0.1, 0.3, 0.2, 0.9

implies the point values:

0.0, 0.1, 0.2, 0.3, 0.5, 0.7, 0.9

The breakpoints are the end points of the groups while the points are the center points of the group. Energy increment input has not been successfully used on the CDC-7600 computer.

3.4.9 WEIGHTING FUNCTION OPTION (IW)

This option chooses the weighting function to be used. The following four are currently available and other built-in functions can be easily added in the future.

IW=1	1/E
IW=2	1.0
IW=3	Input
IW=4	Combination of 1/E plus Maxwellian

3.4.10 GRAPH OPTION (IGRAPH)

This option allows for the absorption, fission and transport cross section to be graphed (IGRAPH > 1). The only medium optioned, in the CDC-7600 environment, is microfiche. Nevertheless, when last tested IGRAPH was inoperative.

3.4.11 TAPE MODE OPTION (MODE)

The ENDF/B may be either in the standard binary or BCD mode. "Binary mode" has not been tested on the CDC 7600. Resonance computations, etc., are a much greater load than BCD data reading.

3.5 OUTPUT

ETOT gives a very thorough listing of the cross sections and values associated with them, and punches cards in KATE, TEMPEST, LASER, THERMOS, or ARK format.

3.6 SAMPLE PROBLEM INPUT

The sample problem processes data for ENDF/B Material Number 1159 and produces a 246-point TEMPEST deck. The 1159 data is that present on ENDF/B Tape 308.

3.7 SAMPLE PROBLEM OUTPUT

The sample problem was run on a CDC 7600 using the Scope 2.0 operating system. The output is on the following pages and is self-explanatory (pp. 3-12 through 3-43).

SAMPLE PROBLEM OUTPUT

WESTINGHOUSE FORM 54857

Westinghouse Electric Corporation — DATA CODING FORM

TITLE SAMPLE PROBLEM FOR SUPPLEMENT TO WCAP-7363 ANALYST _____ DATE SEPT. 1973

ADDRESS MATERIAL 1159 Pu-239 PHONE _____ L.S. NO. _____ LABEL [73 — 76] SHEET 1 OF 1

1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72	77 78 79 80	NO.
	ETOT SAMPLE PROBLEM		PU-239 ENDF/B 1159						1
1 4	1	1	1 0	0					2
1159 4	PU39								3
1 10	0	246	0			1.00E-05		5.0E-05	4
11 308	2	0							5
									6
									7
									8
									9
									0

ETOT SAMPLE PROBLEM PU-239 ENDF/B 1159

TEMPEST

ENDF/B MATERIAL	THERMAL MATERIAL FIRST ID	SECOND ID
1159	4	PU39

ENDF/B TAPE NUMBER = 308

ENDF/B TAPE LABEL = ENDF/B-III TAPE 308 (REV.1) (12-4-72)

EPSMIN = .10E-04 EPSMAX = .50E-04

PUNCH OPTION = 1

NO RESONANCE PARAMETERS WILL BE CALCULATED

THE CROSS SECTIONS ARE POINT VALUES

*** ETOT ***

GROUP STRUCTURE

GROUP	ENERGY POINT	SPEED POINT	ENERGY RANGE	SPEED RANGE
1	0.000000	0.000000	0.0000000 - .0005000	0.000000 - .140580
2	.001000	.198811	.0005000 - .0015000	.140580 - .243492
3	.002000	.281161	.0015000 - .0025000	.243492 - .314347
4	.003000	.344350	.0025000 - .0035000	.314347 - .371941
5	.004000	.397621	.0035000 - .0045000	.371941 - .421741
6	.005000	.444554	.0045000 - .0055000	.421741 - .466252
7	.006000	.486985	.0055000 - .0065000	.466252 - .506870
8	.007000	.526004	.0065000 - .0075000	.506870 - .544466
9	.008000	.562322	.0075000 - .0085000	.544466 - .579628
10	.009000	.596432	.0085000 - .0095000	.579628 - .612776
11	.010000	.628695	.0095000 - .0105000	.612776 - .644220
12	.011000	.659780	.0105000 - .0115000	.644220 - .674200
13	.012000	.689790	.0115000 - .0125000	.674200 - .702902
14	.013000	.718922	.0125000 - .0135000	.702902 - .730477
15	.014000	.747881	.0135000 - .0145000	.730477 - .757049
16	.015000	.776991	.0145000 - .0155000	.757049 - .782718
17	.016000	.795243	.0155000 - .0165000	.782718 - .807573
18	.017000	.819717	.0165000 - .0175000	.807573 - .831685
19	.018000	.843482	.0175000 - .0185000	.831685 - .855117
20	.019000	.866596	.0185000 - .0195000	.855117 - .877924
21	.020000	.889108	.0195000 - .0205000	.877924 - .900154
22	.021000	.911065	.0205000 - .0215000	.900154 - .921847
23	.022000	.932505	.0215000 - .0225000	.921847 - .943042
24	.023000	.953467	.0225000 - .0235000	.943042 - .963771
25	.024000	.973970	.0235000 - .0245000	.963771 - .984063
26	.025000	.994053	.0245000 - .0255000	.984063 - 1.003945
27	.026000	1.013740	.0255000 - .0265000	1.003945 - 1.023441
28	.027000	1.033051	.0265000 - .0275000	1.023441 - 1.042572
29	.028000	1.052007	.0275000 - .0285000	1.042572 - 1.061359
30	.029000	1.070628	.0285000 - .0295000	1.061359 - 1.079818
31	.030000	1.088931	.0295000 - .0305000	1.079818 - 1.097968
32	.031000	1.106931	.0305000 - .0315000	1.097968 - 1.115822
33	.032000	1.124643	.0315000 - .0325000	1.115822 - 1.133395
34	.033000	1.142080	.0325000 - .0335000	1.133395 - 1.150700
35	.034000	1.159256	.0335000 - .0345000	1.150700 - 1.167748
36	.035000	1.176180	.0345000 - .0355000	1.167748 - 1.184551

*** ETOT ***

GROUP STRUCTURE

GROUP	ENERGY POINT	SPEED POINT	ENERGY RANGE	SPEED RANGE
37	.036000	1.192864	.0355000 - .0365000	1.184551 - 1.201119
38	.037000	1.209318	.0365000 - .0375000	1.201119 - 1.217462
39	.038000	1.225551	.0375000 - .0385000	1.217462 - 1.233588
40	.039000	1.241572	.0385000 - .0395000	1.233588 - 1.249506
41	.040000	1.257389	.0395000 - .0405000	1.249506 - 1.265224
42	.041000	1.273010	.0405000 - .0415000	1.265224 - 1.280748
43	.042000	1.288441	.0415000 - .0425000	1.280748 - 1.296087
44	.043000	1.303689	.0425000 - .0435000	1.296087 - 1.311247
45	.044000	1.318761	.0435000 - .0445000	1.311247 - 1.326233
46	.045000	1.333663	.0445000 - .0455000	1.326233 - 1.341051
47	.046000	1.348400	.0455000 - .0465000	1.341051 - 1.355708
48	.047000	1.362977	.0465000 - .0475000	1.355708 - 1.370208
49	.048000	1.377401	.0475000 - .0485000	1.370208 - 1.384556
50	.049000	1.391676	.0485000 - .0495000	1.384556 - 1.398757
51	.050000	1.405804	.0495000 - .0505000	1.398757 - 1.412815
52	.060000	1.539081	.0505000 - .0650000	1.412815 - 1.602863
53	.070000	1.663770	.0650000 - .0750000	1.602863 - 1.721751
54	.080000	1.778217	.0750000 - .0850000	1.721751 - 1.832944
55	.090000	1.886084	.0850000 - .0950000	1.832944 - 1.937767
56	.100000	1.988107	.0950000 - .1050000	1.937767 - 2.037203
57	.110000	2.085144	.1050000 - .1150000	2.037203 - 2.132007
58	.120000	2.177862	.1150000 - .1250000	2.132007 - 2.222771
59	.130000	2.266791	.1250000 - .1350000	2.222771 - 2.309972
60	.140000	2.352363	.1350000 - .1450000	2.309972 - 2.393998
61	.150000	2.434924	.1450000 - .1550000	2.393998 - 2.475173
62	.160000	2.514778	.1550000 - .1650000	2.475173 - 2.553770
63	.170000	2.592174	.1650000 - .1750000	2.553770 - 2.630018
64	.180000	2.667325	.1750000 - .1850000	2.630018 - 2.704118
65	.190000	2.740416	.1850000 - .1950000	2.704118 - 2.776240
66	.200000	2.811608	.1950000 - .2050000	2.776240 - 2.846536
67	.210000	2.881041	.2050000 - .2150000	2.846536 - 2.915137
68	.220000	2.948839	.2150000 - .2250000	2.915137 - 2.982160
69	.230000	3.015113	.2250000 - .2350000	2.982160 - 3.047710
70	.240000	3.079962	.2350000 - .2450000	3.047710 - 3.111880
71	.250000	3.143473	.2450000 - .2550000	3.111880 - 3.174752

*** ETOT ***

GROUP STRUCTURE

GROUP	ENERGY POINT	SPEED POINT	ENERGY RANGE	SPEED RANGE
72	.260000	3.205726	.2550000 - .2650000	3.174752 - 3.236404
73	.270000	3.266793	.2650000 - .2750000	3.236404 - 3.296902
74	.280000	3.326739	.2750000 - .2850000	3.296902 - 3.356311
75	.290000	3.385624	.2850000 - .2950000	3.356311 - 3.414686
76	.300000	3.443502	.2950000 - .3050000	3.414686 - 3.472079
77	.310000	3.500423	.3050000 - .3150000	3.472079 - 3.528540
78	.320000	3.556434	.3150000 - .3250000	3.528540 - 3.584111
79	.330000	3.611576	.3250000 - .3350000	3.584111 - 3.638833
80	.340000	3.665888	.3350000 - .3450000	3.638833 - 3.692745
81	.350000	3.719407	.3450000 - .3550000	3.692745 - 3.745890
82	.360000	3.772168	.3550000 - .3650000	3.745890 - 3.799273
83	.370000	3.824200	.3650000 - .3750000	3.799273 - 3.849953
84	.380000	3.875534	.3750000 - .3850000	3.849953 - 3.900947
85	.390000	3.926197	.3850000 - .3950000	3.900947 - 3.951284
86	.400000	3.976214	.3950000 - .4050000	3.951284 - 4.000988
87	.410000	4.025610	.4050000 - .4150000	4.000988 - 4.050082
88	.420000	4.074407	.4150000 - .4250000	4.050082 - 4.098587
89	.430000	4.122626	.4250000 - .4350000	4.098587 - 4.146526
90	.440000	4.170288	.4350000 - .4450000	4.146526 - 4.193916
91	.450000	4.217412	.4450000 - .4550000	4.193916 - 4.240777
92	.460000	4.264014	.4550000 - .4650000	4.240777 - 4.287126
93	.470000	4.310113	.4650000 - .4750000	4.287126 - 4.332979
94	.480000	4.355724	.4750000 - .4850000	4.332979 - 4.378351
95	.490000	4.400862	.4850000 - .4950000	4.378351 - 4.423259
96	.500000	4.445542	.4950000 - .5050000	4.423259 - 4.467715
97	.510000	4.489778	.5050000 - .5150000	4.467715 - 4.511733
98	.520000	4.533581	.5150000 - .5250000	4.511733 - 4.555325
99	.530000	4.576966	.5250000 - .5350000	4.555325 - 4.598505
100	.540000	4.619943	.5350000 - .5450000	4.598505 - 4.641282
101	.550000	4.662524	.5450000 - .5550000	4.641282 - 4.683669
102	.560000	4.704720	.5550000 - .5650000	4.683669 - 4.725676
103	.570000	4.746540	.5650000 - .5750000	4.725676 - 4.767313
104	.580000	4.787996	.5750000 - .5850000	4.767713 - 4.808589
105	.590000	4.829095	.5850000 - .5950000	4.808589 - 4.849514
106	.600000	4.869848	.5950000 - .6050000	4.849514 - 4.890096

*** ETOT ***

GROUP STRUCTURE

GROUP	ENERGY POINT	SPEED POINT	ENERGY RANGE	SPEED RANGE
107	.610000	4.910252	.6050000 - .6150000	4.890096 - 4.930345
108	.620000	4.950746	.6150000 - .6250000	4.930345 - 4.970267
109	.630000	4.990109	.6250000 - .6350000	4.970267 - 5.009872
110	.640000	5.029557	.6350000 - .6450000	5.009872 - 5.049165
111	.650000	5.068698	.6450000 - .6550000	5.049165 - 5.088156
112	.660000	5.107539	.6550000 - .6650000	5.088156 - 5.126849
113	.670000	5.146087	.6650000 - .6750000	5.126849 - 5.165253
114	.680000	5.184349	.6750000 - .6850000	5.165253 - 5.203374
115	.690000	5.222330	.6850000 - .6950000	5.203374 - 5.241217
116	.700000	5.260037	.6950000 - .7050000	5.241217 - 5.278789
117	.710000	5.297475	.7050000 - .7150000	5.278789 - 5.316095
118	.720000	5.334651	.7150000 - .7250000	5.316095 - 5.353142
119	.730000	5.371569	.7250000 - .7350000	5.353142 - 5.389934
120	.740000	5.408236	.7350000 - .7450000	5.389934 - 5.426476
121	.750000	5.444655	.7450000 - .7550000	5.426476 - 5.462774
122	.760000	5.480833	.7550000 - .7650000	5.462774 - 5.498832
123	.770000	5.516773	.7650000 - .7750000	5.498832 - 5.534655
124	.780000	5.552480	.7750000 - .7850000	5.534655 - 5.570248
125	.790000	5.587960	.7850000 - .7950000	5.570248 - 5.605615
126	.800000	5.623216	.7950000 - .8050000	5.605615 - 5.640761
127	.810000	5.658252	.8050000 - .8150000	5.640761 - 5.675688
128	.820000	5.693072	.8150000 - .8250000	5.675688 - 5.710402
129	.830000	5.727681	.8250000 - .8350000	5.710402 - 5.744907
130	.840000	5.762081	.8350000 - .8450000	5.744907 - 5.779205
131	.850000	5.796278	.8450000 - .8550000	5.779205 - 5.813301
132	.860000	5.830274	.8550000 - .8650000	5.813301 - 5.847198
133	.870000	5.864073	.8650000 - .8750000	5.847198 - 5.880900
134	.880000	5.897678	.8750000 - .8850000	5.880900 - 5.914409
135	.890000	5.931093	.8850000 - .8950000	5.914409 - 5.947730
136	.900000	5.964321	.8950000 - .9050000	5.947730 - 5.980865
137	.910000	5.997364	.9050000 - .9150000	5.980865 - 6.013818
138	.920000	6.030227	.9150000 - .9250000	6.013818 - 6.046591
139	.930000	6.062911	.9250000 - .9350000	6.046591 - 6.079188
140	.940000	6.095420	.9350000 - .9450000	6.079188 - 6.111610
141	.950000	6.127757	.9450000 - .9550000	6.111610 - 6.143862

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GROUP STRUCTURE

GROUP	ENERGY POINT	SPEED POINT	ENERGY RANGE	SPEED RANGE
142	.960000	6.159924	.9550000 - .9650000	6.143862 - 6.175945
143	.970000	6.191924	.9650000 - .9750000	6.175945 - 6.207862
144	.980000	6.223759	.9750000 - .9850000	6.207862 - 6.239616
145	.990000	6.255432	.9850000 - .9950000	6.239616 - 6.271209
146	1.000000	6.286946	.9950000 - 1.0050000	6.271209 - 6.302644
147	1.010000	6.318303	1.0050000 - 1.0150000	6.302644 - 6.333923
148	1.020000	6.349504	1.0150000 - 1.0250000	6.333923 - 6.365048
149	1.030000	6.380553	1.0250000 - 1.0350000	6.365048 - 6.396021
150	1.040000	6.411452	1.0350000 - 1.0450000	6.396021 - 6.426846
151	1.050000	6.442203	1.0450000 - 1.0550000	6.426846 - 6.457523
152	1.060000	6.472807	1.0550000 - 1.0650000	6.457523 - 6.488055
153	1.070000	6.503268	1.0650000 - 1.0750000	6.488055 - 6.518444
154	1.080000	6.533586	1.0750000 - 1.0850000	6.518444 - 6.548693
155	1.090000	6.563764	1.0850000 - 1.0950000	6.548693 - 6.578802
156	1.100000	6.593805	1.0950000 - 1.1050000	6.578802 - 6.608774
157	1.110000	6.623709	1.1050000 - 1.1150000	6.608774 - 6.638610
158	1.120000	6.653478	1.1150000 - 1.1250000	6.638610 - 6.668313
159	1.130000	6.683115	1.1250000 - 1.1350000	6.668313 - 6.697885
160	1.140000	6.712622	1.1350000 - 1.1450000	6.697885 - 6.727326
161	1.150000	6.741999	1.1450000 - 1.1550000	6.727326 - 6.756639
162	1.160000	6.771248	1.1550000 - 1.1650000	6.756639 - 6.785826
163	1.170000	6.800372	1.1650000 - 1.1750000	6.785826 - 6.814887
164	1.180000	6.829372	1.1750000 - 1.1850000	6.814887 - 6.843825
165	1.190000	6.858249	1.1850000 - 1.1950000	6.843825 - 6.872642
166	1.200000	6.887004	1.1950000 - 1.2050000	6.872642 - 6.901337
167	1.210000	6.915641	1.2050000 - 1.2150000	6.901337 - 6.929915
168	1.220000	6.944159	1.2150000 - 1.2250000	6.929915 - 6.958374
169	1.230000	6.972561	1.2250000 - 1.2350000	6.958374 - 6.986718
170	1.240000	7.000847	1.2350000 - 1.2450000	6.986718 - 7.014947
171	1.250000	7.029019	1.2450000 - 1.2550000	7.014947 - 7.043063
172	1.260000	7.057080	1.2550000 - 1.2650000	7.043063 - 7.071068
173	1.270000	7.085028	1.2650000 - 1.2750000	7.071068 - 7.098962
174	1.280000	7.112868	1.2750000 - 1.2850000	7.098962 - 7.126746
175	1.290000	7.140598	1.2850000 - 1.2950000	7.126746 - 7.154423
176	1.300000	7.168221	1.2950000 - 1.3050000	7.154423 - 7.181993

