

WCAP-3845-1
ENDF 114 Supp.

SUPPLEMENT TO WCAP-3845-1
"ETOG-1, A FORTRAN IV PROGRAM TO
PROCESS DATA FROM THE ENDF/B FILE TO
THE MUFT, GAM AND ANISN FORMATS"

Westinghouse Nuclear Energy Systems



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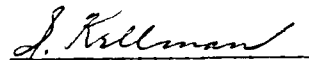
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ABSTRACT

As described in the main report, ETOG processes basic nuclear data in the ENDF/B format and punches neutron data libraries for MUFT, GAM-I, GAM-II, ANISN and LASER. Necessary corrections and changes to ETOG are described in this Supplement. The resulting new version, ETOG-3, successfully reads ENDF/B version III, achieves a high accuracy, and is designed for machine independence within the realm of large scientific computers.

CHAPTER 1

INTRODUCTION

In order to permit users of the MUFT-4^{[12]*}, MUFT-5^[13], GAM-I^[1], GAM-II^[2], ANISN^[3] and LASER^[16] programs to generate library data from ENDF/B Version III^[7], changes have been made in ETOG-1. D. E. Kusner performed a set of changes yielding an unofficial version called ETOG-2. With the need for higher accuracy revealed by TEDIUM^[17], and the advent of Version III of ENDF/B, M. Raymund undertook further modifications to produce ETOG-3. This supplement will give details to correct the main report, corresponding to basic changes of ETOG. A number of new exploitations of mass storage, subroutine changes, etc., will be detailed in Chapters 4 and 5. The details may be helpful to someone implementing the program on machines other than the CDC-7600. However, for ordinary ETOG-3 runs, the main report is a fully adequate users' guide.

As pointed out in the literature^[17,18], ETOG's days are numbered. There will always be possibilities for new versions of ETOG to handle new versions of ENDF/B (ETOG-3 certainly cannot process all of ENDF/B v. I and possibly will fail on some of ENDF/B v. IV). However, the new philosophy of providing central processing of cross sections into "super-group" files, easily collapsible to all major group-average schemes, will put an end to most ETOG running within 3 or 4 years. Release of ETOG-3 is necessary, however, if present ETOG users are to process cross sections with accuracy comparable to ENDF/B-III quality.

*The references given in the main report are reproduced here as Ch. 7, with updating and additions ([16] et. seq.).

CHAPTER 2

PROGRAM DESCRIPTION

2.1 GENERAL INFORMATION

The ground-work concerning codes served by ETOG, and concerning symbol definition, is assumed from the main report.

The alterations represented by ETOG-3 require certain modifications to Chapter 2 of the main report. These are limited to the topics: 1) resolved resonances, 2) inelastic scattering and 3) source spectra. There is a minor change in unresolved resonance calculations, with details given on Page 3-2 of this report.

2.2 RESOLVED RESONANCE TREATMENT

2.2.1 RESOLVED RESONANCE FORMULAE

The formula (2.16) of the main report, and descriptions following, for cross sections from s-wave resolved resonance parameters, are replaced by the specifications given in Appendix D of Reference 7 (official ENDF/B specification). This Appendix is quoted extensively below. Note that ℓ stands for the angular momentum state, so that s-wave cross sections are covered by $\ell=0$. Letting $\ell=1$ covers p-wave, which is also programmed in ETOG-3. Higher values of ℓ are not included in the new version.

1. Elastic Scattering Cross Section

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

where

$$\sigma_{n,n}^{\ell}(E) = (2\ell+1) \frac{4\pi}{k^2} \sin^2 \phi_{\ell}$$

$$+ \frac{\pi}{k^2} \sum_J g_J \sum_{r=1}^{\text{NR}_J} \frac{\Gamma_{nr}^2 \cos 2\phi_{\ell} - 2\Gamma_{nr}(\Gamma_{yr} + \Gamma_{fr}) \sin^2 \phi_{\ell} + 2(E-E'_r)\Gamma_{nr} \sin^2 \phi_{\ell}}{(E-E'_r)^2 + \frac{1}{4} \Gamma_r^2}$$

2. Radiative Capture Cross Section

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

where

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

3. Fission Cross Section

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

where

$$\sigma_{n,f}^{\ell}(E) = \frac{\pi}{k^2} \sum_J g_J \sum_{r=1}^{\text{NR}_J} \frac{\Gamma_{nr} \Gamma_{fr}}{(E-E'_r)^2 + \frac{1}{4} \Gamma_r^2} ,$$

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.

$$\text{NRS} = \sum_J \text{NR}_J$$

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.

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

$\Gamma_r = \Gamma_{nr}(E) + \Gamma_{\gamma r} + \Gamma_{fr}$ 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

$\Gamma_{fr} = GF$, the fission width

$$E_r' = E_r + \frac{S_l(|E_r|) - S_l(E)}{2P_l(|E_r|)} \Gamma_{nr}(|E_r|)$$

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

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.

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

These formulae are extremely difficult to follow through the ETOG programming, especially as symmetric or anti-symmetric parts are called for in an intricate logical system.

The definition of σ_o must be retained, however, to specify the calculation of MUFT resonance parameters. The term $\left(\frac{A + 1.008665}{A}\right)$ in the definition of σ_o was replaced by $\frac{A + 1}{A}$ where A is defined as in Expressions (2.10) and (2.14) of the main report, that is

$$\sigma_o = \frac{(2.6040 \times 10^6) \Gamma_{nr} (|E_r|) g_J}{|E_r| \Gamma_r} * \left(\frac{A+1}{A}\right)^2$$

This considerable change in formulae is justified for high-energy resolved resonances, where differences can be observed between the formalism of the main report and the ENDF/B definitions.

The MLBW calculation specified in Reference 7 is used in ETOG-3 for ENDF/B resolved resonance data which calls for this form. Quoting again from Appendix D of Reference 7:

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 7, but merely a caution, since the classes "NR_J" are not always segregated in ETOG.

ETOG-3 lacks provisions for D-wave Breit-Wigner, for Reich-Moore, and for Adler-Adler formalisms. The only ENDF/B v. III material excluded by these shortcomings is U²³³, Mat 1110.

2.2.2 POINTWISE RESOLVED CROSS SECTIONS

There is a discussion given in the main report, pp. 2-13 and 2-14, concerning pointwise cross sections generated from resolved resonance

parameters. This description is correct for ETOG-3, except that an additional sophistication was added to ETOG-3. It was found that a very fine mesh was used (in earlier versions) from E_0 to $E_0 \pm (1/2)\Gamma_t$, but that for energies further from peak, the grid could be very coarse in ETOG-1. This is a known source of an overestimate in producing group cross sections via the method of forming the pointwise cross sections.

In ETOG-3, the original fine mesh has been left undisturbed from E_0 to $E_0 \pm (1/4)\Gamma_t$, but the points which covered from $\pm (1/4)\Gamma_t$ to $\pm (1/2)\Gamma_t$ have been spread a little more coarsely to cover from $\pm (1/4)\Gamma_t$ to $\pm (5/2)\Gamma_t$.

This moved observed errors from as high as +6% down to as low as 0.25% for isolated resolved resonances. With complete reprogramming, a number of excellent suggestions for further improvements could be considered. It is obvious that when 30 or 40 resolved resonances lie within a single group, the ETOG scheme is hampered by limited total grid point storage available.

2.3 INELASTIC SCATTERING

The paragraph in the middle of p. 2.14 of the main report requires revision due to changes in "LF numbers." The following would now serve as an introduction to the MUFT treatment of inelastic scattering:

MUFT requires an inelastic scattering probability matrix as MUFT 4, File 5 (MUFT 5, File 6). Since the requirement is for a probability (rather than a cross section) matrix, all of the necessary information is contained in ENDF/B, File 5. There are six ENDF/B defined representations of secondary energy distributions, labeled by numbers LF. ETOG-3 will handle LF=1, 3, 7, 9 and 10. The other distribution (LF=5) is ignored by the program.