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GROUP STRUCTURE

GROUP	ENERGY POINT	SPEED POINT	ENERGY RANGE	SPEED RANGE
177	1.310000	7.195739	1.3050000 - 1.3150000	7.181993 - 7.209458
178	1.320000	7.223151	1.3150000 - 1.3250000	7.209458 - 7.236818
179	1.330000	7.250460	1.3250000 - 1.3350000	7.236818 - 7.264076
180	1.340000	7.277666	1.3350000 - 1.3450000	7.264076 - 7.291231
181	1.350000	7.304771	1.3450000 - 1.3550000	7.291231 - 7.318286
182	1.360000	7.331776	1.3550000 - 1.3650000	7.318286 - 7.345241
183	1.370000	7.358682	1.3650000 - 1.3750000	7.345241 - 7.372098
184	1.380000	7.385489	1.3750000 - 1.3850000	7.372098 - 7.398857
185	1.390000	7.412200	1.3850000 - 1.3950000	7.398857 - 7.425520
186	1.400000	7.438815	1.3950000 - 1.4050000	7.425520 - 7.452087
187	1.410000	7.465335	1.4050000 - 1.4150000	7.452087 - 7.478560
188	1.420000	7.491761	1.4150000 - 1.4250000	7.478560 - 7.504939
189	1.430000	7.518094	1.4250000 - 1.4350000	7.504939 - 7.531226
190	1.440000	7.544335	1.4350000 - 1.4450000	7.531226 - 7.557422
191	1.450000	7.570486	1.4450000 - 1.4550000	7.557422 - 7.583527
192	1.460000	7.596546	1.4550000 - 1.4650000	7.583527 - 7.609543
193	1.470000	7.622517	1.4650000 - 1.4750000	7.609543 - 7.635470
194	1.480000	7.648400	1.4750000 - 1.4850000	7.635470 - 7.661309
195	1.490000	7.674196	1.4850000 - 1.4950000	7.661309 - 7.687061
196	1.500000	7.699905	1.4950000 - 1.5050000	7.687061 - 7.712728
197	1.510000	7.725529	1.5050000 - 1.5150000	7.712728 - 7.738309
198	1.520000	7.751068	1.5150000 - 1.5250000	7.738309 - 7.763806
199	1.530000	7.776523	1.5250000 - 1.5350000	7.763806 - 7.789219
200	1.540000	7.801895	1.5350000 - 1.5450000	7.789219 - 7.814550
201	1.550000	7.827185	1.5450000 - 1.5550000	7.814550 - 7.839799
202	1.560000	7.852393	1.5550000 - 1.5650000	7.839799 - 7.864967
203	1.570000	7.877521	1.5650000 - 1.5750000	7.864967 - 7.890055
204	1.580000	7.902569	1.5750000 - 1.5850000	7.890055 - 7.915063
205	1.590000	7.927537	1.5850000 - 1.5950000	7.915063 - 7.939992
206	1.600000	7.952428	1.5950000 - 1.6050000	7.939992 - 7.964844
207	1.610000	7.977240	1.6050000 - 1.6150000	7.964844 - 7.989618
208	1.620000	8.001976	1.6150000 - 1.6250000	7.989618 - 8.014315
209	1.630000	8.026636	1.6250000 - 1.6350000	8.014315 - 8.038937
210	1.640000	8.051219	1.6350000 - 1.6450000	8.038937 - 8.063483
211	1.650000	8.075729	1.6450000 - 1.6550000	8.063483 - 8.087955

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GROUP STRUCTURE

GROUP	ENERGY POINT	SPEED POINT	ENERGY RANGE	SPEED RANGE
212	1.660000	8.100163	1.6550000 - 1.6650000	8.087955 - 8.112353
213	1.670000	8.124525	1.6650000 - 1.6750000	8.112353 - 8.136678
214	1.680000	8.148814	1.6750000 - 1.6850000	8.136678 - 8.160931
215	1.690000	8.173030	1.6850000 - 1.6950000	8.160931 - 8.185111
216	1.700000	8.197175	1.6950000 - 1.7050000	8.185111 - 8.209221
217	1.710000	8.221249	1.7050000 - 1.7150000	8.209221 - 8.233259
218	1.720000	8.245253	1.7150000 - 1.7250000	8.233259 - 8.257228
219	1.730000	8.269187	1.7250000 - 1.7350000	8.257228 - 8.281128
220	1.740000	8.293052	1.7350000 - 1.7450000	8.281128 - 8.304958
221	1.750000	8.316848	1.7450000 - 1.7550000	8.304958 - 8.328721
222	1.760000	8.340577	1.7550000 - 1.7650000	8.328721 - 8.352416
223	1.770000	8.364238	1.7650000 - 1.7750000	8.352416 - 8.376043
224	1.780000	8.387832	1.7750000 - 1.7850000	8.376043 - 8.399605
225	1.790000	8.411361	1.7850000 - 1.7950000	8.399605 - 8.423100
226	1.800000	8.434823	1.7950000 - 1.8050000	8.423100 - 8.446530
227	1.810000	8.458221	1.8050000 - 1.8150000	8.446530 - 8.469896
228	1.820000	8.481554	1.8150000 - 1.8250000	8.469896 - 8.493197
229	1.830000	8.504823	1.8250000 - 1.8350000	8.493197 - 8.516434
230	1.840000	8.528029	1.8350000 - 1.8450000	8.516434 - 8.539608
231	1.850000	8.551171	1.8450000 - 1.8550000	8.539608 - 8.562719
232	1.860000	8.574251	1.8550000 - 1.8650000	8.562719 - 8.585768
233	1.870000	8.597270	1.8650000 - 1.8750000	8.585768 - 8.608756
234	1.880000	8.620226	1.8750000 - 1.8850000	8.608756 - 8.631682
235	1.890000	8.643122	1.8850000 - 1.8950000	8.631682 - 8.654547
236	1.900000	8.665957	1.8950000 - 1.9050000	8.654547 - 8.677352
237	1.910000	8.688732	1.9050000 - 1.9150000	8.677352 - 8.700098
238	1.920000	8.711448	1.9150000 - 1.9250000	8.700098 - 8.722784
239	1.930000	8.734105	1.9250000 - 1.9350000	8.722784 - 8.745411
240	1.940000	8.756703	1.9350000 - 1.9450000	8.745411 - 8.767980
241	1.950000	8.779242	1.9450000 - 1.9550000	8.767980 - 8.790491
242	1.960000	8.801725	1.9550000 - 1.9650000	8.790491 - 8.812944
243	1.970000	8.824149	1.9650000 - 1.9750000	8.812944 - 8.835340
244	1.980000	8.846517	1.9750000 - 1.9850000	8.835340 - 8.857680
245	1.990000	8.868829	1.9850000 - 1.9950000	8.857680 - 8.879964
246	2.000000	8.891084	1.9950000 - 2.0050000	8.879964 - 8.902191

IN PROGRAM ETOT1 CP TIME WAS .1660 SEC. , ELAPSED TIME WAS 1.0000 SEC.

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                                        *** ETOT ***

THE (TAPE) DESCRIPTION OF MATERIAL  1159 IS -
    PU-239     GF,WARD,ANC EVAL-AUG71 LEONARD(BNW),J.P.SMITH(ANC)
    ENDF-162,ENDF-153     DIST-JAN72  PAIK,PITTERLE,DURSTON(WARD) +BNL
    *          *          *          *          *          *          *
                          PLUTONIUM-239
               *          *          *          *          *
    LOW ENERGY CROSS SECTIONS (1.0-05 EV TO 1.0 EV) EVALUATED BY
               B.R.LEONARD, JR. (BATTELLE-PACIFIC NORTHWEST LAB.)
               BNWL-1586 (ENDF-153) JUNE 1971
               *          *          *          *          *
    RESOLVED RESONANCE REGION (1.0 TO 300.0 EV) EVALUATED BY
               J.P.SMITH (AEROJET-IDAHO NUCLEAR CORP)
               *          *          *          *          *
    UNRESOLVED RESONANCE PARAMETERS EVALUATED BY T.A.PITTERLE,
               N.C.PAIK, AND C.DURSTON (WESTINGHOUSE ADVANCED
               REACTOR DIV.
    FAST NEUTRON FISSION AND RADIATIVE CAPTURE CROSS SECTION BASED
    ON DATA BY T.A.PITTERLE AND N.C.PAIK (PROC.CONF.NEUTRON X/S
    AND TECH.,KNOXVILLE, 3/71) 300 EV TO 15 MEV
               *          *          *          *          *          *
    FISSION PRODUCT YIELD DATA BASED ON EVAL. BY M.E.MEEK AND
    B.F.RIDER. YIELDS NORMALIZED TO SUM TO 2.000
    APED-5398-A (REVISED) OCT. 1968.
               *          *          *          *          *
    FAST NEUTRON CROSS SECTIONS (ABOVE 25 KEV) EVALUATED BY
               A.PRINCE (BNL)
               *          *          *          *          *
    THE PU-239 EVALUATION IN THE ENERGY RANGE OF 8.0 KEV TO 20.0 MEV
    WERE CARRIED OUT AT BNL BY A.PRINCE AND M.K.DRAKE.
     GENERAL DESCRIPTION
    THE TOTAL,SHAPE ELASTIC,TOTAL REACTION AND DIRECT INELASTIC CROSS
    SECTIONS WERE CALCULATED USING THE COUPLED CHANNEL CODE JUPITOR 1
    (ORNL-4152,T.TAMURA)
    THE COMPOUND NUCLEUS REACTION CROSS SECTIONS WERE CALCULATED
    WITH THE COMNUC CODE (AT-AEC-12931,C.L.DUNFORD),FISPRO (CEC(69)24
    CNEN,V.BENZI ET AL) AND CODE THRESH (TO BE PUBLISHED S.PEARLSTEIN
    BNL)
    ANGULAR DISTRIBUTION DATA WAS ANALYZED WITH CODE CHAD (NAA-SR-
    11231, B.E.BERLAND)
    THE RESULTS FROM THE  DEFORMED NUCLEUS CALCULATIONS WERE COMBINED
    IN A CONSISTENT MANNER WITH THE COMPOUND NUCLEUS REACTIONS TO
    OBTAIN ESTIMATES OF ALL PARTIAL NEUTRON CROSS SECTIONS.
     FILE 3
    COMPLETE DETAILS OF THE CALCULATIONS FOR MT=1,2,4,18,51 TO 91,102
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251,AND 252 ARE GIVEN IN PROC. OF THIRD CONF. ON NEUTRON CROSS SECTIONS AND TECHNOLOGY USAEC CONF. 710301, VOL 1,BY A.PRINCE AND M.K.DRAKE.
THE PENETRABILITIES USED IN DESCRIBING THE COMPOUND ELASTIC AND INELASTIC CROSS SECTIONS FOR THE 8.0 KEV AND 57.0 KEV LEVELS WERE TAKEN FROM THE COUPLED CHANNEL CALCULATIONS, WHILE THE 22 HIGHER LEVELS WERE DESCRIBED BY THE PENETRABILITIES DERIVED FROM A SPHERICAL POTENTIAL MODEL CALCULATION.
ELEVEN TRANSITION STATES WERE ASSUMED FOR THE CALCULATION OF THE FISSION CROSS SECTIONS IN THE DISCRETE REGION WHICH WERE INTERPRETED IN TERMS OF THE HILL-WHEELER MODEL WITH A CUTOFF ENERGY OF 0.2 MEV FOR THE CONTINUUM.
THESE CALCULATIONS ALONG WITH THE COMPETITIVE REACTIONS (INELASTIC, CAPTURE AND COMPOUND ELASTIC) WERE READJUSTED SO AS TO LEAVE THE FISSION AND CAPTURE CROSS SECTIONS AS(RECOMMENDED BY T.A. PITTERLE ET AL PROC.OF THIRD CONF ON NEUTRON CROSS SECTIONS AND TECHNOLOGY USAEC CONF 710301 VOL 1) UNCHANGED
IN THE HIGH ENERGY REGION, BOTH DIRECT AND SEMIDIRECT CONTRIBUTIONS TO THE CAPTURE CROSS SECTION WERE OBTAINED FROM ETSPRO
THE TOTAL ELASTIC CROSS SECTION (MT=2) IS THE SUM OF THE SHAPE AND COMPOUND ELASTIC COMPONENTS
THE TOTAL INELASTIC (MT=4) IS THE SUM OF THE TOTAL COMPOUND INELASTIC AND THE DIRECT INELASTIC SCATTERING CROSS SECTIONS OF THE 8.0 KEV AND 57.0 KEV LEVELS
MT=51,52 AND 91 (DISCRETE AND CONTINUUM INELASTIC) ALSO CONTAINS THE DIRECT AS WELL AS THE COMPOUND NUCLEUS COMPONENTS
THE INELASTIC ANGULAR DISTRIBUTIONS ARE ASSUMED TO BE ISOTROPIC
MT=16,17,103,104,105 AND 107 ARE BASED ON CALCULATIONS RESULTING FROM PROG. THRESH.
THE BINDING ENERGY AND THRESHOLDS ARE BASED ON THE RECENT ANALYSIS OF A.H.WAPSTRA AND N.B.GOVE AT ORNL AND TABULATED IN UCRL-50400 VOL 1,1970 P.J.HOWERTON.

* * * * *

RESOLVED RESONANCE PARAMETERS PLUS FILE 3 CONTRIBUTION DESCRIBE THE CROSS SECTIONS BETWEEN 1 AND 301 EV. PARAMETERS ARE FROM A SIMULTANEOUS FIT TO TOTAL, FISSION AND CAPTURE CROSS SECTIONS. DATA FIT ARE THOSE OF GWINS (1) AND DERRIEN AND BLONS (2). PARAMETERS WERE DERIVED BY O.D. SIMPSON AND F.B. SIMPSON AEROJET (IDAHO) NUCLEAR CO. AUGUST 1971. A POTENTIAL SCATTERING CROSS SECTION OF 10.2 BARNS WAS USED. FILE 3, MT=2, CONTAINS THE SCATTERING SMOOTH FILE. THE FOLLOWING EQUATION WAS USED TO COMPENSATE FOR THE TAILS OF DISTANCE RESONANCES)
SIGMA SCATT = -.21375*(ENERGY) + 2.2 BARNS. IN THE REGION OF 1 TO 5 EV THERE WAS AN ADDITIONAL SCATTERING CROSS SECTION (LESS THAN 1 BARN) ADDED TO BLEND THE THEORETICAL SCATTERING CROSS SECTION ABOVE 1 EV INTO THE SMOOTH FILE BELOW 1 EV. GWINS FISSION

AND CAPTURE DATA WERE NORMALIZED BY HIM TO THE ENDF/B SMOOTH
FILE BELOW 1 EV. THIS NORMALIZATION WAS CHECKED BY US AND FOUND
TO BE IN EXCELLENT AGREEMENT. THE FISSION DATA OF BLONS WERE
NORMALIZED TO GWINS DATA BY USING A MULTIPLICATION CONSTANT OF
0.9415.

REFERENCES
1. R. GWIN ETAL, ORNL-4707, JULY (1971).
2. H. DERRIEN ETAL, VOL II, IAEA, VIENNA (1967).
PU-239 WARD MODIFICATION TO ENDF/B MATERIAL NUMBER 1194-MAR.1971
REFERENCE REPORT - WARD 4210-1 (PUBLISHED ABOUT MAY 1971)
MODIFICATIONS PERFORMED BY T.A. PITTERLE, N. C. PAIK
MODIFIED DATA ARE CAPTURE AND FISSION CROSS SECTIONS AND
UNRESOLVED RESONANCE PARAMETERS

IN PROGRAM FIOT2 CP TIME WAS 8.3210 SEC. , ELAPSED TIME WAS 17.0003 SEC.

*** ETOT ***

RESONANCE DATA

MICROSCOPIC CROSS SECTIONS

RESONANCE REGION IS .10E+01 TO .30E+03 EV.