On p. 2-16, just after expression 2.24, the reference is now only to LF=10. The new sentence would be:

For LF=10, an E' mesh is constructed to cover the entire energy range; the appropriate (LF) function, $f(E)$, is calculated over this range, and the fractional amount in each sink group computed.

As a new feature, ETOG-3 accommodates the scheme "LF=1" which is really not a secondary energy distribution function (analytic form), but a tabulation. The new computation for LF=1 uses the energy arrangements set up for laws LF=7 and 9 and the general considerations given in pp. 2-16 and 2-17 (of the original report) apply. One caution: a test of a TEDIUM LF=1 data case, with probability in the form of a delta

function, revealed that the energy grid arranged in ETOG-3 would miss the non-zero data, resulting in a completely zero transfer matrix. Work with real ENDF/B v. III data (e.g., Iron, MAT 1180) was satisfactory for LF=1.

2.4 SOURCE SPECTRUM

A correction of the specifications described by p. 2-24 of the main report is required because of changes in LF (distribution law numbers) as now defined for ENDF/B. ETOG-3 will process a fission spectrum described by LF=7, 9, or 10. Combinations of LF number within this set are also processed. The defined LF numbers 1 and 3 are not accepted; an error message is printed and the program stops. If fission source spectrum processing is attempted with LF=5, another message is printed, and zero is contributed to the spectrum. An attempt to process a spectrum for a material lacking any ENDF/B file 5, MT=18 data (fission) results in a program stop, without any message.

CHAPTER 3

EXECUTION INFORMATION AND PROCEDURES

This chapter is written to point out the few sections of Chapter 3 of the main report which should be up-dated in order to correspond with ETOG-3.

3.1 LIMITATIONS

Program restrictions given on p. 3-1 through p. 3-3 need very few changes. ETOG-3 allows 500 resolved resonances as a maximum.

Secondary Energy Distribution Laws 2, 4, 6 and 8 no longer have any official meaning (programming has not been removed). Some enlargement of storage has occurred for LF=1, but a simple description of the limits is not possible. A total tabulation of about 8000 points is the largest that can be handled. This is lowered somewhat if storage has been pre-empted for other features of ENDF/B data. Messages are printed out to show overflows.

3.2 INPUT FORMAT

With regard to Sections 3.3.2.4 and 3.3.4.3, ETOG-3 has always been run in BCD (MODE=3) mode. The binary mode has not been tested in the new ETOG version.

One note of interest is that smooth cross-section information in MUFT format is not possible in the full sense of ENDF/B definitions, if resolved resonance parameters are used to represent part of the cross sections in the data files.

Two alterations have been made in the unresolved resonance treatment in ETOG, with the viewpoint of closer conformation with Appendix D of Reference 7.

Quoting from that Appendix once more:

Cross Sections in the Unresolved Region

a. Elastic Scattering Cross Section

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

$$\sigma_{n,n}^l(E) = \frac{4\pi}{k^2} \sum_J^{NJS} g_J (2l+1) \sin^2 \phi_l$$

$$+ \frac{2\pi^2}{k^2} \sum_J^{NJS} \frac{g_J}{D_{l,J}} \left[\frac{\Gamma_n \Gamma_n}{\Gamma} \right]_{l,J} - 2 \bar{\Gamma}_{n,l,J} \sin^2 \phi_l$$

Notice that there is a phase angle dependence in the elastic scatter of the form $\sin \phi_l$. Without any change of the basic MC²[11] method used in ETOG, this $\sin \phi_l$ dependence shown has been introduced in place of constants previously used. These changes led to a few-percent improvement in results

in the kilovolt range. Tests with TEDIUM^[17] indicate that the ENDF/B prescription is numerically equivalent to ETOG, provided that "SIGP" is input (pp. 3-4 and 3-9 of the main report) as a large positive number. Conventional input has been $+10^7$ for SIGP. The effects of the $\sin \phi_\ell$ dependence in U-238 processing is shown in Chapter 6 of this supplement.

The sample input (p. 3-19 of the main report) must be modernized to MAT 1159 (Card 1, Col. 7-10) and Tape 308 (Card 2, Col. 3-5)--see p. 3-4 of this report.

The new LASER^[16] library option can be described for input in terms of changes in the MUFT-4 library option controls. This does not provide the thermal library data, of course. Referring to p. 3-9 of the main report, the special LASER requirements are:

MAXG = 50

IEU = 8

IPUN = 3

TITLE SAMPLE PROBLEM FOR SUPPLEMENT TO WCAP-3845-1 ANALYST _____ DATE JUNE 1973

73 76

ADDRESS MATERIAL 1159 PU-239 PHONE _____ L.S. NO. _____ LABEL _____ SHEET 1 OF 1

1	2	3	4	5	6	7	8	9	0	NO.
1	1159	21	1	0.0	0.0001	0.2600	1.0E+07			1
308	3	2	99	2	4	0	0	1		2
										3
										4
										5
										6
										7
										8
										9
										0

3.3 OUTPUT FORMAT

3.3.1 PRINTED OUTPUT

Note that the infinitely dilute integral edit now has the elastic scattering integral included. For convenience, ZA and MAT are now shown on this edit.

3.3.2 PUNCHED CARD OUTPUT

ETOG-3 automatically gives the bonus of a MUFT-5 punch whenever MUFT-4 is specified. The MUFT-4 punch comes first, and MUFT-5 after; each is partitioned by an ENDFILE statement in FORTRAN.

Large library handling requires use of permanent files for "punched" output, and the use of film for printed output. Currently this is achieved on the CDC 7600 by the execution card

```
ETOG3(,,FILMPR,,SAVPUN).
```

The file FILMPR is automatically sent to a fiche-making machine, and SAVPUN is preserved as a user file for later library manipulation. No actual cards are punched, and only the system printout called a "dayfile" comes out on paper. Similar dispensing with card handling is available on other modern computers.

3 3.3 SAMPLE PROBLEM OUTPUT

The following pages (3-7 through 3-43) provide the new example of output corresponding to the old example on pp. 3-44 through 3-73 of the main report. These show the changes due to use of ENDF/B Version-III data

and due to processing by ETOG-3, in combination. These results may be useful for someone implementing ETOG-3. They should not be used to draw any quantitative conclusions concerning either ENDF/B or ETOG changes. This output is the result of running the control data shown on p. 3-4. As in the original ETOG report, this sample of output represents only a third of the actual printout.

*** ETOS ***

GAM 2 FILE 21 HAS BEEN CREATED FROM ENDF/B MATERIAL 1159 ON TAPE 308
THE DECK HAS BEEN CREATED USING THE ETOS OPTIONS LISTED BELOW.
THE STANDARD 99 GROUP GAM-2 STRUCTURE IS GENERATED INTERNALLY
WEIGHTING FUNCTION IS 1/E JOINED TO A FISSION SPECTRUM
RESONANCE PARAMETER CARDS ARE CONSTRUCTED IF POSSIBLE
THE J(SPIN) VALUE FOR WHICH UNRESOLVED RESONANCE PARAMETER CARDS ARE DESIRED IS 0.00
THE RESONANCE SCATTERING IS CALCULATED FROM ENDF/B TAPE AND ADDED TO SMOOTH
MINIMUM VALUE OF EPSILON FOR COMBINING TWO TAB1 FUNCTIONS IS 1.0000E-04
MAXIMUM VALUE OF EPSILON FOR COMBINING TWO TAB1 FUNCTIONS IS 2.6000E-01
POTENTIAL SCATTERING CROSS SECTION (PER ABSORBER ATOM) OF NON RESONANCE ISOTOPES IS 1.0000E+

*** ETOG ***

TAPE NO.	MATERIAL NO.	CODE	MULTIGROUP	MATERIAL NO.	NUMBER	HIGHEST INELASTIC	GROUP INFORMATION	LOWEST RESONANCE
308	1159	GAM-2	LETHARGY RANGE	21	99	99		1
GROUP	ENERGY RANGE	LETHARGY RANGE	MULTIGROUP STRUCTURE	GROUP	ENERGY RANGE	LETHARGY RANGE		
1	1.3499E+07 - 1.4918E+07	- .400 -	- .300	37	3.5883E+05 - 4.0762E+05	3.200 -	3.300	
2	1.2214E+07 - 1.3439E+07	- .300 -	- .200	38	3.3373E+05 - 3.6883E+05	3.300 -	3.400	
3	1.1052E+07 - 1.2214E+07	- .200 -	- .100	39	3.0197E+05 - 3.3373E+05	3.400 -	3.500	
4	1.0000E+07 - 1.1052E+07	- .100 -	0.000	40	2.7324E+05 - 3.0197E+05	3.500 -	3.600	
5	9.0484E+06 - 1.0000E+07	0.000 -	.100	41	2.4724E+05 - 2.7324E+05	3.600 -	3.700	
6	8.1873E+06 - 9.0484E+06	.100 -	.200	42	2.2371E+05 - 2.4724E+05	3.700 -	3.800	
7	7.4092E+06 - 8.1873E+06	.200 -	.300	43	2.0242E+05 - 2.2371E+05	3.800 -	3.900	
8	6.7032E+06 - 7.4092E+06	.300 -	.400	44	1.8316E+05 - 2.0242E+05	3.900 -	4.000	
9	6.0653E+06 - 6.7032E+06	.400 -	.500	45	1.6573E+05 - 1.8316E+05	4.000 -	4.100	
10	5.4881E+06 - 6.0653E+06	.500 -	.600	46	1.4995E+05 - 1.6573E+05	4.100 -	4.200	
11	4.9659E+06 - 5.4881E+06	.600 -	.700	47	1.3569E+05 - 1.4995E+05	4.200 -	4.300	
12	4.4933E+06 - 4.9659E+06	.700 -	.800	48	1.2277E+05 - 1.3569E+05	4.300 -	4.400	
13	4.0657E+06 - 4.4933E+06	.800 -	.900	49	1.1109E+05 - 1.2277E+05	4.400 -	4.500	
14	3.6788E+06 - 4.0657E+06	.900 -	1.000	50	8.6517E+04 - 1.1109E+05	4.500 -	4.750	
15	3.3287E+06 - 3.6788E+06	1.000 -	1.100	51	6.7379E+04 - 8.6517E+04	4.750 -	5.000	
16	3.0119E+06 - 3.3287E+06	1.100 -	1.200	52	5.2475E+04 - 6.7379E+04	5.000 -	5.250	
17	2.7253E+06 - 3.0119E+06	1.200 -	1.300	53	4.0853E+04 - 5.2475E+04	5.250 -	5.500	
18	2.4660E+06 - 2.7253E+06	1.300 -	1.400	54	3.1829E+04 - 4.0853E+04	5.500 -	5.750	
19	2.2313E+06 - 2.4660E+06	1.400 -	1.500	55	2.4789E+04 - 3.1829E+04	5.750 -	6.000	
20	2.0190E+06 - 2.2313E+06	1.500 -	1.600	56	1.9305E+04 - 2.4789E+04	6.000 -	6.250	
21	1.8268E+06 - 2.0190E+06	1.600 -	1.700	57	1.5134E+04 - 1.9305E+04	6.250 -	6.500	
22	1.6530E+06 - 1.8268E+06	1.700 -	1.800	58	1.1709E+04 - 1.5134E+04	6.500 -	6.750	
23	1.4957E+06 - 1.6530E+06	1.800 -	1.900	59	9.1188E+03 - 1.1709E+04	6.750 -	7.000	
24	1.3534E+06 - 1.4957E+06	1.900 -	2.000	60	7.1017E+03 - 9.1188E+03	7.000 -	7.250	
25	1.2246E+06 - 1.3534E+06	2.000 -	2.100	61	5.5308E+03 - 7.1017E+03	7.250 -	7.500	
26	1.1080E+06 - 1.2246E+06	2.100 -	2.200	62	4.3074E+03 - 5.5308E+03	7.500 -	7.750	
27	1.0026E+06 - 1.1080E+06	2.200 -	2.300	63	3.3546E+03 - 4.3074E+03	7.750 -	8.000	
28	9.0718E+05 - 1.0026E+06	2.300 -	2.400	64	2.6126E+03 - 3.3546E+03	8.000 -	8.250	
29	8.2085E+05 - 9.0718E+05	2.400 -	2.500	65	2.0347E+03 - 2.6126E+03	8.250 -	8.500	
30	7.4274E+05 - 8.2085E+05	2.500 -	2.600	66	1.5946E+03 - 2.0347E+03	8.500 -	8.750	
31	6.7206E+05 - 7.4274E+05	2.600 -	2.700	67	1.2341E+03 - 1.5946E+03	8.750 -	9.000	
32	6.0810E+05 - 6.7206E+05	2.700 -	2.800	68	9.5112E+02 - 1.2341E+03	9.000 -	9.250	
33	5.5023E+05 - 6.0810E+05	2.800 -	2.900	69	7.4852E+02 - 9.5112E+02	9.250 -	9.500	
34	4.9787E+05 - 5.5023E+05	2.900 -	3.000	70	5.8295E+02 - 7.4852E+02	9.500 -	9.750	
35	4.5049E+05 - 4.9787E+05	3.000 -	3.100	71	4.5400E+02 - 5.8295E+02	9.750 -	10.000	
36	4.0762E+05 - 4.5049E+05	3.100 -	3.200	72	3.5358E+02 - 4.5400E+02	10.000 -	10.250	

*** ETOS ***

73	2.7536E+02	- 3.5358E+02	10.250	- 10.500	87	8.3153E+00	- 1.0677E+01	13.750	- 14.000
74	2.1445E+02	- 2.7536E+02	10.500	- 10.750	88	6.4760E+00	- 8.3153E+00	14.000	- 14.250
75	1.6702E+02	- 2.1445E+02	10.750	- 11.000	89	5.0435E+00	- 6.4760E+00	14.250	- 14.500
76	1.3007E+02	- 1.6702E+02	11.000	- 11.250	90	3.9279E+00	- 5.0435E+00	14.500	- 14.750
77	1.0130E+02	- 1.3007E+02	11.250	- 11.500	91	3.0590E+00	- 3.9279E+00	14.750	- 15.000
78	7.8893E+01	- 1.0130E+02	11.500	- 11.750	92	2.3824E+00	- 3.0590E+00	15.000	- 15.250
79	6.1442E+01	- 7.8893E+01	11.750	- 12.000	93	1.8554E+00	- 2.3824E+00	15.250	- 15.500
80	4.7851E+01	- 6.1442E+01	12.000	- 12.250	94	1.4467E+00	- 1.8554E+00	15.500	- 15.750
81	3.7267E+01	- 4.7851E+01	12.250	- 12.500	95	1.1254E+00	- 1.4467E+00	15.750	- 16.000
82	2.9023E+01	- 3.7267E+01	12.500	- 12.750	96	8.7642E-01	- 1.1254E+00	16.000	- 16.250
83	2.2603E+01	- 2.9023E+01	12.750	- 13.000	97	6.8256E-01	- 8.7642E-01	16.250	- 16.500
84	1.7603E+01	- 2.2603E+01	13.000	- 13.250	98	5.3158E-01	- 6.8256E-01	16.500	- 16.750
85	1.3710E+01	- 1.7603E+01	13.250	- 13.500	99	4.1399E-01	- 5.3158E-01	16.750	- 17.000
86	1.0677E+01	- 1.3710E+01	13.500	- 13.750					