POTENTIAL SCATTERING = 10.20002

GROUP	FISSION	CAPTURE	SCATTERING	GROUP	FISSION	CAPTURE	SCATTERING
147	.16375E+02	.65370E+01	.83418E+01	181	.86020E+01	.29695E+01	.80084E+01
148	.15987E+02	.63497E+01	.83282E+01	182	.84758E+01	.29149E+01	.80014E+01
149	.15615E+02	.61697E+01	.83148E+01	183	.83530E+01	.28628E+01	.79945E+01
150	.15257E+02	.59970E+01	.83018E+01	184	.82335E+01	.28124E+01	.79877E+01
151	.14913E+02	.58333E+01	.82891E+01	185	.81171E+01	.27634E+01	.79810E+01
152	.14582E+02	.56756E+01	.82767E+01	186	.80038E+01	.27159E+01	.79744E+01
153	.14263E+02	.55244E+01	.82646E+01	187	.78934E+01	.26697E+01	.79679E+01
154	.13956E+02	.53794E+01	.82527E+01	188	.77859E+01	.26249E+01	.79614E+01
155	.13660E+02	.52403E+01	.82411E+01	189	.76811E+01	.25814E+01	.79551E+01
156	.13374E+02	.51067E+01	.82298E+01	190	.75789E+01	.25391E+01	.79489E+01
157	.13099E+02	.49783E+01	.82187E+01	191	.74793E+01	.24979E+01	.79427E+01
158	.12833E+02	.48550E+01	.82079E+01	192	.73822E+01	.24580E+01	.79366E+01
159	.12577E+02	.47364E+01	.81973E+01	193	.72875E+01	.24191E+01	.79306E+01
160	.12329E+02	.46222E+01	.81869E+01	194	.71951E+01	.23813E+01	.79247E+01
161	.12090E+02	.45124E+01	.81767E+01	195	.71049E+01	.23446E+01	.79188E+01
162	.11858E+02	.44067E+01	.81667E+01	196	.70169E+01	.23088E+01	.79130E+01
163	.11634E+02	.43048E+01	.81570E+01	197	.69310E+01	.22740E+01	.79073E+01
164	.11418E+02	.42067E+01	.81474E+01	198	.68472E+01	.22401E+01	.79017E+01
165	.11208E+02	.41121E+01	.81380E+01	199	.67653E+01	.22071E+01	.78961E+01
166	.11005E+02	.40208E+01	.81288E+01	200	.66853E+01	.21749E+01	.78906E+01
167	.10809E+02	.39327E+01	.81197E+01	201	.66072E+01	.21437E+01	.78852E+01
168	.10619E+02	.38478E+01	.81108E+01	202	.65309E+01	.21132E+01	.78798E+01
169	.10434E+02	.37657E+01	.81021E+01	203	.64565E+01	.20835E+01	.78745E+01
170	.10255E+02	.36865E+01	.80936E+01	204	.63834E+01	.20545E+01	.78693E+01
171	.10082E+02	.36099E+01	.80852E+01	205	.63121E+01	.20263E+01	.78641E+01
172	.99137E+01	.35359E+01	.80769E+01	206	.62424E+01	.19988E+01	.78590E+01
173	.97504E+01	.34643E+01	.80688E+01	207	.61743E+01	.19719E+01	.78539E+01
174	.95920E+01	.33951E+01	.80608E+01	208	.61076E+01	.19457E+01	.78489E+01
175	.94381E+01	.33281E+01	.80529E+01	209	.60425E+01	.19202E+01	.78439E+01
176	.92886E+01	.32633E+01	.80452E+01	210	.59787E+01	.18953E+01	.78390E+01
177	.91434E+01	.32005E+01	.80376E+01	211	.59163E+01	.18710E+01	.78341E+01
178	.90023E+01	.31397E+01	.80302E+01	212	.58552E+01	.18473E+01	.78293E+01
179	.88651E+01	.30808E+01	.80228E+01	213	.57954E+01	.18241E+01	.78246E+01
180	.87318E+01	.30238E+01	.80156E+01	214	.57369E+01	.18015E+01	.78198E+01

*** ETOT ***

RESONANCE DATA

MICROSCOPIC CROSS SECTIONS

GROUP	FISSION	CAPTURE	SCATTERING	GROUP	FISSION	CAPTURE	SCATTERING
215	.58709E+01	.17794E+01	.78152E+01	231	.49049E+01	.14872E+01	.77461E+01
216	.56235E+01	.17579E+01	.78106E+01	232	.48640E+01	.14721E+01	.77421E+01
217	.55685E+01	.17368E+01	.78060E+01	233	.48240E+01	.14574E+01	.77381E+01
218	.55147E+01	.17162E+01	.78014E+01	234	.47846E+01	.14429E+01	.77342E+01
219	.54620E+01	.16961E+01	.77970E+01	235	.47460E+01	.14288E+01	.77302E+01
220	.54103E+01	.16765E+01	.77925E+01	236	.47081E+01	.14150E+01	.77264E+01
221	.53597E+01	.16573E+01	.77881E+01	237	.46709E+01	.14014E+01	.77225E+01
222	.53101E+01	.16385E+01	.77837E+01	238	.46344E+01	.13881E+01	.77187E+01
223	.52614E+01	.16202E+01	.77794E+01	239	.45985E+01	.13751E+01	.77149E+01
224	.52139E+01	.16022E+01	.77751E+01	240	.45633E+01	.13624E+01	.77111E+01
225	.51670E+01	.15847E+01	.77709E+01	241	.45287E+01	.13499E+01	.77073E+01
226	.51212E+01	.15675E+01	.77666E+01	242	.44947E+01	.13377E+01	.77036E+01
227	.50762E+01	.15508E+01	.77625E+01	243	.44613E+01	.13257E+01	.76999E+01
228	.50322E+01	.15343E+01	.77583E+01	244	.44285E+01	.13140E+01	.76963E+01
229	.49889E+01	.15183E+01	.77542E+01	245	.43963E+01	.13025E+01	.76926E+01
230	.49465E+01	.15026E+01	.77501E+01	246	.43646E+01	.12912E+01	.76890E+01

IN PROGRAM ETOT3 CP TIME WAS .8901 SEC. , ELAPSED TIME WAS 2.0000 SEC.

IN PROGRAM ETOT4 CP TIME WAS .7650 SEC. , ELAPSED TIME WAS 2.0000 SEC.

*** ETOT ***

TRANSPORT MICROSCOPIC CROSS SECTION
SMOOTH COEFICIENTS

P 0	P 1	P 2	P 3	P 4
.87405E+01	0.	-.43160E+01	0.	-.10336E+03

FISSION MICROSCOPIC CROSS SECTION
SMOOTH COEFICIENTS

P 0	P 1	P 2	P 3	P 4
.11569E+03	0.	.28432E+02	0.	.21685E+04

ABSORPTION MICROSCOPIC CROSS SECTION
SMOOTH COEFICIENTS

P 0	P 1	P 2	P 3	P 4
.15171E+03	0.	.30797E+03	0.	.25346E+04

*** ETOT ***

MATERIAL NUMBER 4

SELECTED DATA SUMMARY

	2200 M/S	WEIGHTED AVERAGE	EQUIVALENT 2200 M/S
ABSORPTION	.10130E+04	0.	0.
FISSION	.74169E+03	0.	0.
CAPTURE	.27126E+03	0.	0.
ALPHA	.36574E+00	0.	0.
ETA	.21088E+01	.28800E+01	.28801E+01
SCATTERING	.86274E+01	0.	0.
TRANSPORT	.86032E+01	0.	0.

*** ETOT ***

MATERIAL NUMBER 4

NU = 2.88000 XS(EPI) = .10489E+02 XI*XS(EPI) = .88267E-01

GROUP	E	SQRT(E)	SIGA	SIGF	SIGC	SIGTR	SIGS	MUBAR
1	0.	0.	0.	0.	0.	.87405E+01	.87651E+01	.28134E-02
2	.10000E-02	.31623E-01	.48074E+04	.36596E+04	.11479E+04	.87373E+01	.87620E+01	.28134E-02
3	.20000E-02	.44721E-01	.34064E+04	.25884E+04	.81801E+03	.87311E+01	.87557E+01	.28134E-02
4	.30000E-02	.54772E-01	.27872E+04	.21141E+04	.67306E+03	.87274E+01	.87520E+01	.28134E-02
5	.40000E-02	.63246E-01	.24189E+04	.18315E+04	.58740E+03	.87212E+01	.87458E+01	.28134E-02
6	.50000E-02	.70711E-01	.21682E+04	.16399E+04	.52930E+03	.87164E+01	.87410E+01	.28134E-02
7	.60000E-02	.77460E-01	.19837E+04	.14968E+04	.48686E+03	.87105E+01	.87350E+01	.28134E-02
8	.70000E-02	.83666E-01	.18406E+04	.13864E+04	.45417E+03	.87054E+01	.87300E+01	.28134E-02
9	.80000E-02	.89443E-01	.17256E+04	.12976E+04	.42797E+03	.86995E+01	.87240E+01	.28134E-02
10	.90000E-02	.94868E-01	.16306E+04	.12242E+04	.40640E+03	.86942E+01	.87189E+01	.28134E-02
11	.10000E-01	.10000E+00	.15505E+04	.11622E+04	.38871E+03	.86895E+01	.87140E+01	.28134E-02
12	.11000E-01	.10488E+00	.14817E+04	.11088E+04	.37295E+03	.86838E+01	.87083E+01	.28134E-02
13	.12000E-01	.10954E+00	.14220E+04	.10623E+04	.35965E+03	.86795E+01	.87039E+01	.28134E-02
14	.13000E-01	.11402E+00	.13695E+04	.10214E+04	.34806E+03	.86727E+01	.86972E+01	.28134E-02
15	.14000E-01	.11832E+00	.13228E+04	.98497E+03	.33785E+03	.86674E+01	.86918E+01	.28134E-02
16	.15000E-01	.12247E+00	.12811E+04	.95230E+03	.32877E+03	.86615E+01	.86859E+01	.28134E-02
17	.16000E-01	.12649E+00	.12435E+04	.92282E+03	.32064E+03	.86560E+01	.86805E+01	.28134E-02
18	.17000E-01	.13038E+00	.12093E+04	.89603E+03	.31328E+03	.86501E+01	.86745E+01	.28134E-02
19	.18000E-01	.13416E+00	.11782E+04	.87161E+03	.30661E+03	.86446E+01	.86690E+01	.28134E-02
20	.19000E-01	.13784E+00	.11497E+04	.84924E+03	.30044E+03	.86386E+01	.86630E+01	.28134E-02
21	.20000E-01	.14142E+00	.11235E+04	.82864E+03	.29482E+03	.86330E+01	.86573E+01	.28134E-02
22	.21000E-01	.14491E+00	.10992E+04	.80962E+03	.28958E+03	.86269E+01	.86513E+01	.28134E-02
23	.22000E-01	.14832E+00	.10768E+04	.79194E+03	.28482E+03	.86212E+01	.86455E+01	.28134E-02
24	.23000E-01	.15166E+00	.10558E+04	.77549E+03	.28034E+03	.86151E+01	.86394E+01	.28134E-02
25	.24000E-01	.15492E+00	.10364E+04	.76019E+03	.27616E+03	.86092E+01	.86335E+01	.28134E-02
26	.25000E-01	.15811E+00	.10182E+04	.74576E+03	.27229E+03	.86032E+01	.86274E+01	.28134E-02
27	.26000E-01	.16125E+00	.10012E+04	.73246E+03	.26870E+03	.85971E+01	.86214E+01	.28134E-02
28	.27000E-01	.16432E+00	.98515E+03	.72000E+03	.26515E+03	.85909E+01	.86151E+01	.28134E-02
29	.28000E-01	.16733E+00	.97010E+03	.70822E+03	.26188E+03	.85849E+01	.86091E+01	.28134E-02
30	.29000E-01	.17029E+00	.95593E+03	.69716E+03	.25887E+03	.85786E+01	.86028E+01	.28134E-02
31	.30000E-01	.17321E+00	.94244E+03	.68644E+03	.25610E+03	.85725E+01	.85966E+01	.28134E-02
32	.31000E-01	.17607E+00	.92994E+03	.67586E+03	.25398E+03	.85661E+01	.85902E+01	.28134E-02
33	.32000E-01	.17889E+00	.91780E+03	.66577E+03	.25203E+03	.85599E+01	.85840E+01	.28134E-02
34	.33000E-01	.18166E+00	.90642E+03	.65686E+03	.24956E+03	.85534E+01	.85775E+01	.28134E-02
35	.34000E-01	.18439E+00	.89562E+03	.64902E+03	.24661E+03	.85471E+01	.85712E+01	.28134E-02
36	.35000E-01	.18708E+00	.88526E+03	.64149E+03	.24377E+03	.85409E+01	.85646E+01	.28134E-02

*** FTOT ***

MATERIAL NUMBER 4

GROUP	E	SQRT(E)	SIGA	SIGF	SIGC	SIGTR	SIGS	MUBAR
37	.36000E-01	.18974E+00	.87554E+03	.63350E+03	.24204E+03	.85342E+01	.85582E+01	.28134E-02
38	.37000E-01	.19235E+00	.86619E+03	.62582E+03	.24037E+03	.85275E+01	.85516E+01	.28134E-02
39	.38000E-01	.19494E+00	.85729E+03	.61848E+03	.23881E+03	.85210E+01	.85451E+01	.28134E-02
40	.39000E-01	.19748E+00	.84882E+03	.61147E+03	.23734E+03	.85143E+01	.85383E+01	.28134E-02
41	.40000E-01	.20000E+00	.84064E+03	.60472E+03	.23592E+03	.85078E+01	.85319E+01	.28134E-02
42	.41000E-01	.20248E+00	.83294E+03	.59885E+03	.23409E+03	.85009E+01	.85249E+01	.28134E-02
43	.42000E-01	.20494E+00	.82550E+03	.59318E+03	.23231E+03	.84943E+01	.85183E+01	.28134E-02
44	.43000E-01	.20736E+00	.81839E+03	.58725E+03	.23114E+03	.84874E+01	.85113E+01	.28134E-02
45	.44000E-01	.20976E+00	.81162E+03	.58107E+03	.23055E+03	.84806E+01	.85046E+01	.28134E-02
46	.45000E-01	.21213E+00	.80507E+03	.57510E+03	.22997E+03	.84736E+01	.84976E+01	.28134E-02
47	.46000E-01	.21448E+00	.79892E+03	.57050E+03	.22841E+03	.84668E+01	.84907E+01	.28134E-02
48	.47000E-01	.21679E+00	.79294E+03	.56604E+03	.22690E+03	.84597E+01	.84836E+01	.28134E-02
49	.48000E-01	.21909E+00	.78725E+03	.56155E+03	.22570E+03	.84528E+01	.84766E+01	.28134E-02
50	.49000E-01	.22136E+00	.78182E+03	.55702E+03	.22480E+03	.84456E+01	.84694E+01	.28134E-02
51	.50000E-01	.22361E+00	.77654E+03	.55267E+03	.22392E+03	.84386E+01	.84624E+01	.28134E-02
52	.60000E-01	.24496E+00	.73552E+03	.51789E+03	.21767E+03	.83646E+01	.83882E+01	.28134E-02
53	.70000E-01	.26458E+00	.70153E+03	.49542E+03	.21511E+03	.83054E+01	.83288E+01	.28134E-02
54	.80000E-01	.28284E+00	.69778E+03	.47908E+03	.21870E+03	.82007E+01	.82239E+01	.28134E-02
55	.90000E-01	.30000E+00	.68493E+03	.47193E+03	.22700E+03	.81100E+01	.81329E+01	.28134E-02
56	.10000E+00	.31623E+00	.70092E+03	.47091E+03	.23001E+03	.80129E+01	.80355E+01	.28134E-02
57	.11000E+00	.33166E+00	.71469E+03	.47091E+03	.24779E+03	.78995E+01	.79218E+01	.28134E-02
58	.12000E+00	.34641E+00	.73595E+03	.47806E+03	.25789E+03	.77975E+01	.78195E+01	.28134E-02
59	.13000E+00	.36056E+00	.76644E+03	.49134E+03	.27510E+03	.76687E+01	.76903E+01	.28134E-02
60	.14000E+00	.37417E+00	.80459E+03	.50768E+03	.29691E+03	.75513E+01	.75726E+01	.28134E-02
61	.15000E+00	.38730E+00	.85721E+03	.53730E+03	.31990E+03	.74151E+01	.74360E+01	.28134E-02
62	.16000E+00	.40000E+00	.90328E+03	.57305E+03	.35022E+03	.72734E+01	.72939E+01	.28134E-02
63	.17000E+00	.41231E+00	.10109E+04	.62259E+03	.38877E+03	.71159E+01	.71360E+01	.28134E-02
64	.18000E+00	.42426E+00	.11217E+04	.68443E+03	.43728E+03	.69736E+01	.69903E+01	.28134E-02
65	.19000E+00	.43589E+00	.12666E+04	.76816E+03	.49845E+03	.68159E+01	.68352E+01	.28134E-02
66	.20000E+00	.44721E+00	.14476E+04	.87337E+03	.57426E+03	.66724E+01	.66912E+01	.28134E-02
67	.21000E+00	.45826E+00	.16502E+04	.99084E+03	.65932E+03	.65536E+01	.65690E+01	.28134E-02
68	.22000E+00	.46904E+00	.19199E+04	.11481E+04	.77176E+03	.64717E+01	.64900E+01	.28134E-02
69	.23000E+00	.47958E+00	.22478E+04	.13371E+04	.90663E+03	.64929E+01	.65113E+01	.28134E-02
70	.24000E+00	.48990E+00	.26833E+04	.15945E+04	.10889E+04	.66371E+01	.66518E+01	.28134E-02
71	.25000E+00	.50000E+00	.32098E+04	.19013E+04	.13058E+04	.70834E+01	.71034E+01	.28134E-02
72	.26000E+00	.50990E+00	.38462E+04	.22779E+04	.15663E+04	.78148E+01	.78369E+01	.28134E-02