*** ET06 ***

WEIGHTING FUNCTION
IS GENERATED AS FOLLOWS

ENERGY	WEIGHT	ENERGY	WEIGHT	ENERGY	WEIGHT	ENERGY	WEIGHT
4.0985E-01	1.1416E+07	6.7379E+04	6.3442E+01	9.5505E+04	9.6278E+01	1.2353E+05	1.2191E+02
2.3613E+05	2.1315E+02	2.9238E+05	2.5251E+02	3.8853E+05	2.8008E+02	4.0488E+05	3.2010E+02
4.7519E+05	3.5550E+02	5.4551E+05	3.8617E+02	6.1582E+05	4.1252E+02	6.8651E+05	4.3492E+02
7.7402E+05	4.5790E+02	8.6191E+05	4.7588E+02	9.7178E+05	4.9218E+02	1.1191E+06	5.0429E+02
1.2808E+06	5.0887E+02	1.7958E+06	4.7610E+02	2.1211E+06	4.4891E+02	2.6970E+06	3.5226E+02
3.0349E+06	3.0398E+02	3.3729E+06	2.5906E+02	3.7953E+06	2.0918E+02	4.2178E+06	1.6681E+02
4.7459E+05	1.2397E+02	5.2739E+06	9.0986E+01	5.9340E+06	6.0954E+01	6.5941E+06	4.0329E+01
7.4192E+06	2.3732E+01	8.2443E+06	1.3792E+01	9.2756E+06	6.9319E+03	1.0307E+07	3.4111E+03
1.1596E+07	1.3940E+00	1.2885E+07	5.5261E-01	1.4437E+07	1.7843E-01	1.5037E+07	1.1851E-01

NBT	JNT	NBT	JNT	NBT	JNT	NBT	JNT
2	5	4	5	14	3	19	2
20	3	36	4				

WEIGHTING FUNCTION
INTERPOLATION TABLE

*** EFG ***

THE (TAPE) DESCRIPTION OF MATERIAL 1153 IS -
PU-239 GE, HARD, ANG EVAL-AUG71 LEONARD(BWH), J.R. SMITH(ANG)
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.R. SMITH (AEROMET-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 PF 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 (AI-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, R.F. 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 MF=1,2,4,18,51 TO 91,102

*** ETOS ***

RESOLVED
RESONANCE CALCULATION RESULTS
RESOLVED (THERMAL AND NEGATIVE ENERGY) RESONANCES BELOW GROUP STRUCTURE

E-ZERO	GAMMA-N	GAMMA-G	GAMMA-F	G-FACTOR	NPOIM
-2.2000E-01	2.3311E-05	4.0000E-02	5.0000E-01	5.0000E-01	1
2.9600E-01	1.2105E-04	3.9000E-02	6.0000E-02	5.0000E-01	1

*** ET03 ***

RESOLVED
 RESONANCE CALCULATION RESULTS
 ACCEPTED RESONANCES - GAM PARAMETERS PRODUCED

NO.	Σ-ZERO	GAMMA-N	GAMMA-G	GAMMA-F	G-F-FACTOR	NROIM
1	7.8130E+00	1.2886E-03	4.1100E-02	4.4300E-02	5.0000E-01	1
2	1.0941E+01	2.9108E-03	4.6300E-02	1.5100E-01	5.0000E-01	1
3	1.1890E+01	1.6206E-03	4.0900E-02	2.4200E-02	5.0000E-01	1
4	1.4310E+01	9.4571E-04	3.7800E-02	6.3200E-02	5.0000E-01	1
5	1.4685E+01	2.8779E-03	3.7300E-02	2.9700E-02	5.0000E-01	1
6	1.5470E+01	1.0030E-03	3.9000E-02	6.8330E-01	5.0000E-01	1
7	1.7650E+01	2.7560E-03	3.9200E-02	3.2800E-02	5.0000E-01	1
8	2.2266E+01	4.0581E-03	4.9000E-02	6.7300E-02	5.0000E-01	1
9	2.3905E+01	1.2712E-04	3.3000E-02	3.7000E-02	5.0000E-01	2
10	2.6255E+01	2.2494E-03	4.0200E-02	4.0800E-02	5.0000E-01	1
11	2.7260E+01	2.0884E-04	3.9000E-02	2.0000E-03	5.0000E-01	2
12	3.2328E+01	4.2643E-04	4.6000E-02	1.2000E-01	5.0000E-01	2
13	3.5460E+01	4.0612E-04	4.1900E-02	5.2000E-03	5.0000E-01	2
14	4.1430E+01	6.4366E-03	4.2000E-02	4.0000E-03	5.0000E-01	1
15	4.1685E+01	1.9369E-03	6.0000E-02	4.4000E-02	5.0000E-01	1
16	4.4500E+01	1.0340E-02	3.9000E-02	3.9000E-03	5.0000E-01	1
17	4.7640E+01	2.2777E-03	3.9000E-02	2.2000E-01	5.0000E-01	1
18	4.9700E+01	1.9035E-03	6.1900E-02	7.4600E-01	5.0000E-01	1
19	5.0113E+01	4.6722E-03	4.3500E-02	1.1000E-02	5.0000E-01	2
20	5.2620E+01	1.6421E-02	4.5000E-02	7.4000E-03	5.0000E-01	1
21	5.5660E+01	2.2028E-03	3.7000E-02	1.8500E-02	5.0000E-01	2
22	5.7550E+01	5.3103E-03	4.5000E-02	5.8000E-01	5.0000E-01	1
23	5.7900E+01	4.8699E-03	3.9000E-02	9.5000E-01	5.0000E-01	1
24	5.9254E+01	7.3885E-03	3.9000E-02	1.0000E-01	5.0000E-01	1
25	6.0970E+01	1.1712E-02	5.2999E-02	6.7360E+00	5.0000E-01	1
26	6.3110E+01	1.1361E-03	6.0000E-02	9.2000E-02	5.0000E-01	2
27	6.5550E+01	1.9855E-03	3.0000E-02	1.0000E-01	5.0000E-01	2
28	6.5790E+01	1.7931E-02	6.1200E-02	5.4000E-02	5.0000E-01	1
29	7.4087E+01	5.1783E-03	4.0000E-02	3.0000E-02	5.0000E-01	2
30	7.5003E+01	3.2910E-02	3.7500E-02	7.6500E-02	5.0000E-01	1
31	8.1600E+01	2.2854E-03	3.9000E-02	1.2000E+00	5.0000E-01	1
32	8.2650E+01	1.9092E-03	3.9000E-02	1.2000E+00	5.0000E-01	1
33	8.2710E+01	4.6209E-04	3.9000E-02	0.	5.0000E-01	2
34	8.5270E+01	2.5302E-02	3.9000E-02	2.2550E+00	5.0000E-01	1
35	9.5535E+01	1.2228E-02	4.1000E-02	1.1000E-02	5.0000E-01	2
36	9.0770E+01	2.1845E-02	3.9000E-02	7.7800E-03	5.0000E-01	2
37	9.2980E+01	1.1571E-03	4.9000E-02	8.5000E-03	5.0000E-01	2
38	9.5430E+01	2.7353E-03	3.5000E-02	1.3500E-02	5.0000E-01	2
39	9.5627E+01	7.6673E-03	3.9000E-02	1.8000E+00	5.0000E-01	1

*** ETOS ***

UNRESOLVED
RESONANCE CALCULATION RESULTS
GAM PARAMETERS

NONE

*** ET05 ***

RESOLVED
 RESONANCE CALCULATION RESULTS
 THE FOLLOWING CROSS SECTIONS ARE ADDED TO THE SMOOTH VALUES TO ACCOUNT FOR
 RESOLVED (THERMAL AND NEGATIVE ENERGY) RESONANCES BELOW GROUP STRUCTURE

GROUP	CAPTURE	FISSION	SCATTER	GROUP	CAPTURE	FISSION	SCATTER
1	0.	0.	0.	51	0.	0.	0.
2	0.	0.	0.	52	0.	0.	0.
3	0.	0.	0.	53	0.	0.	0.
4	0.	0.	0.	54	0.	0.	0.
5	0.	0.	0.	55	0.	0.	0.
6	0.	0.	0.	56	0.	0.	0.
7	0.	0.	0.	57	0.	0.	0.
8	0.	0.	0.	58	0.	0.	0.
9	0.	0.	0.	59	0.	0.	0.
10	0.	0.	0.	60	0.	0.	0.
11	0.	0.	0.	61	0.	0.	0.
12	0.	0.	0.	62	0.	0.	0.
13	0.	0.	0.	63	0.	0.	0.
14	0.	0.	0.	64	0.	0.	0.
15	0.	0.	0.	65	0.	0.	0.
16	0.	0.	0.	66	0.	0.	0.
17	0.	0.	0.	67	0.	0.	0.
18	0.	0.	0.	68	0.	0.	0.
19	0.	0.	0.	69	0.	0.	0.
20	0.	0.	0.	70	0.	0.	0.
21	0.	0.	0.	71	0.	0.	0.
22	0.	0.	0.	72	0.	0.	0.
23	0.	0.	0.	73	8.3879E-07	2.9992E-06	8.4152E-04
24	0.	0.	0.	74	3.8717E-06	1.3839E-05	2.9081E-03
25	0.	0.	0.	75	7.2368E-06	2.5853E-05	3.7362E-03
26	0.	0.	0.	76	1.3528E-05	4.8293E-05	7.4339E-03
27	0.	0.	0.	77	2.5294E-05	9.0210E-05	6.1665E-03
28	0.	0.	0.	78	4.7304E-05	1.6855E-04	7.9218E-03
29	0.	0.	0.	79	8.8491E-05	3.1473E-04	1.0182E-02
30	0.	0.	0.	80	1.6560E-04	5.8780E-04	1.3096E-02
31	0.	0.	0.	81	3.1006E-04	1.0977E-03	1.6825E-02
32	0.	0.	0.	82	5.8089E-04	2.0498E-03	2.1637E-02
33	0.	0.	0.	83	1.0992E-03	3.8272E-03	2.7866E-02
34	0.	0.	0.	84	2.0444E-03	7.1443E-03	3.5823E-02
35	0.	0.	0.	85	3.8427E-03	1.3336E-02	4.6176E-02
36	0.	0.	0.	86	7.2358E-03	2.4888E-02	5.9537E-02
37	0.	0.	0.	87	1.3658E-02	4.5441E-02	7.6835E-02
38	0.	0.	0.	88	2.5862E-02	8.6649E-02	9.9412E-02
39	0.	0.	0.	89	4.9179E-02	1.6168E-01	1.2884E-01

*** ET03 ***

RESOLVED
 RESONANCE CALCULATION RESULTS
 TO AVOID COUNTING THE ASYMMETRIC PART OF THE BREIT-WIGNER FORMULA TWICE.
 IT IS IMPLICITLY CONTAINED WITHIN THE END-7B (FILE 3) SMOOTH DATA AND EXPLICITLY CALCULATED BY GAM-2.

GROUP	CAPTURE	FISSION	GROUP	CAPTURE	FISSION	GROUP	CAPTURE	FISSION
1	0.	0.	34	0.	0.	57	0.	0.
2	0.	0.	35	0.	0.	58	0.	0.
3	0.	0.	36	0.	0.	59	0.	0.
4	0.	0.	37	0.	0.	70	0.	0.
5	0.	0.	38	0.	0.	71	0.	0.
6	0.	0.	39	0.	0.	72	0.	0.
7	0.	0.	40	0.	0.	73	0.	0.
8	0.	0.	41	0.	0.	74	0.	0.
9	0.	0.	42	0.	0.	75	0.	0.
10	0.	0.	43	0.	0.	76	0.	0.
11	0.	0.	44	0.	0.	77	0.	0.
12	0.	0.	45	0.	0.	78	0.	0.
13	0.	0.	46	0.	0.	79	0.	0.
14	0.	0.	47	0.	0.	80	0.	0.
15	0.	0.	48	0.	0.	81	0.	0.
16	0.	0.	49	0.	0.	82	0.	0.
17	0.	0.	50	0.	0.	83	0.	0.
18	0.	0.	51	0.	0.	84	0.	0.
19	0.	0.	52	0.	0.	85	0.	0.
20	0.	0.	53	0.	0.	86	0.	0.
21	0.	0.	54	0.	0.	87	0.	0.
22	0.	0.	55	0.	0.	88	0.	0.
23	0.	0.	56	0.	0.	89	0.	0.
24	0.	0.	57	0.	0.	90	0.	0.
25	0.	0.	58	0.	0.	91	0.	0.
26	0.	0.	59	0.	0.	92	0.	0.
27	0.	0.	60	0.	0.	93	0.	0.
28	0.	0.	61	0.	0.	94	0.	0.
29	0.	0.	62	0.	0.	95	0.	0.
30	0.	0.	63	0.	0.	96	2.3966E-01	1.2284E+00
31	0.	0.	64	0.	0.	97	5.0468E-01	2.5889E+00
32	0.	0.	65	0.	0.	98	5.7656E-01	2.9588E+00
33	0.	0.	66	0.	0.	99	6.5932E-01	3.3815E+00

*** ETOS ***

RESONANCE CALCULATION RESULTS

THE FOLLOWING CROSS SECTIONS ARE SUBTRACTED FROM THE SMOOTH VALUES BELOW THE END-78 RESOLVED RANGE TO AVOID COUNTING THE SYMMETRIC PART OF THE BREIT-WIGNER FORMULA TWICE.
IT IS IMPLICITLY CONTAINED WITHIN THE END-78 (FILE 3) SMOOTH DATA AND EXPLICITLY CALCULATED BY GAM-2.

GROUP	CAPTURE	FISSION	GROUP	CAPTURE	FISSION	GROUP	CAPTURE	FISSION	GROUP	CAPTURE	FISSION
1	0.	0.	34	0.	0.	67	0.	0.	96	8.11E-02	2.6077E-01
2	0.	0.	35	0.	0.	68	0.	0.	97	1.4978E-01	4.8665E-01
3	0.	0.	36	0.	0.	69	0.	0.	98	1.4504E-01	4.7552E-01
4	0.	0.	37	0.	0.	70	0.	0.	99	1.4153E-01	4.6897E-01
5	0.	0.	38	0.	0.	71	0.	0.			
6	0.	0.	39	0.	0.	72	0.	0.			
7	0.	0.	40	0.	0.	73	0.	0.			
8	0.	0.	41	0.	0.	74	0.	0.			
9	0.	0.	42	0.	0.	75	0.	0.			
10	0.	0.	43	0.	0.	76	0.	0.			
11	0.	0.	44	0.	0.	77	0.	0.			
12	0.	0.	45	0.	0.	78	0.	0.			
13	0.	0.	46	0.	0.	79	0.	0.			
14	0.	0.	47	0.	0.	80	0.	0.			
15	0.	0.	48	0.	0.	81	0.	0.			
16	0.	0.	49	0.	0.	82	0.	0.			
17	0.	0.	50	0.	0.	83	0.	0.			
18	0.	0.	51	0.	0.	84	0.	0.			
19	0.	0.	52	0.	0.	85	0.	0.			
20	0.	0.	53	0.	0.	86	0.	0.			
21	0.	0.	54	0.	0.	87	0.	0.			
22	0.	0.	55	0.	0.	88	0.	0.			
23	0.	0.	56	0.	0.	89	0.	0.			
24	0.	0.	57	0.	0.	90	0.	0.			
25	0.	0.	58	0.	0.	91	0.	0.			
26	0.	0.	59	0.	0.	92	0.	0.			
27	0.	0.	60	0.	0.	93	0.	0.			
28	0.	0.	61	0.	0.	94	0.	0.			
29	0.	0.	62	0.	0.	95	0.	0.			
30	0.	0.	63	0.	0.						
31	0.	0.	64	0.	0.						
32	0.	0.	65	0.	0.						
33	0.	0.	66	0.	0.						