*** ETOT ***

MATERIAL NUMBER 4

GROUP	E	SQRT(E)	SIGA	SIGF	SIGC	SIGTR	SIGS	MUBAR
73	.27000E+00	.51962E+00	.44275E+04	.26222E+04	.18053E+04	.91506E+01	.91765E+01	.28134E-02
74	.28000E+00	.52915E+00	.49576E+04	.29337E+04	.20199E+04	.11044E+02	.11075E+02	.28134E-02
75	.29000E+00	.53852E+00	.52712E+04	.30982E+04	.21330E+04	.13406E+02	.13444E+02	.28134E-02
76	.30000E+00	.54772E+00	.52398E+04	.31033E+04	.21365E+04	.15765E+02	.15809E+02	.28134E-02
77	.31000E+00	.55678E+00	.49639E+04	.29398E+04	.20240E+04	.17546E+02	.17595E+02	.28134E-02
78	.32000E+00	.56569E+00	.44137E+04	.26140E+04	.17997E+04	.18589E+02	.18641E+02	.28134E-02
79	.33000E+00	.57446E+00	.37255E+04	.22064E+04	.15191E+04	.18803E+02	.18861E+02	.28134E-02
80	.34000E+00	.58310E+00	.30580E+04	.18111E+04	.12469E+04	.18696E+02	.18749E+02	.28134E-02
81	.35000E+00	.59161E+00	.25330E+04	.14995E+04	.10325E+04	.18264E+02	.18255E+02	.28134E-02
82	.36000E+00	.60000E+00	.20575E+04	.12179E+04	.83161E+03	.17738E+02	.17788E+02	.28134E-02
83	.37000E+00	.60828E+00	.17254E+04	.10409E+04	.68447E+03	.17196E+02	.17245E+02	.28134E-02
84	.38000E+00	.61644E+00	.14376E+04	.88154E+03	.55208E+03	.16681E+02	.16728E+02	.28134E-02
85	.39000E+00	.62450E+00	.11917E+04	.74467E+03	.44722E+03	.16215E+02	.16262E+02	.28134E-02
86	.40000E+00	.63246E+00	.10025E+04	.63434E+03	.36811E+03	.15782E+02	.15826E+02	.28134E-02
87	.41000E+00	.64031E+00	.85671E+03	.54752E+03	.30919E+03	.15409E+02	.15453E+02	.28134E-02
88	.42000E+00	.64807E+00	.72764E+03	.46886E+03	.25877E+03	.15061E+02	.15104E+02	.28134E-02
89	.43000E+00	.65574E+00	.63420E+03	.41166E+03	.22254E+03	.14763E+02	.14802E+02	.28134E-02
90	.44000E+00	.66332E+00	.55359E+03	.36161E+03	.19198E+03	.14488E+02	.14529E+02	.28134E-02
91	.45000E+00	.67082E+00	.48836E+03	.32075E+03	.16761E+03	.14253E+02	.14293E+02	.28134E-02
92	.46000E+00	.67823E+00	.43670E+03	.28836E+03	.14834E+03	.14028E+02	.14068E+02	.28134E-02
93	.47000E+00	.68557E+00	.39609E+03	.26252E+03	.13357E+03	.13838E+02	.13877E+02	.28134E-02
94	.48000E+00	.69282E+00	.36304E+03	.24209E+03	.12195E+03	.13654E+02	.13693E+02	.28134E-02
95	.49000E+00	.70000E+00	.33759E+03	.22269E+03	.11401E+03	.13496E+02	.13534E+02	.28134E-02
96	.50000E+00	.70711E+00	.30589E+03	.20532E+03	.10057E+03	.13346E+02	.13383E+02	.28134E-02
97	.51000E+00	.71414E+00	.27350E+03	.18387E+03	.89635E+02	.13215E+02	.13252E+02	.28134E-02
98	.52000E+00	.72111E+00	.25579E+03	.17263E+03	.83158E+02	.13087E+02	.13124E+02	.28134E-02
99	.53000E+00	.72801E+00	.23689E+03	.16037E+03	.76814E+02	.12977E+02	.13013E+02	.28134E-02
100	.54000E+00	.73485E+00	.22227E+03	.15118E+03	.71086E+02	.12869E+02	.12905E+02	.28134E-02
101	.55000E+00	.74162E+00	.20496E+03	.13994E+03	.65018E+02	.12772E+02	.12808E+02	.28134E-02
102	.56000E+00	.74833E+00	.19374E+03	.13270E+03	.61047E+02	.12681E+02	.12717E+02	.28134E-02
103	.57000E+00	.75498E+00	.18275E+03	.12564E+03	.57106E+02	.12599E+02	.12635E+02	.28134E-02
104	.58000E+00	.76158E+00	.17343E+03	.11951E+03	.53913E+02	.12519E+02	.12554E+02	.28134E-02
105	.59000E+00	.76811E+00	.16792E+03	.11579E+03	.50531E+02	.12447E+02	.12482E+02	.28134E-02
106	.60000E+00	.77460E+00	.15310E+03	.10623E+03	.46870E+02	.12377E+02	.12412E+02	.28134E-02
107	.61000E+00	.78102E+00	.14516E+03	.10103E+03	.44139E+02	.12313E+02	.12349E+02	.28134E-02
108	.62000E+00	.78740E+00	.13928E+03	.96531E+02	.41751E+02	.12252E+02	.12287E+02	.28134E-02

*** FTOT ***

MATERIAL NUMBER 4

GROUP	E	SQRT(E)	SIGA	SIGF	SIGC	SIGTR	SIGS	MUBAR
109	.63000E+00	.79373E+00	.13101E+03	.91730E+02	.39281E+02	.12197E+02	.12231E+02	.28134E-02
110	.64000E+00	.80000E+00	.12572E+03	.88359E+02	.37861E+02	.12142E+02	.12176E+02	.28134E-02
111	.65000E+00	.80623E+00	.11931E+03	.84477E+02	.34833E+02	.12092E+02	.12126E+02	.28134E-02
112	.66000E+00	.81240E+00	.11495E+03	.81228E+02	.33740E+02	.12043E+02	.12077E+02	.28134E-02
113	.67000E+00	.81854E+00	.11119E+03	.78655E+02	.32433E+02	.11998E+02	.12032E+02	.28134E-02
114	.68000E+00	.82462E+00	.10641E+03	.75488E+02	.30919E+02	.11954E+02	.11988E+02	.28134E-02
115	.69000E+00	.83066E+00	.10285E+03	.73036E+02	.29810E+02	.11914E+02	.11947E+02	.28134E-02
116	.70000E+00	.83666E+00	.98726E+02	.70687E+02	.28739E+02	.11874E+02	.11907E+02	.28134E-02
117	.71000E+00	.84261E+00	.96015E+02	.68746E+02	.27869E+02	.11837E+02	.11870E+02	.28134E-02
118	.72000E+00	.84853E+00	.93015E+02	.66601E+02	.26914E+02	.11801E+02	.11834E+02	.28134E-02
119	.73000E+00	.85440E+00	.89914E+02	.64354E+02	.25960E+02	.11768E+02	.11801E+02	.28134E-02
120	.74000E+00	.86023E+00	.87464E+02	.62617E+02	.24847E+02	.11735E+02	.11768E+02	.28134E-02
121	.75000E+00	.86603E+00	.85174E+02	.60983E+02	.24101E+02	.11704E+02	.11737E+02	.28134E-02
122	.76000E+00	.87178E+00	.82893E+02	.59349E+02	.23545E+02	.11674E+02	.11707E+02	.28134E-02
123	.77000E+00	.87750E+00	.80613E+02	.57714E+02	.22899E+02	.11646E+02	.11679E+02	.28134E-02
124	.78000E+00	.88318E+00	.78473E+02	.56182E+02	.22291E+02	.11618E+02	.11651E+02	.28134E-02
125	.79000E+00	.88882E+00	.77182E+02	.55263E+02	.21920E+02	.11592E+02	.11625E+02	.28134E-02
126	.80000E+00	.89443E+00	.75762E+02	.54241E+02	.21521E+02	.11566E+02	.11599E+02	.28134E-02
127	.81000E+00	.90000E+00	.73762E+02	.52811E+02	.20951E+02	.11543E+02	.11575E+02	.28134E-02
128	.82000E+00	.90554E+00	.71621E+02	.51279E+02	.20343E+02	.11519E+02	.11551E+02	.28134E-02
129	.83000E+00	.91104E+00	.70341E+02	.50359E+02	.19982E+02	.11497E+02	.11529E+02	.28134E-02
130	.84000E+00	.91652E+00	.69201E+02	.49542E+02	.19659E+02	.11475E+02	.11507E+02	.28134E-02
131	.85000E+00	.92195E+00	.67201E+02	.48112E+02	.19089E+02	.11454E+02	.11486E+02	.28134E-02
132	.86000E+00	.92736E+00	.66065E+02	.47295E+02	.18766E+02	.11434E+02	.11465E+02	.28134E-02
133	.87000E+00	.93274E+00	.64920E+02	.46478E+02	.18443E+02	.11414E+02	.11446E+02	.28134E-02
134	.88000E+00	.93808E+00	.63499E+02	.45456E+02	.18034E+02	.11395E+02	.11427E+02	.28134E-02
135	.89000E+00	.94340E+00	.62060E+02	.44435E+02	.17625E+02	.11377E+02	.11409E+02	.28134E-02
136	.90000E+00	.94868E+00	.61870E+02	.43413E+02	.18456E+02	.11359E+02	.11391E+02	.28134E-02
137	.91000E+00	.95394E+00	.59920E+02	.42903E+02	.17017E+02	.11342E+02	.11374E+02	.28134E-02
138	.92000E+00	.95917E+00	.58349E+02	.41779E+02	.16571E+02	.11326E+02	.11358E+02	.28134E-02
139	.93000E+00	.96437E+00	.57639E+02	.41268E+02	.16371E+02	.11310E+02	.11342E+02	.28134E-02
140	.94000E+00	.96954E+00	.56359E+02	.40349E+02	.16010E+02	.11294E+02	.11326E+02	.28134E-02
141	.95000E+00	.97468E+00	.55639E+02	.39838E+02	.15801E+02	.11279E+02	.11311E+02	.28134E-02
142	.96000E+00	.97980E+00	.54359E+02	.38919E+02	.15443E+02	.11265E+02	.11296E+02	.28134E-02
143	.97000E+00	.98489E+00	.53920E+02	.38612E+02	.15316E+02	.11250E+02	.11282E+02	.28134E-02
144	.98000E+00	.98995E+00	.52939E+02	.37897E+02	.15041E+02	.11236E+02	.11268E+02	.28134E-02

*** FTOT ***

MATERIAL NUMBER 4

GROUP	E	SQRT(E)	SIGA	SIGF	SIGC	SIGTR	SIGS	MUBAR
145	.99000E+00	.99499E+00	.51928E+02	.37182E+02	.14746E+02	.11222E+02	.11254E+02	.28134E-02
146	.10000E+01	.10000E+01	.50928E+02	.36467E+02	.14461E+02	.11208E+02	.11240E+02	.28134E-02
147	.10100E+01	.10050E+01	.50266E+02	.36057E+02	.14209E+02	.11302E+02	.11334E+02	.28134E-02
148	.10200E+01	.10100E+01	.49469E+02	.35549E+02	.13919E+02	.11286E+02	.11318E+02	.28134E-02
149	.10300E+01	.10149E+01	.48695E+02	.35057E+02	.13638E+02	.11271E+02	.11303E+02	.28134E-02
150	.10400E+01	.10198E+01	.47943E+02	.34579E+02	.13364E+02	.11256E+02	.11288E+02	.28134E-02
151	.10500E+01	.10247E+01	.47212E+02	.34114E+02	.13098E+02	.11242E+02	.11273E+02	.28134E-02
152	.10600E+01	.10296E+01	.46501E+02	.33663E+02	.12837E+02	.11227E+02	.11259E+02	.28134E-02
153	.10700E+01	.10344E+01	.45810E+02	.33224E+02	.12585E+02	.11213E+02	.11245E+02	.28134E-02
154	.10800E+01	.10392E+01	.45135E+02	.32797E+02	.12338E+02	.11200E+02	.11231E+02	.28134E-02
155	.10900E+01	.10440E+01	.44477E+02	.32380E+02	.12097E+02	.11186E+02	.11218E+02	.28134E-02
156	.11000E+01	.10488E+01	.43836E+02	.31975E+02	.11861E+02	.11173E+02	.11205E+02	.28134E-02
157	.11100E+01	.10536E+01	.43211E+02	.31579E+02	.11631E+02	.11160E+02	.11192E+02	.28134E-02
158	.11200E+01	.10583E+01	.42599E+02	.31193E+02	.11406E+02	.11147E+02	.11179E+02	.28134E-02
159	.11300E+01	.10630E+01	.42001E+02	.30815E+02	.11186E+02	.11135E+02	.11166E+02	.28134E-02
160	.11400E+01	.10677E+01	.41415E+02	.30447E+02	.11000E+02	.11122E+02	.11153E+02	.28134E-02
161	.11500E+01	.10724E+01	.40842E+02	.30130E+02	.10812E+02	.11109E+02	.11141E+02	.28134E-02
162	.11600E+01	.10770E+01	.40421E+02	.29794E+02	.10627E+02	.11097E+02	.11128E+02	.28134E-02
163	.11700E+01	.10817E+01	.39911E+02	.29466E+02	.10445E+02	.11085E+02	.11116E+02	.28134E-02
164	.11800E+01	.10863E+01	.39413E+02	.29146E+02	.10267E+02	.11073E+02	.11104E+02	.28134E-02
165	.11900E+01	.10909E+01	.38924E+02	.28832E+02	.10092E+02	.11061E+02	.11092E+02	.28134E-02
166	.12000E+01	.10954E+01	.38446E+02	.28525E+02	.99208E+01	.11050E+02	.11081E+02	.28134E-02
167	.12100E+01	.11000E+01	.37978E+02	.28225E+02	.97527E+01	.11038E+02	.11069E+02	.28134E-02
168	.12200E+01	.11045E+01	.37518E+02	.27931E+02	.95879E+01	.11027E+02	.11058E+02	.28134E-02
169	.12300E+01	.11091E+01	.37068E+02	.27642E+02	.94257E+01	.11016E+02	.11047E+02	.28134E-02
170	.12400E+01	.11136E+01	.36626E+02	.27359E+02	.92665E+01	.11005E+02	.11036E+02	.28134E-02
171	.12500E+01	.11180E+01	.36192E+02	.27082E+02	.91099E+01	.10994E+02	.11025E+02	.28134E-02
172	.12600E+01	.11225E+01	.35766E+02	.26834E+02	.89719E+01	.10985E+02	.11016E+02	.28134E-02
173	.12700E+01	.11269E+01	.35427E+02	.26591E+02	.88763E+01	.10976E+02	.11007E+02	.28134E-02
174	.12800E+01	.11314E+01	.35055E+02	.26352E+02	.87831E+01	.10967E+02	.10998E+02	.28134E-02
175	.12900E+01	.11358E+01	.34690E+02	.26118E+02	.86921E+01	.10959E+02	.10990E+02	.28134E-02
176	.13000E+01	.11402E+01	.34332E+02	.25889E+02	.86033E+01	.10950E+02	.10981E+02	.28134E-02
177	.13100E+01	.11446E+01	.33980E+02	.25663E+02	.85165E+01	.10942E+02	.10973E+02	.28134E-02
178	.13200E+01	.11489E+01	.33634E+02	.25442E+02	.84317E+01	.10934E+02	.10965E+02	.28134E-02
179	.13300E+01	.11533E+01	.33294E+02	.25225E+02	.83488E+01	.10926E+02	.10956E+02	.28134E-02
180	.13400E+01	.11576E+01	.32960E+02	.25012E+02	.82678E+01	.10918E+02	.10948E+02	.28134E-02