*** ETOS ***

UNRESOLVED
RESONANCE CALCULATION RESULTS
SECTIONS ARE ADDED TO THE SMOOTH VALUES TO ACCOUNT FOR
UNRESOLVED RESONANCE CONTRIBUTIONS

GROUP	SCATTER	GROUP	CAPTURE	FISSION	SCATTER	GROUP	CAPTURE	FISSION	SCATTER
1	0.	51	0.	0.	0.	51	0.	0.	0.
2	0.	52	0.	0.	0.	52	0.	0.	0.
3	0.	53	0.	0.	0.	53	0.	0.	0.
4	0.	54	0.	0.	0.	54	0.	0.	0.
5	0.	55	0.	0.	0.	55	2.2866E-02	6.1599E-02	3.7367E-01
6	0.	56	0.	0.	0.	56	7.2441E-01	1.8024E+00	1.1023E+01
7	0.	57	0.	0.	0.	57	8.2230E-01	1.8355E+00	1.1164E+01
8	0.	58	0.	0.	0.	58	9.6574E-01	1.9516E+00	1.1399E+01
9	0.	59	0.	0.	0.	59	1.1706E+00	2.0063E+00	1.1664E+01
10	0.	60	0.	0.	0.	60	1.3769E+00	2.3363E+00	1.1941E+01
11	0.	61	0.	0.	0.	61	1.8149E+00	2.1521E+00	1.2424E+01
12	0.	62	0.	0.	0.	62	2.0633E+00	2.4678E+00	1.2554E+01
13	0.	63	0.	0.	0.	63	2.4220E+00	2.8453E+00	1.2788E+01
14	0.	64	0.	0.	0.	64	2.7267E+00	3.4833E+00	1.2922E+01
15	0.	65	0.	0.	0.	65	3.5123E+00	3.0364E+00	1.3173E+01
16	0.	66	0.	0.	0.	66	3.9802E+00	3.5095E+00	1.3256E+01
17	0.	67	0.	0.	0.	67	3.1289E+00	5.8278E+00	1.2294E+01
18	0.	68	0.	0.	0.	68	4.3284E+00	6.2345E+00	1.2961E+01
19	0.	69	0.	0.	0.	69	5.0272E+00	6.3972E+00	1.2996E+01
20	0.	70	0.	0.	0.	70	7.1135E+00	6.2381E+00	1.3851E+01
21	0.	71	0.	0.	0.	71	7.6313E+00	1.4496E+01	1.5979E+01
22	0.	72	0.	0.	0.	72	5.6935E+00	1.0110E+01	1.2161E+01
23	0.	73	0.	0.	0.	73	8.1221E+00	5.7021E+00	9.8299E+00
24	0.	74	0.	0.	0.	74	0.	0.	0.
25	0.	75	0.	0.	0.	75	0.	0.	0.
26	0.	76	0.	0.	0.	76	0.	0.	0.
27	0.	77	0.	0.	0.	77	0.	0.	0.
28	0.	78	0.	0.	0.	78	0.	0.	0.
29	0.	79	0.	0.	0.	79	0.	0.	0.
30	0.	80	0.	0.	0.	80	0.	0.	0.
31	0.	81	0.	0.	0.	81	0.	0.	0.
32	0.	82	0.	0.	0.	82	0.	0.	0.
33	0.	83	0.	0.	0.	83	0.	0.	0.
34	0.	84	0.	0.	0.	84	0.	0.	0.
35	0.	85	0.	0.	0.	85	0.	0.	0.
36	0.	86	0.	0.	0.	86	0.	0.	0.
37	0.	87	0.	0.	0.	87	0.	0.	0.
38	0.	88	0.	0.	0.	88	0.	0.	0.
39	0.	89	0.	0.	0.	89	0.	0.	0.

*** ETOG ***

TIMING NOTES

SECTION	ELAPSED SEC	CP SEC	PP SEC
OVERLAY (ETOG,2,0)	18.519	123.657	0.000
INF2	0.000	0.600	0.000
TMF2	0.000	.001	0.000
RESS	.077	.238	0.000
RESO	10.725	103.943	0.000
RESR	0.000	.069	0.000
RESU	.309	4.112	0.000
	7.407	15.294	0.000
TOTAL TIME USED	139.837	0.000	

*** ET06 ***

ENDF/B FILE 3 SMOOTH ELASTIC

GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC																																																																																																																																																																																						
1	2.7095E+00	2	2.6133E+00	3	2.5906E+00	4	2.6354E+00	5	2.7425E+00	6	2.8957E+00	7	3.0938E+00	8	3.3062E+00	9	3.5170E+00	10	3.7153E+00	11	3.8723E+00	12	3.9669E+00	13	3.9758E+00	14	3.9335E+00	15	3.8595E+00	16	3.7587E+00	17	3.6474E+00	18	3.5271E+00	19	3.4147E+00	20	3.3109E+00	21	3.2452E+00	22	3.2074E+00	23	3.2116E+00	24	3.2567E+00	25	3.3909E+00	26	3.5592E+00	27	3.7665E+00	28	3.9933E+00	29	4.2436E+00	30	4.5125E+00	31	4.8179E+00	32	5.1497E+00	33	5.4593E+00	34	5.7970E+00	35	6.1233E+00	36	6.4294E+00	37	6.6790E+00	38	6.9237E+00	39	7.1748E+00	40	7.4329E+00	41	7.6935E+00	42	7.9661E+00	43	8.1075E+00	44	8.3160E+00	45	8.5211E+00	46	8.7158E+00	47	8.9176E+00	48	9.1039E+00	49	9.3024E+00	50	9.5990E+00	51	1.0048E+01	52	1.0425E+01	53	1.0693E+01	54	1.0878E+01	55	1.0535E+01	56	-3.0915E-01	57	-3.0065E-01	58	-2.9093E-01	59	-2.6422E-01	60	-5.7355E-02	61	0.	62	0.	63	0.	64	0.	65	0.	66	0.	67	0.	68	0.	69	0.	70	0.	71	0.	72	0.	73	-5.1345E-01	74	-1.1193E+00	75	-3.8592E-01	76	1.8528E-01	77	6.3013E-01	78	9.7657E-01	79	1.2465E+00	80	1.4565E+00	81	1.6202E+00	82	1.7476E+00	83	1.8469E+00	84	1.9241E+00	85	1.9844E+00	86	2.0312E+00	87	2.0678E+00	88	2.0993E+00	89	2.1268E+00	90	2.1506E+00	91	2.1624E+00	92	2.1756E+00	93	2.1808E+00	94	2.1800E+00	95	2.1790E+00	96	2.1789E+00	97	1.1581E+01	98	1.2427E+01	99	1.3977E+01	100	1.5811E+01