*** FTOT ***

MATERIAL NUMBER 4

GROUP	F	SQRT(E)	SIGA	SIGF	SIGC	SIGTR	SIGS	MUBAR
181	.13500E+01	.11610E+01	.32631E+02	.24802E+02	.78285E+01	.10910E+02	.10940E+02	.28134E-02
182	.13600E+01	.11662E+01	.32307E+02	.24596E+02	.77108E+01	.10902E+02	.10933E+02	.28134E-02
183	.13700E+01	.11705E+01	.31988E+02	.24393E+02	.75948E+01	.10894E+02	.10925E+02	.28134E-02
184	.13800E+01	.11747E+01	.31686E+02	.24199E+02	.74844E+01	.10886E+02	.10917E+02	.28134E-02
185	.13900E+01	.11790E+01	.31401E+02	.24009E+02	.73914E+01	.10878E+02	.10909E+02	.28134E-02
186	.14000E+01	.11832E+01	.31120E+02	.23824E+02	.72959E+01	.10870E+02	.10900E+02	.28134E-02
187	.14100E+01	.11874E+01	.30843E+02	.23641E+02	.72017E+01	.10862E+02	.10892E+02	.28134E-02
188	.14200E+01	.11916E+01	.30571E+02	.23462E+02	.71089E+01	.10854E+02	.10884E+02	.28134E-02
189	.14300E+01	.11958E+01	.30302E+02	.23285E+02	.70174E+01	.10846E+02	.10876E+02	.28134E-02
190	.14400E+01	.12000E+01	.30038E+02	.23111E+02	.69271E+01	.10838E+02	.10868E+02	.28134E-02
191	.14500E+01	.12042E+01	.29777E+02	.22939E+02	.68379E+01	.10830E+02	.10861E+02	.28134E-02
192	.14600E+01	.12083E+01	.29520E+02	.22770E+02	.67500E+01	.10822E+02	.10853E+02	.28134E-02
193	.14700E+01	.12124E+01	.29267E+02	.22603E+02	.66631E+01	.10815E+02	.10845E+02	.28134E-02
194	.14800E+01	.12166E+01	.29016E+02	.22439E+02	.65773E+01	.10807E+02	.10839E+02	.28134E-02
195	.14900E+01	.12207E+01	.28769E+02	.22277E+02	.64926E+01	.10800E+02	.10830E+02	.28134E-02
196	.15000E+01	.12247E+01	.28526E+02	.22117E+02	.64088E+01	.10793E+02	.10823E+02	.28134E-02
197	.15100E+01	.12288E+01	.28293E+02	.21967E+02	.63260E+01	.10787E+02	.10817E+02	.28134E-02
198	.15200E+01	.12329E+01	.28063E+02	.21810E+02	.62441E+01	.10780E+02	.10811E+02	.28134E-02
199	.15300E+01	.12369E+01	.27836E+02	.21657E+02	.61631E+01	.10775E+02	.10805E+02	.28134E-02
200	.15400E+01	.12410E+01	.27612E+02	.21509E+02	.60829E+01	.10769E+02	.10799E+02	.28134E-02
201	.15500E+01	.12450E+01	.27391E+02	.21367E+02	.60037E+01	.10763E+02	.10793E+02	.28134E-02
202	.15600E+01	.12490E+01	.27172E+02	.21247E+02	.59252E+01	.10757E+02	.10787E+02	.28134E-02
203	.15700E+01	.12530E+01	.26956E+02	.21118E+02	.58476E+01	.10751E+02	.10782E+02	.28134E-02
204	.15800E+01	.12570E+01	.26742E+02	.20971E+02	.57709E+01	.10746E+02	.10776E+02	.28134E-02
205	.15900E+01	.12610E+01	.26530E+02	.20836E+02	.56947E+01	.10740E+02	.10770E+02	.28134E-02
206	.16000E+01	.12649E+01	.26321E+02	.20703E+02	.56188E+01	.10735E+02	.10765E+02	.28134E-02
207	.16100E+01	.12689E+01	.26114E+02	.20573E+02	.55439E+01	.10729E+02	.10759E+02	.28134E-02
208	.16200E+01	.12728E+01	.25909E+02	.20446E+02	.54697E+01	.10724E+02	.10754E+02	.28134E-02
209	.16300E+01	.12767E+01	.25707E+02	.20319E+02	.53962E+01	.10719E+02	.10749E+02	.28134E-02
210	.16400E+01	.12806E+01	.25506E+02	.20193E+02	.53233E+01	.10713E+02	.10743E+02	.28134E-02
211	.16500E+01	.12845E+01	.25307E+02	.20056E+02	.52510E+01	.10708E+02	.10738E+02	.28134E-02
212	.16600E+01	.12884E+01	.25110E+02	.19931E+02	.51793E+01	.10703E+02	.10733E+02	.28134E-02
213	.16700E+01	.12923E+01	.24916E+02	.19807E+02	.51081E+01	.10698E+02	.10728E+02	.28134E-02
214	.16800E+01	.12961E+01	.24722E+02	.19685E+02	.50375E+01	.10692E+02	.10723E+02	.28134E-02
215	.16900E+01	.13000E+01	.24531E+02	.19564E+02	.49674E+01	.10687E+02	.10718E+02	.28134E-02
216	.17000E+01	.13038E+01	.24341E+02	.19443E+02	.48979E+01	.10682E+02	.10713E+02	.28134E-02

*** ETOT ***

MATERIAL NUMBER 4

GROUP	E	SQRT(E)	SIGA	SIGF	SIGC	SIGTR	SIGS	MUBAR
217	.17100E+01	.13077E+01	.24153E+02	.19325E+02	.48288E+01	.10677E+02	.10708E+02	.28134E-02
218	.17200E+01	.13115E+01	.23967E+02	.19207E+02	.47602E+01	.10673E+02	.10703E+02	.28134E-02
219	.17300E+01	.13153E+01	.23782E+02	.19091E+02	.46921E+01	.10668E+02	.10698E+02	.28134E-02
220	.17400E+01	.13191E+01	.23599E+02	.18974E+02	.46245E+01	.10663E+02	.10693E+02	.28134E-02
221	.17500E+01	.13229E+01	.23417E+02	.18860E+02	.45573E+01	.10659E+02	.10688E+02	.28134E-02
222	.17600E+01	.13266E+01	.23236E+02	.18750E+02	.44905E+01	.10650E+02	.10680E+02	.28134E-02
223	.17700E+01	.13304E+01	.23074E+02	.18641E+02	.44322E+01	.10641E+02	.10671E+02	.28134E-02
224	.17800E+01	.13342E+01	.22904E+02	.18534E+02	.43702E+01	.10633E+02	.10663E+02	.28134E-02
225	.17900E+01	.13379E+01	.22736E+02	.18427E+02	.43087E+01	.10625E+02	.10655E+02	.28134E-02
226	.18000E+01	.13416E+01	.22569E+02	.18321E+02	.42475E+01	.10617E+02	.10647E+02	.28134E-02
227	.18100E+01	.13454E+01	.22403E+02	.18216E+02	.41868E+01	.10609E+02	.10638E+02	.28134E-02
228	.18200E+01	.13491E+01	.22238E+02	.18112E+02	.41263E+01	.10600E+02	.10630E+02	.28134E-02
229	.18300E+01	.13528E+01	.22075E+02	.18009E+02	.40663E+01	.10592E+02	.10622E+02	.28134E-02
230	.18400E+01	.13565E+01	.21913E+02	.17906E+02	.40066E+01	.10584E+02	.10614E+02	.28134E-02
231	.18500E+01	.13601E+01	.21752E+02	.17805E+02	.39472E+01	.10576E+02	.10606E+02	.28134E-02
232	.18600E+01	.13638E+01	.21592E+02	.17704E+02	.38881E+01	.10568E+02	.10598E+02	.28134E-02
233	.18700E+01	.13675E+01	.21433E+02	.17604E+02	.38294E+01	.10560E+02	.10590E+02	.28134E-02
234	.18800E+01	.13711E+01	.21276E+02	.17505E+02	.37709E+01	.10552E+02	.10582E+02	.28134E-02
235	.18900E+01	.13748E+01	.21119E+02	.17406E+02	.37128E+01	.10544E+02	.10574E+02	.28134E-02
236	.19000E+01	.13784E+01	.20963E+02	.17308E+02	.36550E+01	.10537E+02	.10566E+02	.28134E-02
237	.19100E+01	.13820E+01	.20808E+02	.17211E+02	.35974E+01	.10529E+02	.10558E+02	.28134E-02
238	.19200E+01	.13856E+01	.20655E+02	.17114E+02	.35401E+01	.10521E+02	.10551E+02	.28134E-02
239	.19300E+01	.13892E+01	.20502E+02	.17019E+02	.34831E+01	.10513E+02	.10543E+02	.28134E-02
240	.19400E+01	.13928E+01	.20350E+02	.16923E+02	.34264E+01	.10505E+02	.10535E+02	.28134E-02
241	.19500E+01	.13964E+01	.20199E+02	.16829E+02	.33699E+01	.10498E+02	.10527E+02	.28134E-02
242	.19600E+01	.14000E+01	.20048E+02	.16735E+02	.33137E+01	.10490E+02	.10520E+02	.28134E-02
243	.19700E+01	.14036E+01	.19899E+02	.16641E+02	.32577E+01	.10482E+02	.10512E+02	.28134E-02
244	.19800E+01	.14071E+01	.19750E+02	.16548E+02	.32020E+01	.10475E+02	.10504E+02	.28134E-02
245	.19900E+01	.14107E+01	.19602E+02	.16456E+02	.31465E+01	.10467E+02	.10497E+02	.28134E-02
246	.20000E+01	.14142E+01	.19456E+02	.16365E+02	.30912E+01	.10459E+02	.10489E+02	.28134E-02

*** FTOT ***

MATERIAL NUMBER 4

GROUP	E	SQRT(E)	NUSIGF	ALPHA	ETA	RTE*SIGA	RTE*SIGF
1	0.	0.	0.	0.	.28803E+01	.15171E+03	.11569E+03
2	.10000E-02	.31623E-01	.10540E+03	.31366E+00	.21927E+01	.15202E+03	.11573E+03
3	.20000E-02	.44721E-01	.74546E+04	.31603E+00	.21884E+01	.15234E+03	.11576E+03
4	.30000E-02	.54772E-01	.60887E+04	.31837E+00	.21845E+01	.15266E+03	.11580E+03
5	.40000E-02	.63246E-01	.52748E+04	.32072E+00	.21806E+01	.15299E+03	.11584E+03
6	.50000E-02	.70711E-01	.47201E+04	.32295E+00	.21769E+01	.15332E+03	.11589E+03
7	.60000E-02	.77460E-01	.43108E+04	.32527E+00	.21731E+01	.15365E+03	.11594E+03
8	.70000E-02	.83666E-01	.39928E+04	.32759E+00	.21693E+01	.15399E+03	.11599E+03
9	.80000E-02	.89443E-01	.37371E+04	.32982E+00	.21657E+01	.15434E+03	.11606E+03
10	.90000E-02	.94868E-01	.35256E+04	.33198E+00	.21622E+01	.15469E+03	.11614E+03
11	.10000E-01	.10000E+00	.33470E+04	.33413E+00	.21587E+01	.15505E+03	.11621E+03
12	.11000E-01	.10488E+00	.31977E+04	.33635E+00	.21551E+01	.15541E+03	.11629E+03
13	.12000E-01	.10954E+00	.30596E+04	.33854E+00	.21516E+01	.15577E+03	.11637E+03
14	.13000E-01	.11402E+00	.29416E+04	.34077E+00	.21481E+01	.15614E+03	.11646E+03
15	.14000E-01	.11832E+00	.28367E+04	.34301E+00	.21444E+01	.15652E+03	.11654E+03
16	.15000E-01	.12247E+00	.27426E+04	.34524E+00	.21409E+01	.15690E+03	.11663E+03
17	.16000E-01	.12649E+00	.26577E+04	.34745E+00	.21374E+01	.15729E+03	.11673E+03
18	.17000E-01	.13038E+00	.25816E+04	.34963E+00	.21339E+01	.15769E+03	.11683E+03
19	.18000E-01	.13416E+00	.25102E+04	.35178E+00	.21305E+01	.15809E+03	.11694E+03
20	.19000E-01	.13784E+00	.24458E+04	.35377E+00	.21274E+01	.15847E+03	.11706E+03
21	.20000E-01	.14142E+00	.23865E+04	.35579E+00	.21242E+01	.15888E+03	.11719E+03
22	.21000E-01	.14491E+00	.23317E+04	.35768E+00	.21213E+01	.15929E+03	.11732E+03
23	.22000E-01	.14832E+00	.22808E+04	.35964E+00	.21182E+01	.15971E+03	.11746E+03
24	.23000E-01	.15166E+00	.22334E+04	.36149E+00	.21153E+01	.16012E+03	.11761E+03
25	.24000E-01	.15492E+00	.21893E+04	.36328E+00	.21125E+01	.16055E+03	.11777E+03
26	.25000E-01	.15811E+00	.21474E+04	.36525E+00	.21095E+01	.16098E+03	.11792E+03
27	.26000E-01	.16125E+00	.21095E+04	.36685E+00	.21070E+01	.16143E+03	.11811E+03
28	.27000E-01	.16432E+00	.20736E+04	.36826E+00	.21049E+01	.16188E+03	.11831E+03
29	.28000E-01	.16733E+00	.20397E+04	.36977E+00	.21025E+01	.16237E+03	.11851E+03
30	.29000E-01	.17029E+00	.20075E+04	.37139E+00	.21001E+01	.16279E+03	.11870E+03
31	.30000E-01	.17321E+00	.19769E+04	.37294E+00	.20977E+01	.16324E+03	.11889E+03
32	.31000E-01	.17607E+00	.19466E+04	.37578E+00	.20934E+01	.16371E+03	.11900E+03
33	.32000E-01	.17889E+00	.19174E+04	.37455E+00	.20891E+01	.16418E+03	.11910E+03
34	.33000E-01	.18166E+00	.18917E+04	.37993E+00	.20871E+01	.16466E+03	.11932E+03
35	.34000E-01	.18439E+00	.18692E+04	.37997E+00	.20870E+01	.16514E+03	.11967E+03
36	.35000E-01	.18708E+00	.18475E+04	.38000E+00	.20870E+01	.16562E+03	.12001E+03

*** FTOT ***

MATERIAL NUMBER 4

GROUP	E	SQRT(E)	NUSIGF	ALPHA	ETA	RTE*SIGA	RTE*SIGF
37	.360000E-01	.18974E+00	.18245E+04	.38207E+00	.20838E+01	.16612E+03	.12020E+03
38	.370000E-01	.19235E+00	.18023E+04	.38410E+00	.20808E+01	.16661E+03	.12038E+03
39	.380000E-01	.19494E+00	.17812E+04	.38612E+00	.20777E+01	.16712E+03	.12056E+03
40	.390000E-01	.19748E+00	.17610E+04	.38815E+00	.20747E+01	.16763E+03	.12076E+03
41	.400000E-01	.20000E+00	.17416E+04	.39013E+00	.20717E+01	.16813E+03	.12094E+03
42	.410000E-01	.20248E+00	.17247E+04	.39099E+00	.20706E+01	.16866E+03	.12126E+03
43	.420000E-01	.20494E+00	.17084E+04	.39163E+00	.20695E+01	.16918E+03	.12157E+03
44	.430000E-01	.20736E+00	.16913E+04	.39360E+00	.20666E+01	.16971E+03	.12178E+03
45	.440000E-01	.20976E+00	.16735E+04	.39676E+00	.20619E+01	.17025E+03	.12189E+03
46	.450000E-01	.21213E+00	.16563E+04	.39989E+00	.20573E+01	.17079E+03	.12200E+03
47	.460000E-01	.21448E+00	.16431E+04	.40037E+00	.20566E+01	.17135E+03	.12236E+03
48	.470000E-01	.21679E+00	.16302E+04	.40085E+00	.20559E+01	.17191E+03	.12272E+03
49	.480000E-01	.21909E+00	.16177E+04	.40102E+00	.20543E+01	.17249E+03	.12303E+03
50	.490000E-01	.22136E+00	.16042E+04	.40357E+00	.20519E+01	.17306E+03	.12330E+03
51	.500000E-01	.22361E+00	.15916E+04	.40519E+00	.20495E+01	.17364E+03	.12357E+03
52	.600000E-01	.24495E+00	.14915E+04	.42022E+00	.20279E+01	.18017E+03	.12686E+03
53	.700000E-01	.26458E+00	.14268E+04	.43420E+00	.20081E+01	.18799E+03	.13108E+03
54	.800000E-01	.28284E+00	.13797E+04	.45651E+00	.19773E+01	.19736E+03	.13550E+03
55	.900000E-01	.30000E+00	.13592E+04	.47254E+00	.19558E+01	.20848E+03	.14158E+03
56	.100000E+00	.31623E+00	.13562E+04	.48845E+00	.19349E+01	.22165E+03	.14891E+03
57	.110000E+00	.33166E+00	.13562E+04	.51773E+00	.18976E+01	.23704E+03	.15618E+03
58	.120000E+00	.34641E+00	.13768E+04	.53946E+00	.18708E+01	.25494E+03	.16560E+03
59	.130000E+00	.36056E+00	.14150E+04	.55991E+00	.18463E+01	.27634E+03	.17715E+03
60	.140000E+00	.37417E+00	.14621E+04	.58493E+00	.18172E+01	.30105E+03	.18998E+03
61	.150000E+00	.38730E+00	.15474E+04	.59539E+00	.18052E+01	.33199E+03	.20813E+03
62	.160000E+00	.40000E+00	.16504E+04	.61115E+00	.17875E+01	.36931E+03	.22923E+03
63	.170000E+00	.41231E+00	.17916E+04	.62495E+00	.17724E+01	.41679E+03	.25649E+03
64	.180000E+00	.42426E+00	.19711E+04	.63897E+00	.17572E+01	.47589E+03	.29037E+03
65	.190000E+00	.43589E+00	.22123E+04	.64888E+00	.17466E+01	.55210E+03	.33487E+03
66	.200000E+00	.44721E+00	.25153E+04	.65752E+00	.17375E+01	.64740E+03	.39059E+03
67	.210000E+00	.45826E+00	.28576E+04	.66541E+00	.17293E+01	.75620E+03	.45404E+03
68	.220000E+00	.46904E+00	.32067E+04	.67217E+00	.17223E+01	.90052E+03	.53851E+03
69	.230000E+00	.47958E+00	.35609E+04	.67804E+00	.17163E+01	.10761E+04	.64127E+03
70	.240000E+00	.48990E+00	.45923E+04	.68282E+00	.17114E+01	.13146E+04	.78116E+03
71	.250000E+00	.50000E+00	.54749E+04	.68843E+00	.17057E+01	.16049E+04	.95249E+03
72	.260000E+00	.50990E+00	.65604E+04	.68847E+00	.17057E+01	.19612E+04	.11613E+04

*** ETOT ***

MATERIAL NUMBER 4

GROUP	E	SQRT(E)	NUSIGF	ALPHA	ETA	PTE*SIGA	PTE*SIGF
73	.27000E+00	.51962E+00	.75518E+04	.69950E+00	.17057E+01	.23006E+04	.13625E+04
74	.28000E+00	.52915E+00	.84491E+04	.68850E+00	.17057E+01	.26212E+04	.15524E+04
75	.29000E+00	.53852E+00	.89228E+04	.68849E+00	.17057E+01	.28171E+04	.16684E+04
76	.30000E+00	.54772E+00	.89374E+04	.68848E+00	.17057E+01	.28200E+04	.16997E+04
77	.31000E+00	.55678E+00	.84667E+04	.68849E+00	.17057E+01	.27638E+04	.16368E+04
78	.32000E+00	.56569E+00	.75283E+04	.68849E+00	.17057E+01	.24968E+04	.14787E+04
79	.33000E+00	.57446E+00	.63545E+04	.68848E+00	.17057E+01	.21401E+04	.12675E+04
80	.34000E+00	.58310E+00	.52160E+04	.68847E+00	.17057E+01	.17831E+04	.10560E+04
81	.35000E+00	.59161E+00	.43187E+04	.68252E+00	.17117E+01	.14926E+04	.88714E+03
82	.36000E+00	.60000E+00	.35479E+04	.67506E+00	.17193E+01	.12381E+04	.73915E+03
83	.37000E+00	.60828E+00	.29978E+04	.66757E+00	.17275E+01	.10495E+04	.63315E+03
84	.38000E+00	.61644E+00	.25398E+04	.62626E+00	.17709E+01	.88374E+03	.54742E+03
85	.39000E+00	.62450E+00	.21446E+04	.60030E+00	.17997E+01	.74421E+03	.46534E+03
86	.40000E+00	.63246E+00	.18269E+04	.58031E+00	.18224E+01	.63401E+03	.40119E+03
87	.41000E+00	.64031E+00	.15768E+04	.56471E+00	.18406E+01	.54856E+03	.35058E+03
88	.42000E+00	.64807E+00	.13503E+04	.55191E+00	.18558E+01	.47156E+03	.30396E+03
89	.43000E+00	.65574E+00	.11856E+04	.54059E+00	.18694E+01	.41587E+03	.26994E+03
90	.44000E+00	.66332E+00	.10414E+04	.53091E+00	.18812E+01	.36721E+03	.23986E+03
91	.45000E+00	.67082E+00	.92375E+03	.52256E+00	.18915E+01	.32760E+03	.21516E+03
92	.46000E+00	.67823E+00	.82961E+03	.51601E+00	.18997E+01	.29618E+03	.19577E+03
93	.47000E+00	.68557E+00	.75627E+03	.50879E+00	.19088E+01	.27155E+03	.17998E+03
94	.48000E+00	.69282E+00	.69723E+03	.50330E+00	.19158E+01	.25214E+03	.16773E+03
95	.49001E+00	.70000E+00	.64133E+03	.49805E+00	.19225E+01	.23352E+03	.15588E+03
96	.50000E+00	.70711E+00	.59132E+03	.49382E+00	.19731E+01	.21630E+03	.14518E+03
97	.51000E+00	.71414E+00	.52954E+03	.48750E+00	.19761E+01	.19532E+03	.13171E+03
98	.52000E+00	.72111E+00	.49718E+03	.48171E+00	.19437E+01	.18445E+03	.12449E+03
99	.53000E+00	.72801E+00	.46199E+03	.47715E+00	.19498E+01	.17246E+03	.11675E+03
100	.54000E+00	.73485E+00	.43540E+03	.47021E+00	.19589E+01	.16333E+03	.11009E+03
101	.55000E+00	.74162E+00	.40374E+03	.46460E+00	.19664E+01	.15200E+03	.10379E+03
102	.56000E+00	.74833E+00	.38245E+03	.45896E+00	.19740E+01	.14499E+03	.99374E+02
103	.57000E+00	.75498E+00	.36185E+03	.45451E+00	.19801E+01	.13797E+03	.94859E+02
104	.58000E+00	.76158E+00	.34420E+03	.45110E+00	.19847E+01	.13209E+03	.91019E+02
105	.59000E+00	.76811E+00	.32655E+03	.44565E+00	.19922E+01	.12591E+03	.87093E+02
106	.60000E+00	.77460E+00	.30595E+03	.44123E+00	.19983E+01	.11859E+03	.82289E+02
107	.61000E+00	.78102E+00	.29095E+03	.43693E+00	.20043E+01	.11338E+03	.78903E+02
108	.62000E+00	.78740E+00	.27801E+03	.43252E+00	.20104E+01	.10888E+03	.76008E+02

*** ETOT ***

MATERIAL NUMBER 4

GROUP	E	SQRT(E)	NUSIGF	ALPHA	ETA	RTE*SIGA	RTE*SIGF
109	.63000E+00	.79373E+00	.26418E+03	.42822E+00	.20165E+01	.10399E+03	.72908E+02
110	.64000E+00	.80000E+00	.25447E+03	.42284E+00	.20241E+01	.10059E+03	.70687E+02
111	.65000E+00	.80623E+00	.24329E+03	.41232E+00	.20392E+01	.96199E+02	.68108E+02
112	.66000E+00	.81240E+00	.23288E+03	.41547E+00	.20347E+01	.93384E+02	.65974E+02
113	.67000E+00	.81854E+00	.22653E+03	.41235E+00	.20392E+01	.90929E+02	.64382E+02
114	.68000E+00	.82462E+00	.21741E+03	.40959E+00	.20431E+01	.87746E+02	.62249E+02
115	.69000E+00	.83066E+00	.21074E+03	.40815E+00	.20452E+01	.85430E+02	.60669E+02
116	.70000E+00	.83666E+00	.20358E+03	.39666E+00	.20621E+01	.82600E+02	.59141E+02
117	.71000E+00	.84261E+00	.19799E+03	.39667E+00	.20621E+01	.80904E+02	.57926E+02
118	.72000E+00	.84853E+00	.19191E+03	.39659E+00	.20622E+01	.78926E+02	.56513E+02
119	.73000E+00	.85440E+00	.18574E+03	.39719E+00	.20613E+01	.76823E+02	.54984E+02
120	.74000E+00	.86023E+00	.18074E+03	.39680E+00	.20619E+01	.75239E+02	.53865E+02
121	.75000E+00	.86603E+00	.17563E+03	.39668E+00	.20620E+01	.73762E+02	.52913E+02
122	.76000E+00	.87178E+00	.17092E+03	.39672E+00	.20620E+01	.72265E+02	.51739E+02
123	.77000E+00	.87750E+00	.16622E+03	.39676E+00	.20619E+01	.70737E+02	.50644E+02
124	.78000E+00	.88318E+00	.16119E+03	.39676E+00	.20619E+01	.69355E+02	.49618E+02
125	.79000E+00	.88882E+00	.15916E+03	.39665E+00	.20621E+01	.68601E+02	.49118E+02
126	.80000E+00	.89443E+00	.15621E+03	.39677E+00	.20619E+01	.67764E+02	.48515E+02
127	.81000E+00	.90000E+00	.15210E+03	.39671E+00	.20620E+01	.66386E+02	.47530E+02
128	.82000E+00	.90554E+00	.14768E+03	.39671E+00	.20620E+01	.64856E+02	.46435E+02
129	.83000E+00	.91104E+00	.14504E+03	.39678E+00	.20619E+01	.64084E+02	.45880E+02
130	.84000E+00	.91652E+00	.14268E+03	.39681E+00	.20618E+01	.63424E+02	.45406E+02
131	.85000E+00	.92195E+00	.13856E+03	.39675E+00	.20619E+01	.61956E+02	.44357E+02
132	.86000E+00	.92736E+00	.13621E+03	.39679E+00	.20619E+01	.61262E+02	.43859E+02
133	.87000E+00	.93274E+00	.13386E+03	.39681E+00	.20618E+01	.60554E+02	.43352E+02
134	.88000E+00	.93808E+00	.13091E+03	.39677E+00	.20620E+01	.59559E+02	.42642E+02
135	.89000E+00	.94340E+00	.12797E+03	.39665E+00	.20621E+01	.58547E+02	.41920E+02
136	.90000E+00	.94868E+00	.12513E+03	.42513E+00	.20209E+01	.58695E+02	.41185E+02
137	.91000E+00	.95394E+00	.12356E+03	.39664E+00	.20621E+01	.57163E+02	.40926E+02
138	.92000E+00	.95917E+00	.12072E+03	.39662E+00	.20621E+01	.55967E+02	.40073E+02
139	.93000E+00	.96437E+00	.11885E+03	.39671E+00	.20620E+01	.55585E+02	.39799E+02
140	.94000E+00	.96954E+00	.11620E+03	.39679E+00	.20619E+01	.54642E+02	.39120E+02
141	.95000E+00	.97468E+00	.11473E+03	.39663E+00	.20621E+01	.54232E+02	.38829E+02
142	.96000E+00	.97979E+00	.11209E+03	.39672E+00	.20620E+01	.53261E+02	.38132E+02
143	.97000E+00	.98489E+00	.11120E+03	.39667E+00	.20621E+01	.53114E+02	.38029E+02
144	.98000E+00	.98995E+00	.10914E+03	.39689E+00	.20617E+01	.52436E+02	.37516E+02

*** FTOT ***

MATERIAL NUMBER 4

GROUP	E	SQRT(E)	NUSIGF	ALPHA	ETA	PTE*SIGA	PTE*SIGF
145	.99000E+00	.99499E+00	.10708E+03	.39659E+00	.20622E+01	.51668E+02	.36996E+02
146	.10000E+01	.10000E+01	.10503E+03	.39655E+00	.20622E+01	.50928E+02	.36467E+02
147	.10100E+01	.10050E+01	.10384E+03	.39407E+00	.20659E+01	.50516E+02	.36237E+02
148	.10200E+01	.10100E+01	.10238E+03	.39155E+00	.20696E+01	.49961E+02	.35903E+02
149	.10300E+01	.10149E+01	.10096E+03	.38903E+00	.20734E+01	.49420E+02	.35579E+02
150	.10400E+01	.10198E+01	.99587E+02	.38649E+00	.20772E+01	.48892E+02	.35263E+02
151	.10500E+01	.10247E+01	.98249E+02	.38393E+00	.20810E+01	.48378E+02	.34957E+02
152	.10600E+01	.10296E+01	.96949E+02	.38137E+00	.20849E+01	.47876E+02	.34658E+02
153	.10700E+01	.10344E+01	.95685E+02	.37879E+00	.20888E+01	.47385E+02	.34367E+02
154	.10800E+01	.10392E+01	.94454E+02	.37620E+00	.20927E+01	.46905E+02	.34083E+02
155	.10900E+01	.10440E+01	.93256E+02	.37359E+00	.20967E+01	.46436E+02	.33806E+02
156	.11000E+01	.10488E+01	.92088E+02	.37096E+00	.21007E+01	.45976E+02	.33536E+02
157	.11100E+01	.10536E+01	.90949E+02	.36832E+00	.21048E+01	.45525E+02	.33271E+02
158	.11200E+01	.10583E+01	.89837E+02	.36565E+00	.21089E+01	.45083E+02	.33012E+02
159	.11300E+01	.10630E+01	.88752E+02	.36322E+00	.21126E+01	.44669E+02	.32767E+02
160	.11400E+01	.10677E+01	.87693E+02	.36105E+00	.21160E+01	.44284E+02	.32536E+02
161	.11500E+01	.10724E+01	.86658E+02	.35886E+00	.21194E+01	.43906E+02	.32310E+02
162	.11600E+01	.10770E+01	.85647E+02	.35667E+00	.21228E+01	.43535E+02	.32089E+02
163	.11700E+01	.10817E+01	.84663E+02	.35447E+00	.21263E+01	.43171E+02	.31873E+02
164	.11800E+01	.10863E+01	.83701E+02	.35225E+00	.21298E+01	.42813E+02	.31661E+02
165	.11900E+01	.10909E+01	.82037E+02	.35003E+00	.21333E+01	.42462E+02	.31452E+02
166	.12000E+01	.10954E+01	.82153E+02	.34779E+00	.21368E+01	.42116E+02	.31248E+02
167	.12100E+01	.11000E+01	.81288E+02	.34554E+00	.21404E+01	.41776E+02	.31048E+02
168	.12200E+01	.11045E+01	.80440E+02	.34327E+00	.21440E+01	.41440E+02	.30852E+02
169	.12300E+01	.11091E+01	.79610E+02	.34099E+00	.21477E+01	.41110E+02	.30657E+02
170	.12400E+01	.11136E+01	.78795E+02	.33869E+00	.21514E+01	.40785E+02	.30466E+02
171	.12500E+01	.11180E+01	.77996E+02	.33638E+00	.21551E+01	.40464E+02	.30279E+02
172	.12600E+01	.11225E+01	.77211E+02	.33405E+00	.21589E+01	.40148E+02	.30096E+02
173	.12700E+01	.11269E+01	.76440E+02	.33171E+00	.21627E+01	.39836E+02	.29916E+02
174	.12800E+01	.11314E+01	.75684E+02	.32936E+00	.21665E+01	.39528E+02	.29739E+02
175	.12900E+01	.11358E+01	.74940E+02	.32699E+00	.21703E+01	.39224E+02	.29564E+02
176	.13000E+01	.11402E+01	.74209E+02	.32461E+00	.21742E+01	.38924E+02	.29392E+02
177	.13100E+01	.11446E+01	.73491E+02	.32222E+00	.21781E+01	.38628E+02	.29223E+02
178	.13200E+01	.11489E+01	.72784E+02	.31981E+00	.21820E+01	.38336E+02	.29056E+02
179	.13300E+01	.11533E+01	.72088E+02	.31739E+00	.21860E+01	.38047E+02	.28891E+02
180	.13400E+01	.11576E+01	.71404E+02	.31496E+00	.21899E+01	.37763E+02	.28729E+02

*** ETOT ***

MATERIAL NUMBER 4

GROUP	E	SQRT(E)	NUSIGF	ALPHA	ETA	PTF*SIGA	PTF*SIGF
181	.13500E+01	.11619E+01	.71470E+02	.31564E+00	.21891E+01	.37913E+02	.28817E+02
182	.13600E+01	.11662E+01	.70836E+02	.31350E+00	.21926E+01	.37676E+02	.28683E+02
183	.13700E+01	.11705E+01	.70252E+02	.31135E+00	.21962E+01	.37441E+02	.28551E+02
184	.13800E+01	.11747E+01	.69689E+02	.30947E+00	.21994E+01	.37222E+02	.28426E+02
185	.13900E+01	.11790E+01	.69146E+02	.30786E+00	.22021E+01	.37021E+02	.28306E+02
186	.14000E+01	.11832E+01	.68613E+02	.30624E+00	.22049E+01	.36821E+02	.28189E+02
187	.14100E+01	.11874E+01	.68087E+02	.30462E+00	.22075E+01	.36624E+02	.28073E+02
188	.14200E+01	.11916E+01	.67570E+02	.30300E+00	.22103E+01	.36429E+02	.27958E+02
189	.14300E+01	.11958E+01	.67061E+02	.30177E+00	.22131E+01	.36236E+02	.27845E+02
190	.14400E+01	.12000E+01	.66559E+02	.29973E+00	.22158E+01	.36046E+02	.27733E+02
191	.14500E+01	.12042E+01	.66065E+02	.29809E+00	.22186E+01	.35857E+02	.27623E+02
192	.14600E+01	.12083E+01	.65578E+02	.29644E+00	.22215E+01	.35669E+02	.27513E+02
193	.14700E+01	.12124E+01	.65098E+02	.29479E+00	.22243E+01	.35484E+02	.27405E+02
194	.14800E+01	.12166E+01	.64625E+02	.29312E+00	.22272E+01	.35300E+02	.27298E+02
195	.14900E+01	.12207E+01	.64158E+02	.29145E+00	.22301E+01	.35118E+02	.27192E+02
196	.15000E+01	.12247E+01	.63697E+02	.28977E+00	.22330E+01	.34937E+02	.27088E+02
197	.15100E+01	.12288E+01	.63243E+02	.28808E+00	.22361E+01	.34757E+02	.26984E+02
198	.15200E+01	.12329E+01	.62795E+02	.28617E+00	.22392E+01	.34579E+02	.26881E+02
199	.15300E+01	.12369E+01	.62419E+02	.28436E+00	.22424E+01	.34432E+02	.26803E+02
200	.15400E+01	.12410E+01	.62004E+02	.28254E+00	.22455E+01	.34266E+02	.26717E+02
201	.15500E+01	.12450E+01	.61595E+02	.28071E+00	.22487E+01	.34101E+02	.26627E+02
202	.15600E+01	.12490E+01	.61191E+02	.27887E+00	.22520E+01	.33938E+02	.26537E+02
203	.15700E+01	.12530E+01	.60792E+02	.27702E+00	.22552E+01	.33775E+02	.26449E+02
204	.15800E+01	.12570E+01	.60398E+02	.27516E+00	.22585E+01	.33614E+02	.26361E+02
205	.15900E+01	.12610E+01	.60008E+02	.27329E+00	.22619E+01	.33454E+02	.26273E+02
206	.16000E+01	.12649E+01	.59623E+02	.27141E+00	.22653E+01	.33294E+02	.26187E+02
207	.16100E+01	.12689E+01	.59242E+02	.26951E+00	.22686E+01	.33135E+02	.26101E+02
208	.16200E+01	.12728E+01	.58866E+02	.26760E+00	.22720E+01	.32977E+02	.26015E+02
209	.16300E+01	.12767E+01	.58494E+02	.26569E+00	.22754E+01	.32820E+02	.25931E+02
210	.16400E+01	.12806E+01	.58126E+02	.26376E+00	.22789E+01	.32664E+02	.25846E+02
211	.16500E+01	.12845E+01	.57762E+02	.26181E+00	.22824E+01	.32508E+02	.25763E+02
212	.16600E+01	.12884E+01	.57402E+02	.25986E+00	.22860E+01	.32353E+02	.25680E+02
213	.16700E+01	.12923E+01	.57045E+02	.25789E+00	.22895E+01	.32198E+02	.25597E+02
214	.16800E+01	.12961E+01	.56692E+02	.25591E+00	.22932E+01	.32044E+02	.25515E+02
215	.16900E+01	.13000E+01	.56343E+02	.25391E+00	.22968E+01	.31890E+02	.25433E+02
216	.17000E+01	.13038E+01	.55997E+02	.25190E+00	.23005E+01	.31737E+02	.25351E+02