*** ET0G ***

ENDF/B FILE 3 SMOOTH N,GAMMA REACTION

GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC
1	2.5527E-03	2	2.5058E-03	3	2.4908E-03	4	2.1851E-03	5	1.3122E-03	6	7.4341E-04	7	1.6567E-03
7	4.3918E-04	8	3.4112E-04	9	4.3334E-04	10	7.5266E-04	11	1.2794E-03	12	1.6567E-03	13	1.8303E-03
14	1.8303E-03	15	2.0490E-03	16	2.3221E-03	17	2.7239E-03	18	3.3159E-03	19	4.3963E-03	20	5.2696E-03
25	1.5705E-02	26	1.9167E-02	27	2.3403E-02	28	2.8643E-02	29	3.5897E-02	30	4.7409E-02	31	6.4794E-02
32	7.6595E-02	33	9.9137E-02	34	1.3161E-01	35	1.7975E-01	36	2.4747E-01	37	3.5897E-01	38	5.2696E-01
43	2.0430E-01	44	2.8339E-01	45	3.8357E-01	46	5.2011E-01	47	7.2730E-01	48	1.0175E-01	49	1.4202E-01
50	2.4202E-01	51	3.2025E-01	52	4.3039E-01	53	5.8039E-01	54	7.9755E-01	55	1.0951E-01	56	1.4961E+00
61	0.	62	0.	63	0.	64	0.	65	0.	66	0.	67	0.
73	0.	74	0.	75	8.1559E-01	76	1.1328E-01	77	1.5951E-02	78	0.	79	0.
80	0.	81	0.	82	0.	83	0.	84	0.	85	3.8675E+00	86	0.
85	3.8675E+00	87	2.3228E+00	88	2.3228E+00	89	4.7153E+00	90	4.3541E-01	91	0.	92	2.5027E-01
91	0.	92	2.5027E-01	93	1.4531E+00	94	3.4253E+00	95	5.3710E+00	96	1.1986E+01	97	2.3228E+01
97	2.3228E+01	98	4.8487E+01	99	1.4961E+02								

*** ETOS ***

ENDF/B FILE 2 RESONANCE CONTRIBUTION TO N,GAMMA

GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC
1	0.	2	0.	3	0.	4	0.	5	0.	6	0.
7	0.	8	0.	9	0.	10	0.	11	0.	12	0.
13	0.	14	0.	15	0.	16	0.	17	0.	18	0.
19	0.	20	0.	21	0.	22	0.	23	0.	24	0.
25	0.	25	0.	27	0.	28	0.	29	0.	30	0.
31	0.	32	0.	33	0.	34	0.	35	0.	36	0.
37	0.	38	0.	39	0.	40	0.	41	0.	42	0.
43	0.	44	0.	45	0.	46	0.	47	0.	48	0.
49	0.	50	0.	51	0.	52	0.	53	0.	54	0.
55	2.2866E-02	56	7.2441E-01	57	3.2230E-01	58	9.6574E-01	59	1.1706E+00	60	1.3769
61	1.8149E+00	62	2.0633E+00	63	2.4220E+00	64	2.7267E+00	65	3.5123E+00	66	3.9852
67	3.1289E+00	68	4.3284E+00	69	5.0272E+00	70	7.1135E+00	71	7.6313E+00	72	5.6935
73	1.3929E+01	74	1.8505E+01	75	9.8543E+00	76	2.0222E+01	77	2.1655E+01	78	2.5225
79	3.3910E+01	80	5.3738E+01	81	5.2593E+01	82	3.5095E+00	83	1.7475E+01	84	5.6712
85	8.1668E+01	85	9.8556E+01	87	7.6344E+00	88	7.9923E+01	89	1.1924E+00	90	7.5305
91	7.2407E-01	92	8.6050E-01	93	1.2053E+00	94	1.9362E+00	95	3.5058E+00	96	2.6453
97	0.	98	0.	99	0.						

*** EIOS ***

MULTI- GROUP	CAPTURE	FISSION	ABSORPTION	SCATTERING	ANISOTROPIC SCATTERING	INELASTIC SCATTERING	N-2N	NEUTRONS PER FISSION
1	2.2100E-02	2.5456E+00	2.5677E+00	2.7095E+00	2.4670E+00	4.4791E-01	9.8524E-02	4.9035E+00
2	1.2742E-02	2.3405E+00	2.3532E+00	2.6133E+00	2.3511E+00	7.0339E-01	1.5173E-01	4.7503E+00
3	8.2239E-03	2.1462E+00	2.1544E+00	2.5906E+00	2.3160E+00	9.3099E-01	1.5965E-01	4.5935E+00
4	5.6780E-03	2.1688E+00	2.1745E+00	2.6354E+00	2.3571E+00	9.3463E-01	1.5741E-01	4.4504E+00
5	3.4786E-03	2.3054E+00	2.3088E+00	2.7425E+00	2.4589E+00	8.3359E-01	1.5147E-01	4.3071E+00
5	2.3318E-03	2.3650E+00	2.3673E+00	2.8957E+00	2.6058E+00	8.2560E-01	1.3901E-01	4.1715E+00
7	1.6476E-03	2.3017E+00	2.3033E+00	3.0939E+00	2.7922E+00	9.5254E-01	1.1788E-01	4.0462E+00
8	1.2849E-03	2.1226E+00	2.1239E+00	3.3002E+00	2.9820E+00	1.2289E+00	7.9799E-02	3.9279E+00
9	1.2002E-03	1.8249E+00	1.8261E+00	3.5170E+00	3.1662E+00	1.6684E+00	2.8669E-02	3.8205E+00
10	1.4028E-03	1.6742E+00	1.6756E+00	3.7153E+00	3.3305E+00	1.9546E+00	2.3065E-03	3.7223E+00
11	1.5929E-03	1.6659E+00	1.6675E+00	3.8723E+00	3.4579E+00	2.0858E+00	0.	3.6253E+00
12	1.6508E-03	1.6821E+00	1.6837E+00	3.9669E+00	3.5170E+00	2.1867E+00	0.	3.5562E+00
13	1.8303E-03	1.7189E+00	1.7207E+00	3.9758E+00	3.4928E+00	2.2515E+00	0.	3.4849E+00
14	2.0490E-03	1.7600E+00	1.7621E+00	3.9335E+00	3.4195E+00	2.3024E+00	0.	3.4211E+00
15	2.3221E-03	1.8023E+00	1.8046E+00	3.8585E+00	3.3172E+00	2.3540E+00	0.	3.3647E+00
16	2.7230E-03	1.8542E+00	1.8569E+00	3.7587E+00	3.1987E+00	2.3529E+00	0.	3.3135E+00
17	3.3159E-03	1.9509E+00	1.9542E+00	3.6473E+00	3.0666E+00	2.2475E+00	0.	3.2683E+00
18	4.3863E-03	2.0304E+00	2.0348E+00	3.5269E+00	2.9223E+00	2.1357E+00	0.	3.2293E+00
19	5.2696E-03	2.0514E+00	2.0576E+00	3.4145E+00	2.7648E+00	2.0593E+00	0.	3.1933E+00
20	9.0784E-03	2.0576E+00	2.0657E+00	3.3110E+00	2.6090E+00	2.0034E+00	0.	3.1609E+00
21	9.3386E-03	2.0532E+00	2.0625E+00	3.2452E+00	2.4893E+00	1.9356E+00	0.	3.1325E+00
22	1.0205E-02	2.0373E+00	2.0476E+00	3.2074E+00	2.3937E+00	1.8849E+00	0.	3.1079E+00
23	1.1204E-02	1.9856E+00	1.9978E+00	3.2116E+00	2.3361E+00	1.8632E+00	0.	3.0853E+00
24	1.3218E-02	1.8956E+00	1.9088E+00	3.2558E+00	2.2895E+00	1.8815E+00	0.	3.0694E+00
25	1.5705E-02	1.8306E+00	1.8463E+00	3.3809E+00	2.2745E+00	1.8196E+00	0.	3.0471E+00
26	1.9167E-02	1.7812E+00	1.8004E+00	3.5592E+00	2.2747E+00	1.7375E+00	0.	3.0305E+00
27	2.3403E-02	1.7381E+00	1.7615E+00	3.7665E+00	2.2901E+00	1.6704E+00	0.	3.0154E+00
28	2.8643E-02	1.7083E+00	1.7369E+00	3.9933E+00	2.3151E+00	1.6027E+00	0.	3.0024E+00
29	3.5897E-02	1.7020E+00	1.7379E+00	4.2436E+00	2.3509E+00	1.5265E+00	0.	2.9909E+00
30	4.7409E-02	1.6954E+00	1.7428E+00	4.5124E+00	2.3885E+00	1.4506E+00	0.	2.9805E+00
31	6.4794E-02	1.6541E+00	1.7189E+00	4.8179E+00	2.4257E+00	1.3701E+00	0.	2.9712E+00
32	7.6585E-02	1.6194E+00	1.6960E+00	5.1497E+00	2.4669E+00	1.2742E+00	0.	2.9627E+00
33	8.9137E-02	1.6000E+00	1.6891E+00	5.4593E+00	2.4862E+00	1.1880E+00	0.	2.9555E+00
34	1.0061E-01	1.5863E+00	1.6869E+00	5.7870E+00	2.5018E+00	1.0788E+00	0.	2.9481E+00
35	1.1247E-01	1.5767E+00	1.6891E+00	6.1253E+00	2.5188E+00	9.5762E-01	0.	2.9417E+00