*** FTOT ***

MATERIAL NUMBER 4

GROUP	E	SQRT(E)	NUSIGF	ALPHA	ETA	FTE*SIGA	FTE*SIGF
217	.17100E+01	.13077E+01	.55655E+02	.24988E+00	.23042E+01	.31585E+02	.25270E+02
218	.17200E+01	.13115E+01	.55315E+02	.24794E+00	.23080E+01	.31432E+02	.25189E+02
219	.17300E+01	.13153E+01	.54979E+02	.24579E+00	.23119E+01	.31280E+02	.25109E+02
220	.17400E+01	.13191E+01	.54646E+02	.24372E+00	.23156E+01	.31129E+02	.25029E+02
221	.17500E+01	.13229E+01	.54316E+02	.24164E+00	.23195E+01	.30978E+02	.24949E+02
222	.17600E+01	.13266E+01	.54000E+02	.23971E+00	.23231E+01	.30837E+02	.24875E+02
223	.17700E+01	.13304E+01	.53687E+02	.23776E+00	.23268E+01	.30697E+02	.24801E+02
224	.17800E+01	.13342E+01	.53377E+02	.23581E+00	.23305E+01	.30558E+02	.24727E+02
225	.17900E+01	.13379E+01	.53070E+02	.23383E+00	.23342E+01	.30418E+02	.24654E+02
226	.18000E+01	.13416E+01	.52765E+02	.23184E+00	.23380E+01	.30279E+02	.24580E+02
227	.18100E+01	.13454E+01	.52463E+02	.22984E+00	.23419E+01	.30140E+02	.24507E+02
228	.18200E+01	.13491E+01	.52163E+02	.22792E+00	.23456E+01	.30001E+02	.24435E+02
229	.18300E+01	.13528E+01	.51866E+02	.22579E+00	.23495E+01	.29863E+02	.24362E+02
230	.18400E+01	.13565E+01	.51571E+02	.22376E+00	.23534E+01	.29724E+02	.24290E+02
231	.18500E+01	.13601E+01	.51278E+02	.22189E+00	.23574E+01	.29586E+02	.24217E+02
232	.18600E+01	.13638E+01	.50989E+02	.21962E+00	.23614E+01	.29449E+02	.24145E+02
233	.18700E+01	.13675E+01	.50699E+02	.21757E+00	.23654E+01	.29310E+02	.24073E+02
234	.18800E+01	.13711E+01	.50413E+02	.21543E+00	.23695E+01	.29172E+02	.24001E+02
235	.18900E+01	.13748E+01	.50129E+02	.21331E+00	.23737E+01	.29034E+02	.23929E+02
236	.19000E+01	.13784E+01	.49847E+02	.21117E+00	.23779E+01	.28896E+02	.23858E+02
237	.19100E+01	.13820E+01	.49567E+02	.20902E+00	.23821E+01	.28758E+02	.23786E+02
238	.19200E+01	.13856E+01	.49289E+02	.20685E+00	.23864E+01	.28620E+02	.23714E+02
239	.19300E+01	.13892E+01	.49013E+02	.20467E+00	.23907E+01	.28482E+02	.23643E+02
240	.19400E+01	.13928E+01	.48739E+02	.20247E+00	.23951E+01	.28344E+02	.23571E+02
241	.19500E+01	.13964E+01	.48467E+02	.20025E+00	.23996E+01	.28206E+02	.23500E+02
242	.19600E+01	.14000E+01	.48196E+02	.19801E+00	.24040E+01	.28068E+02	.23429E+02
243	.19700E+01	.14036E+01	.47927E+02	.19576E+00	.24085E+01	.27931E+02	.23357E+02
244	.19800E+01	.14071E+01	.47660E+02	.19349E+00	.24131E+01	.27791E+02	.23286E+02
245	.19900E+01	.14107E+01	.47394E+02	.19120E+00	.24177E+01	.27653E+02	.23214E+02
246	.20000E+01	.14142E+01	.47130E+02	.18889E+00	.24224E+01	.27515E+02	.23143E+02

PUNCHED OUTPUT FOR TEMPEST

ETOT SAMPLE PROBLEM PU-239 ENDF/B 1159

```
DECIMAL
PU39 A     4                                                                  246    4    1
 1.517E+02 0.          7.090E+02 0.          2.575E+03                                4    2
 0.        0.          0.        0.          0.                                       4    3
 .1517E+03 .1520E+03 .1523E+03 .1527E+03 .1530E+03 .1533E+03 .1537E+03              4    4
 .1540E+03 .1543E+03 .1547E+03 .1550E+03 .1554E+03 .1558E+03 .1561E+03              4    5
 .1565E+03 .1569E+03 .1573E+03 .1577E+03 .1581E+03 .1585E+03 .1589E+03              4    6
 .1593E+03 .1597E+03 .1601E+03 .1606E+03 .1610E+03 .1614E+03 .1619E+03              4    7
 .1623E+03 .1628E+03 .1632E+03 .1637E+03 .1642E+03 .1647E+03 .1651E+03              4    8
 .1656E+03 .1661E+03 .1666E+03 .1671E+03 .1676E+03 .1681E+03 .1687E+03              4    9
 .1692E+03 .1697E+03 .1703E+03 .1708E+03 .1713E+03 .1719E+03 .1725E+03              4   10
 .1731E+03 .1736E+03 .1802E+03 .1880E+03 .1974E+03 .2095E+03 .2217E+03              4   11
 .8370E+03 .2549E+03 .2763E+03 .3013E+03 .3320E+03 .3693E+03 .4168E+03              4   12
 .4759E+03 .5521E+03 .6474E+03 .7562E+03 .9005E+03 .1076E+04 .1315E+04              4   13
 .1605E+04 .1961E+04 .2391E+04 .2821E+04 .2817E+04 .2870E+04 .2764E+04              4   14
 .2497E+04 .2140E+04 .1783E+04 .1497E+04 .1238E+04 .1050E+04 .8837E+03              4   15
 .7442E+03 .6340E+03 .5486E+03 .4716E+03 .4159E+03 .3672E+03 .3276E+03              4   16
 .2962E+03 .2715E+03 .2521E+03 .2335E+03 .2163E+03 .1953E+03 .1845E+03              4   17
 .1725E+03 .1633E+03 .1520E+03 .1450E+03 .1380E+03 .1321E+03 .1259E+03              4   18
 .1186E+03 .1134E+03 .1089E+03 .1040E+03 .1006E+03 .9619E+02 .9338E+02              4   19
 .9093E+02 .8775E+02 .8543E+02 .8261E+02 .8090E+02 .7893E+02 .7682E+02              4   20
 .7524E+02 .7376E+02 .7226E+02 .7074E+02 .6931E+02 .6850E+02 .6778E+02              4   21
 .6630E+02 .6496E+02 .6408E+02 .6342E+02 .6196E+02 .6126E+02 .6055E+02              4   22
 .5956E+02 .5855E+02 .5869E+02 .5715E+02 .5597E+02 .5559E+02 .5464E+02              4   23
 .5427E+02 .5326E+02 .5211E+02 .5241E+02 .5167E+02 .5033E+02 .5052E+02              4   24
 .4996E+02 .4942E+02 .4889E+02 .4838E+02 .4788E+02 .4773E+02 .4691E+02              4   25
 .4644E+02 .4598E+02 .4557E+02 .4518E+02 .4467E+02 .4428E+02 .4391E+02              4   26
 .4357E+02 .4317E+02 .4281E+02 .4246E+02 .4212E+02 .4178E+02 .4144E+02              4   27
 .4111E+02 .4078E+02 .4046E+02 .4019E+02 .3992E+02 .3966E+02 .3940E+02              4   28
 .3914E+02 .3889E+02 .3864E+02 .3840E+02 .3815E+02 .3791E+02 .3768E+02              4   29
 .3744E+02 .3722E+02 .3702E+02 .3683E+02 .3662E+02 .3643E+02 .3624E+02              4   30
 .3605E+02 .3586E+02 .3567E+02 .3549E+02 .3532E+02 .3512E+02 .3494E+02              4   31
 .3477E+02 .3460E+02 .3443E+02 .3427E+02 .3410E+02 .3394E+02 .3378E+02              4   32
 .3361E+02 .3345E+02 .3329E+02 .3314E+02 .3298E+02 .3282E+02 .3266E+02              4   33
 .3251E+02 .3235E+02 .3220E+02 .3204E+02 .3189E+02 .3174E+02 .3158E+02              4   34
 .3143E+02 .3128E+02 .3113E+02 .3098E+02 .3084E+02 .3070E+02 .3056E+02              4   35
 .3042E+02 .3028E+02 .3014E+02 .3000E+02 .2986E+02 .2972E+02 .2959E+02              4   36
 .2945E+02 .2931E+02 .2917E+02 .2903E+02 .2890E+02 .2876E+02 .2862E+02              4   37
 .2848E+02 .2834E+02 .2821E+02 .2807E+02 .2793E+02 .2779E+02 .2765E+02              4   38
 .2751E+020.          0.          0.          0.          0.          0.            4   39
```

```
PU79 F   104                                                                                                  24F 104   1
 1.157E+02 0.          2.847E+01 0.          2.169E+03                                                         104   2
 0.        0.          0.        0.          2.880E+00                                                         104   3
 .1157E+03 .1157E+03 .1158E+03 .1158E+03 .1158E+03 .1159E+03 .1159E+03                                         104   4
 .1160E+03 .1161E+03 .1161E+03 .1162E+03 .1163E+03 .1164E+03 .1165E+03                                         104   5
 .1165E+03 .1166E+03 .1167E+03 .1169E+03 .1169E+03 .1171E+03 .1172E+03                                         104   6
 .1173E+03 .1175E+03 .1176E+03 .1179E+03 .1179E+03 .1181E+03 .1183E+03                                         104   7
 .1185E+03 .1187E+03 .1189E+03 .1190E+03 .1191E+03 .1193E+03 .1197E+03                                         104   8
 .1200E+03 .1202E+03 .1204E+03 .1206E+03 .1208E+03 .1209E+03 .1213E+03                                         104   9
 .1216E+03 .1218E+03 .1219E+03 .1220E+03 .1224E+03 .1227E+03 .1230E+03                                         104  10
 .1233E+03 .1236E+03 .1269E+03 .1311E+03 .1355E+03 .1416E+03 .1489E+03                                         104  11
 .1562E+03 .1656E+03 .1772E+03 .1909E+03 .2081E+03 .2292E+03 .2565E+03                                         104  12
 .2904E+03 .3348E+03 .3906E+03 .4541E+03 .5285E+03 .6413E+03 .7812E+03                                         104  13
 .9505E+03 .1162E+04 .1363E+04 .1552E+04 .1668E+04 .1700E+04 .1637E+04                                         104  14
 .1479E+04 .1267E+04 .1056E+04 .8871E+03 .7391E+03 .6332E+03 .5434E+03                                         104  15
 .4650E+03 .4012E+03 .3506E+03 .3039E+03 .2699E+03 .2399E+03 .2152E+03                                         104  16
 .1956E+03 .1800E+03 .1677E+03 .1559E+03 .1452E+03 .1313E+03 .1245E+03                                         104  17
 .1168E+03 .1111E+03 .1038E+03 .9977E+02 .9486E+02 .9102E+02 .8709E+02                                         104  18
 .8290E+02 .7890E+02 .7601E+02 .7281E+02 .7069E+02 .6911E+02 .6597E+02                                         104  19
 .6438E+02 .6225E+02 .6067E+02 .5914E+02 .5793E+02 .5651E+02 .5490E+02                                         104  20
 .5347E+02 .5281E+02 .5174E+02 .5064E+02 .4962E+02 .4912E+02 .4851E+02                                         104  21
 .4753E+02 .4643E+02 .4588E+02 .4541E+02 .4436E+02 .4386E+02 .4335E+02                                         104  22
 .4264E+02 .4192E+02 .4119E+02 .4037E+02 .4007E+02 .3931E+02 .3912E+02                                         104  23
 .3883E+02 .3813E+02 .3803E+02 .3752E+02 .3701E+02 .3647E+02 .3624E+02                                         104  24
 .3591E+02 .3558E+02 .3526E+02 .3496E+02 .3466E+02 .3437E+02 .3408E+02                                         104  25
 .3391E+02 .3354E+02 .3327E+02 .3301E+02 .3277E+02 .3254E+02 .3231E+02                                         104  26
 .3209E+02 .3187E+02 .3166E+02 .3145E+02 .3125E+02 .3105E+02 .3085E+02                                         104  27
 .3066E+02 .3047E+02 .3028E+02 .3012E+02 .2997E+02 .2981E+02 .2966E+02                                         104  28
 .2952E+02 .2937E+02 .2923E+02 .2909E+02 .2895E+02 .2882E+02 .2868E+02                                         104  29
 .2855E+02 .2843E+02 .2831E+02 .2819E+02 .2807E+02 .2796E+02 .2784E+02                                         104  30
 .2773E+02 .2762E+02 .2751E+02 .2741E+02 .2730E+02 .2719E+02 .2709E+02                                         104  31
 .2699E+02 .2690E+02 .2681E+02 .2672E+02 .2663E+02 .2654E+02 .2645E+02                                         104  32
 .2636E+02 .2627E+02 .2619E+02 .2610E+02 .2602E+02 .2593E+02 .2585E+02                                         104  33
 .2576E+02 .2568E+02 .2560E+02 .2551E+02 .2543E+02 .2535E+02 .2527E+02                                         104  34
 .2519E+02 .2511E+02 .2503E+02 .2495E+02 .2487E+02 .2480E+02 .2473E+02                                         104  35
 .2465E+02 .2458E+02 .2451E+02 .2443E+02 .2436E+02 .2429E+02 .2422E+02                                         104  36
 .2415E+02 .2407E+02 .2400E+02 .2393E+02 .2386E+02 .2379E+02 .2371E+02                                         104  37
 .2364E+02 .2357E+02 .2350E+02 .2343E+02 .2336E+02 .2329E+02 .2321E+02                                         104  38
 .2314E+020.          0.          0.          0.          0.          0.                                       104  39
PU79 Y   204                                                                                                  24F 204   1
 8.740E+00 0.         -4.716E+00 0.         -1.034E+02                                                        204   2
 0.        0.          0.        0.          1.000E+00                                                         204   3
 .8740E+01 .8737E+01 .8731E+01 .8727E+01 .8721E+01 .8716E+01 .8710E+01                                         204   4
 .8705E+01 .8699E+01 .8694E+01 .8690E+01 .8684E+01 .8679E+01 .8673E+01                                         204   5
 .8667E+01 .8662E+01 .8656E+01 .8650E+01 .8645E+01 .8639E+01 .8633E+01                                         204   6
 .8627E+01 .8621E+01 .8615E+01 .8609E+01 .8603E+01 .8597E+01 .8591E+01                                         204   7
 .8585E+01 .8579E+01 .8572E+01 .8566E+01 .8560E+01 .8553E+01 .8547E+01                                         204   8
```

```
.8541E+01 .8574E+01 .8528E+01 .8521E+01 .8514E+01 .8508E+01 .8501E+01   204   9
.8494E+01 .8487E+01 .8481E+01 .8474E+01 .8467E+01 .8460E+01 .8453E+01   204  10
.8446E+01 .8439E+01 .8365E+01 .8285E+01 .8201E+01 .8113E+01 .8013E+01   204  11
.7900E+01 .7797E+01 .7669E+01 .7551E+01 .7415E+01 .7273E+01 .7116E+01   204  12
.6971E+01 .6816E+01 .6672E+01 .6551E+01 .6472E+01 .6493E+01 .6633E+01   204  13
.7283E+01 .7815E+01 .8151E+01 .1104E+02 .1341E+02 .1577E+02 .1755E+02   204  14
.1850E+02 .1881E+02 .1870E+02 .1820E+02 .1774E+02 .1720E+02 .1668E+02   204  15
.1622E+02 .1578E+02 .1541E+02 .1506E+02 .1476E+02 .1449E+02 .1425E+02   204  16
.1403E+02 .1384E+02 .1365E+02 .1350E+02 .1335E+02 .1321E+02 .1309E+02   204  17
.1298E+02 .1287E+02 .1277E+02 .1268E+02 .1260E+02 .1252E+02 .1245E+02   204  18
.1238E+02 .1231E+02 .1225E+02 .1220E+02 .1214E+02 .1209E+02 .1204E+02   204  19
.1200E+02 .1195E+02 .1191E+02 .1187E+02 .1184E+02 .1180E+02 .1177E+02   204  20
.1173E+02 .1170E+02 .1167E+02 .1165E+02 .1162E+02 .1159E+02 .1157E+02   204  21
.1154E+02 .1152E+02 .1150E+02 .1147E+02 .1145E+02 .1143E+02 .1141E+02   204  22
.1140E+02 .1138E+02 .1136E+02 .1134E+02 .1133E+02 .1131E+02 .1129E+02   204  23
.1128E+02 .1126E+02 .1125E+02 .1124E+02 .1122E+02 .1121E+02 .1119E+02   204  24
.1120E+02 .1117E+02 .1116E+02 .1124E+02 .1123E+02 .1121E+02 .1120E+02   204  25
.1119E+02 .1117E+02 .1116E+02 .1115E+02 .1113E+02 .1112E+02 .1111E+02   204  26
.1110E+02 .1108E+02 .1107E+02 .1106E+02 .1105E+02 .1104E+02 .1103E+02   204  27
.1102E+02 .1100E+02 .1099E+02 .1099E+02 .1098E+02 .1097E+02 .1096E+02   204  28
.1095E+02 .1094E+02 .1093E+02 .1093E+02 .1092E+02 .1091E+02 .1090E+02   204  29
.1089E+02 .1089E+02 .1088E+02 .1087E+02 .1086E+02 .1085E+02 .1085E+02   204  30
.1084E+02 .1083E+02 .1082E+02 .1081E+02 .1081E+02 .1080E+02 .1079E+02   204  31
.1079E+02 .1078E+02 .1077E+02 .1077E+02 .1076E+02 .1076E+02 .1075E+02   204  32
.1075E+02 .1074E+02 .1073E+02 .1073E+02 .1072E+02 .1072E+02 .1071E+02   204  33
.1071E+02 .1070E+02 .1070E+02 .1069E+02 .1069E+02 .1068E+02 .1068E+02   204  34
.1067E+02 .1067E+02 .1066E+02 .1066E+02 .1065E+02 .1064E+02 .1063E+02   204  35
.1062E+02 .1062E+02 .1061E+02 .1060E+02 .1059E+02 .1058E+02 .1058E+02   204  36
.1057E+02 .1056E+02 .1055E+02 .1054E+02 .1054E+02 .1053E+02 .1052E+02   204  37
.1051E+02 .1051E+02 .1050E+02 .1049E+02 .1048E+02 .1047E+02 .1047E+02   204  38
.1046E+020.         0.          0.          0.          0.          0.    204  39
Y-LAST

IN PROGRAM STATE CP TIME WAS      .4321 SEC. , ELAPSED TIME WAS     3.0003 SEC.
```

CHAPTER 4

PROGRAMMER'S INFORMATION

This section contains many of the internal details of the program. The intent is that this section will provide the programmer with information that will prove helpful for making additions or modifications and also assist in making the program operational at other installations.

4.1 GENERAL PROGRAM DESIGN PHILOSOPHY

This program was written with the assumption that it would likely be used at many installations with a variety of computing machinery. Also it is not primarily a production program but one that will simply be used from time to time to generate new libraries or update old ones. Hence, a basic aim was to produce straightforward, clear programming that would be readily understood. The program is entirely in ASA standard FORTRAN (FORTRAN IV) and uses no programming tricks and takes no advantage of any particular hardware or software. Also in the spirit of simplicity, variable dimensioning was not used.

The program was written with the expectation that there will be future additions and modifications. Some of these are anticipated with statement allocations and comments. Others are already wholly or partially included. In any case, adequate storage remains to handle any foreseeable contingency.

The main program is simply a series of tests and calls. It is quite straightforward and serves as a gross flow diagram. The flow is in a straight line with few deviations hence segmenting is readily accomplished. The program as distributed is segmented according to the overlay structure given in Section 4.3.

Many of the subroutines used by the program may be useful in other (present and future) codes connected with the ENDF/B system. Hence an attempt has been made to write these routines with general use in mind and they are self-contained (or nearly so). Some ETOT subroutines may be replaced by similar routines from other ENDF/B codes when they become available.

Most of the data handling is done with large common storage blocks. All tape data are first read into these blocks before processing. When data are manipulated, they are done in blocks. The blocks also serve as temporary space for some processed results before they are output. These blocks are the device which permits the general purpose subroutines to be self-contained. At present there are 3 floating point blocks, two of length 4000 and 1 of length 8000.

The logical flow of the program is designed so that the ENDF/B library tape will be scanned only once; hence, the library tape is never backspaced and is only read forward. Thus, the data are processed in the order they appear on the ENDF/B tape.

4.2 LABELLED COMMON VARIABLES

/TAPES/	
MODE	mode of the ENDF/B library tape
I05	input tape
I06	output print tape
I07	output punch tape
NDFB	ENDF/B library tape
LTAPE	thermal library tape
ITP4	spare
/DENS/*	
JMT	record identifier
JAT	record starting location
JTT	record type
JLT	record length
A	bulk storage array
JNS,MNS	pointers for next record
JX	maximum length of A array
MX	maximum length of JMT, JAT, JTT, and JLT arrays
/RECS/*	
MAT	material number
MF	file number
MT	reaction type number
C1,C2	floating point constants
L1,L2	integer constants

*This common block is part of the package of Retrieval Subroutines for the ENDF/B system written by H. C. Honeck (Reference 10).

/RECS/* (cont'd.)

N1	count of items in a list to follow
N2	count of items in a second list to follow
NBT,JNT	general integer storage space
X,Y	general floating point storage space
N1X	maximum length of the NBT and JNT arrays
N2X	maximum length of the X and Y arrays
NS	card sequence number

Note: In ETOT-3, the /RECS/ labelled common is used as storage for various cross sections and other nuclear data which are edited by ETOT.

/GROUPS/

EGRP	energy breakpoints
VGRP	speed breakpoints
EPTS	energy points
V	speed points

/FILE3/

XS	scattering cross section
XC	capture cross section
XF	fission cross section
XSMU	average cosine of the scattering angle
ZETA	weighting function
GNU	neutrons per fission

/FILE6/

TRUM	extra cross section storage

/RESP/

NREF	number of resonances
EZERO	energy at resonance peak (E_o)
GAMN	neutron width evaluated at E_o
GAMG	radiation width evaluated at E_o
GAMF	fission width evaluated at E_o
G	spin factor
ELOW	lower bound of resonance region
EHIGH	upper bound of resonance region
SIGP	potential scattering

/OPTION/

IDTAP	ENDF/B tape ID
MCODE	output format
MAXG	number of groups (or points)
MAXG1	MAXG+1
MAXG2	MAXG+2
IW	type of weight
IEU	energy structure
IGRPE	if lower group is at 0 eV
IRES	maximum number of resonance parameters
IPUN	punch option flag
IAV	group averaged or point values
IAPX	test 1/v approximation fit
IXL	spare
LEGO	spare
TEMP	temperature (°K) for Maxwellian distribution
IGRAPH	graph option flag

/IN/ (Eight words--see input description)

/MATS/

NMAT	number of materials
IMAT	number of current material being processed
MATNOS	ENDF/B material numbers
MATIDS	thermal material numbers
MAT2ID	second thermal ID

/LABL/

LABEL	punched output label
ELABEL	store 1st line of Hollerith description of material from ENDF/B tape (for GRAPH)

/TLABL/

TLABEL	ENDF/B tape label

/FLAGS/

KEY	data presence indicator
NOXS	elastic cross-section indicator
NOXIN	inelastic cross-section indicator
NON2N	(n, 2n) cross-section indicator
NOXF	fission cross-section indicator
NONG	(n, γ) cross-section indicator
NONP	(n, p) cross-section indicator
NOND	(n, d) cross-section indicator
NONT	(n, t) cross-section indicator
NOHE	(n, He^3) cross-section indicator
NONA	(n, alpha) cross-section indicator
NON2A	(n, 2-alpha) cross-section indicator
NOCAP	absorption (ENDF/B) cross-section indicator
IVA	1/v fit to absorption cross section
IVF	1/v fit to fission cross section
IVS	constant fit to scattering cross section

/ENDS/	(lowest group where data is tabulated)
/CONTF1/	
ZA	material (Z, A) designation
AWR	atomic weight ratio
LRP	resonance indicator
LFI	fission indicator (data)
LDD	radioactive decay data indicator
LFP	fission product yield data indicator
NWD	length of Hollerith description of data
LNU	indicates type of $\bar{\nu}$ data
NC	number of polynomial terms of $\bar{\nu}$ data
C	polynomial coefficients of $\bar{\nu}$ data
NR1	spare
NP1	spare
/CONF2/	resonance data, subscripted often for isotope and energy range
NIS	number of isotopes
ZAI	isotope (Z, A) designation
ABN	isotope abundance
LFW	for unresolved resonances (not used by ETOT)
NER	number of energy ranges
LISR	obsolete
EL	low end of an energy range
EH	upper end of an energy range
LRU	resolved/unresolved indicator
LRF	formalism of resonance representation
SPIR	nuclear spin of target (energy range, isotope)
AP	effective scattering radius (energy range, isotope) (spin-up)
NLSR	number ℓ-states (energy range, isotope)
CR	"AWR" mass of isotope in units of neutron mass
AM	effective scattering radius (spin down; zero if spin independence)
LR	ℓ value (energy range, isotope, ℓ state)
NRS	number of resolved resonances (energy range, isotope, ℓ-state)
LFWX	fission indicator
/CONTF4/	(not used)
/AWRI/	
AWRI	isotopic mass in units of neutron mass
/BLOKS/	carries lengths of interpolation tables, etc.
/CONTF3/	parameters for ENDF/B "File 3" data
LFS	final state indicator
NR3	number of energy ranges (interpolation table size)
NP3	number of energy points

4.3 OVERLAY STRUCTURE AND ROUTINE LIST

Following is a list of the programs, subroutines, and functions used by ETOT. A brief summary of the purpose of each is included. The order of the list is the same as that of the physical deck. It is arranged by program segment. Hence this list also serves as the overlay structure description. The subroutines with an asterisk are part of the package of Retrieval Subroutines for the ENDF/B System written by H. C. Honeck (Reference 10).

Overlay (0,0)

ETOT03	control flow of ETOT
ERR	print error message
ERROR	print error message*
TIMEIT	compute and print elapsed time
STORE	store record in dense storage*
FETCH	fetch record from dense storage*
DELETE	delete record from dense storage*
LRIDS	locate record in dense storage*
FPDS	fetch point from dense storage*
IPDS	interpolate point in dense storage*
TPOS	position ENDF/B tape to file (MF) and reaction (MT)
CONT	read control (CONT) record
HOLL	read hollerith material description
LIST	read LIST record
TAB1	read TAB1 record
TAB2	read TAB2 record
COMBP	combine one panel of two TAB1 functions*
COMB	combine two TAB1 functions*
ADD	combining function for addition*
SUB	combining function for subtraction*
MULT	combining function for multiplication*
DIV	combining function for division*
TERP	interpolate between two points*
TERP1	interpolate one point*
TERP2	form new table by interpolation*
TERP0	interpolate data array
XTND	extend data array

```
ECSI          compute integral of y(K)*
GRATE         integrate TAB1 function*
AVRG          average over a selected range
GPAV          average over selected groups

POINT         calculate cross sections at energy points
RES           calculate resolved resonance cross sections
PHASE         calculate resolved resonance"phase shift" argument for elastic
              scattering formulae
PEN           calculate resolved resonance "penetration factor"
SHIFF         calculate resolved resonance "shift factor" (to get change
              in resonance energy as viewed from another energy)

OVERLAY (1,0)

ETOT1         read input
EU            construct group structure
WEIGHT        construct weight and weight averages
GENT1         generate TAB1 function*
WELL          generating function for Maxwellian distribution
TRID          read ENDF/B tape I.D.
OUT1          print input data

OVERLAY (2,0)

ETOT2         control flow of program in overlay (2,0)

ZERO          initialize
TMAT          position ENDF/B tape to material
TMF1          read ENDF/B File 1

OVERLAY (3,0)

ETOT3         control flow of program in overlay (3,0)

TMF2          read ENDF/B File 2
RESCAL        calculate resonance data
OUT3          print resonance data

OVERLAY (4,0)

ETOT4         control flow of program in overlay (4,0)

TMF3          read ENDF/B File 3
CROS          calculate smooth cross sections

OVERLAY (5,0)

ETOT5         control flow of program in overlay (5,0)

PRELIM        calculate coefficients and resonance parameters (KATE type)
FIT2V         tests for fit to 1/v
FINDC         calculate second order least squares polynomial
```

SIMQ	simultaneous equation solver
SETUP	extends and prints cross sections and related data
GRAPH	graph the cross sections
PLOT	graph data array
LOUT	punch in ARK format
KOUT	punch in KATE format
CVRT	convert real into decimal and exponent
ALPHA	convert integer into alphanumeric
CARD	punch one KATE card
TOUT	punch in TEMPEST format
LAUT	punch in LASER or THERMOS format
XSET	punch "libp" format for LAUT

4.4 ERROR STOPS

If certain errors are detected, an error message will be printed. Some messages are printed directly from the routine where they are detected. Others are printed by one of the error printing subroutines. Subroutine ERR will print an error number, the subroutine and the statement number where the error occurred and the control words, MAT, MF, MT, C1, C2, L1, L2, N1 and N2. Subroutine ERROR prints only the error number and the control words, MAT, MF, and MT. Following is a list of the error numbers, the subroutine which detects the error and an explanation of the error.

Error Number	Detecting Subroutine	Explanation
110	ECSI	Interpolation code out of range
130	TERP2	X(N) not in increasing order
131	TERP2	XP(N) not in increasing order
132	TERP2	Interpolation table incorrect
133	TERP1	Interpolation code not in range 1-5
134	TERP1	X $\leq$ 0 cannot be interpolated by logs
135	TERP1	X1=X2, discontinuity
300	STORE	JT not in range 1-6
301	STORE	MA=0 not allowed
302	STORE	Overflow, record will not fit in /DENS/
or	GENT1	Overflow, record will not fit in /RECS/
303	FETCH	MA=0, record not in /DENS/
308	COMB	Overflow, answer will not fit in /RECS/
309	COMB	MA or MB not in /DENS/

Error Number	Detecting Subroutine	Explanation
310	COMB	XL $\geq$ XH
311	COMB	MA or MB is zero
314	IPDS	Improper interpolation table
315	GRATE	Interpolation table incorrect
401	CROS	Inelastic cross section non-zero within the group structure
402	CROS	n-2n cross section non-zero within the group structure

Error stops not handled by ERR or ERROR include: (from)

a. "ENDF/B TAPE ID NO. = n REQUESTED TAPE ID NO. m"
meaning the data tape disagrees with control cards; (TRID)

b. "TAPE END ECØUNTERED. HENCE"; (TMAT)

c. "DESIRED MATERIAL NUMBER n IS NOT ON TAPE OR IS
OUT OF ORDER
TAPE HAS BEEN SEARCHED TO MATERIAL NUMBER m"; (TMAT)

d. "ERROR - LNU = n BUT MUST BE EITHER 1 OR 2" (TMF1)
meaning ETOT cannot handle ν data (file) found;

e. "TAPE ENTRY ERROR -" (TMF2)
"NER = n BUT MUST = 1 OR 2";
or "LRU = n BUT MUST = 1 OR 2";
or "LRF = n BUT MUST = 1 OR 2";
or "LFI = n BUT MUST = 0 OR 1";
("LRF = n," etc., for one or more isotopes does not
result in a program stop, but causes the resonance calculation
to be skipped);

f. "UNRESOLVED REGION EXTENDS INTO GROUP STRUCTURE." (TMF2)

CHAPTER 5

ENVIRONMENT INFORMATION

ETOT requires approximately $50{,}000_{10}$ locations and uses the ENDF/B data tape and produces a library tape. It also requires standard system input, output, and punch units. Since the program is entirely in FORTRAN IV, it should compile and execute on any configuration meeting these requirements. The only possible difficulty is that ETOT calls the SC-4020 plotting routine AICRT3.

CHAPTER 6

COMMENTS AND CONCLUSIONS

An alternative title for this brief chapter could be "Accuracy and Speed." Improvements leading to the new ETOT-3 version were discussed in Reference 12. Some recapitulation is given here, with user and programmer in mind.

Quoting from Reference 12:

> A version of ETOT-3 with modified output (ETCO) has been used to process all 133 "materials" of ENDF/B-III to give a preliminary "Universal Thermal Library." Comparisons of 2200 m/s results from ETOT-3 and from RESEND/INTEND[13,14,15] gave agreement better than 0.1% for 122 ENDF/B-III materials. The eleven exceptions with disagreements < 1% appear to be caused by interpolation defects in ETOT-3 edits.

First, an amplification about "ETCO" is appropriate. A 460 group structure had to be handled, so simple storage increases were made in ETOT-3. An output subroutine was written to produce an ENDF/B-like format. Long computer time was required because resonance calculations were being done at a large fraction of 46,000 energy points. Consequently, improvements were made in ETOT-3 itself to reduce the number of calls to resonance routines (per group) and to reduce the number of calls to sine and cosine routines (by applying algebraic identities).

As a few materials were intensively compared with results from other processors, minor errors were corrected in ETOT-3 itself until complete 5-digit agreement was obtained. (The other processors were RESEND-INTEND[13,14] and FLANGE-II.[16]) As processing was pushed, with "ETCO," through all of ENDF/B III, processing failures resulted in corrections of ETOT-3 itself. Likewise, when a gross disagreement in 2200 m/s values (from comparison with Reference 15) was remedied in "ETCO," the correction was applied also to the basic ETOT-3.

When ETOT edits 2200 m/s cross sections, the interpolation table information, available at data intake, has been thrown away. In many cases interpolation information provided is inadequate anyway, because the cross section is entirely or partially prescribed by resonance parameters. Consequently, ETOT assumes a log-log interpolation, and 2200 m/s edits can be distorted. Much better results may be obtained if the energy structure contains a 2200 m/s point or micro-group. This is wasted for library applications, but is thoroughly useful in checking on processing quality. This concludes the discussion of speed and accuracy from a programming point of view.

A final remark on software configuration is appropriate. The CDC high-efficiency Fortran compiler called "FTN" has a user parameter called "OPT." Setting OPT to allowed higher values may double compiling time, but may shorten ETOT execution time by as much as 10%. It is easy to see, since the extra compilation time is about 5 seconds, and complete library processing may require half an hour or so. that compiling for high efficiency in the program is worthwhile.

CHAPTER 7

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