*** ET0G ***

TOTAL N,GAMMA

GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC
1	2.5527E-03	2	2.5058E-03	3	2.4909E-03	4	2.1851E-03	5	1.3122E-03	6	7.4341E-04		
7	4.3818E-04	8	3.4112E-04	9	4.3334E-04	10	7.5265E-04	11	1.2794E-03	12	1.6557E-03		
13	1.8303E-03	14	2.0490E-03	15	2.3221E-03	16	2.7230E-03	17	3.3159E-03	18	4.3863E-03		
19	6.2596E-03	20	8.0784E-03	21	9.3386E-03	22	1.0205E-02	23	1.1204E-02	24	1.3218E-02		
25	1.5705E-02	25	1.9167E-02	27	2.3403E-02	28	2.8643E-02	29	3.5977E-02	30	4.7459E-02		
31	6.4794E-02	32	7.6585E-02	33	8.9137E-02	34	1.0061E-01	35	1.1247E-01	36	1.2542E-01		
37	1.3993E-01	38	1.5478E-01	39	1.6844E-01	40	1.7976E-01	41	1.8939E-01	42	1.9755E-01		
43	2.0430E-01	44	2.0839E-01	45	2.1357E-01	46	2.2011E-01	47	2.2730E-01	48	2.3463E-01		
49	2.4202E-01	50	2.5615E-01	51	2.8025E-01	52	3.1939E-01	53	4.0588E-01	54	4.9753E-01		
55	6.1751E-01	56	7.2441E-01	57	8.2230E-01	58	9.6574E-01	59	1.1706E+00	60	1.3769E+00		
61	1.8149E+00	62	2.0633E+00	63	2.4220E+00	64	2.7267E+00	65	3.5123E+00	66	3.9802E+00		
67	3.1289E+00	68	4.3284E+00	69	5.0272E+00	70	7.1135E+00	71	7.6313E+00	72	5.6935E+00		
73	1.3929E+01	74	1.8505E+01	75	1.0670E+01	76	2.1035E+01	77	2.1656E+01	78	2.5225E+01		
79	3.3910E+01	80	5.3738E+01	81	5.2583E+01	82	3.5095E+00	83	1.7475E+01	84	5.6712E+01		
85	8.5535E+01	86	9.8556E+01	87	7.8671E+00	88	8.4639E+01	89	1.6278E+00	90	8.7086E-01		
91	7.2+07E-01	92	1.1108E+00	93	2.6584E+00	94	5.3611E+00	95	8.8758E+00	96	1.4631E+01		
97	2.3228E+01	98	4.8487E+01	99	1.4951E+02								

*** ETOG ***

ENDF/B FILE 3 SMOOTH N,ALPHA REACTION

GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC	GRP	CROSS SEC
1	1.2405E-02	2	7.1892E-03	3	4.4500E-03	4	2.9852E-03	5	2.1351E-03	6	1.5884E-03
7	1.2095E-03	8	9.4376E-04	9	7.6687E-04	10	6.5016E-04	11	5.4351E-04	12	4.4411E-04
13	0.	14	0.	15	0.	16	0.	17	0.	18	0.
19	0.	20	0.	21	0.	22	0.	23	0.	24	0.
25	0.	26	0.	27	0.	28	0.	29	0.	30	0.
31	0.	32	0.	33	0.	34	0.	35	0.	36	0.
37	0.	38	0.	39	0.	40	0.	41	0.	42	0.
43	0.	44	0.	45	0.	46	0.	47	0.	48	0.
49	0.	50	0.	51	0.	52	0.	53	0.	54	0.
55	0.	56	0.	57	0.	58	0.	59	0.	60	0.
61	0.	62	0.	63	0.	64	0.	65	0.	66	0.
67	0.	68	0.	69	0.	70	0.	71	0.	72	0.
73	0.	74	0.	75	0.	76	0.	77	0.	78	0.
79	0.	80	0.	81	0.	82	0.	83	0.	84	0.
85	0.	86	0.	87	0.	88	0.	89	0.	90	0.
91	0.	92	0.	93	0.	94	0.	95	0.	96	0.
97	0.	98	0.	99	0.						

NO DATA IN FILE 3 FOR MATERIAL 1159, REACTION TYPE 108
TAPE HAS BEEN SEARCHED TO MATERIAL 1159, FILE 3, REACTION TYPE 251
CONSEQUENTLY, THERE IS NO N,2*ALPHA REACTION

*** [TOS] ***

ZA= 94239. MAT= 1159

INFINITELY DILUTE RESONANCE INTEGRALS

N,GAMMA= 2.3139E+02 BARNS
N,GAMMA= 2.3275E+02 BARNS (AS CALCULATED FROM TOTAL N,GAMMA GROUP AVERAGED VALUES)
FISSION= 3.6384E+02 BARNS
N,P= 4.6789E-04 BARNS
N,D= 2.2860E-04 BARNS
N,T= 5.0751E-04 BARNS
N,HE-3= 0. BARNS
N,ALPHA= 3.4611E-03 BARNS
N,2*ALPHA= 0. BARNS
ABSORPTION= 5.9524E+02 BARNS
ELASTIC SCATTER= 1.9240E+02 BARNS

*** ETOG ***

TIMING NOTES

SECTION	ELAPSED SEC	CP SEC	PP SEC
OVERLAY (ETOG,3,0)	11.651	7.960	0.000
	0.000	0.000	0.000
CROS	11.651	7.954	0.000
	0.000	0.000	0.000
PROCESSING MT=2	10.880	.657	0.000
PROCESSING MT=4	.077	.351	0.000
PROCESSING MT=16	0.000	.207	0.000
PROCESSING MT=18	.231	2.145	0.000
PROCESSING MT=27	0.000	.002	0.000
PROCESSING MT=51-91	.309	2.788	0.000
PROCESSING MT=102	.077	.849	0.000
PROCESSING MT=103	0.000	.248	0.000
PROCESSING MT=104	0.000	.266	0.000
PROCESSING MT=105	.077	.238	0.000
PROCESSING MT=106	0.000	.001	0.000
PROCESSING MT=107	0.000	.194	0.000
PROCESSING MT=108	0.000	.002	0.000
PROCESSING MT=251	0.000	.004	0.000
RESI	0.000	.007	0.000

TOTAL TIME USED 147.803 0.000

GADD - <IND = 3 - EPS INCREASED FROM .1000E-03 TO .5000E-03

*** ETOG ***

MULTI- GROUP	CAPTURE	FISSION	ABSORPTION	SCATTERING	ANISOTROPIC SCATTERING	INELASTIC SCATTERING	N-2N	NEUTRONS PER FISSION
36	1.2542E-01	1.5685E+00	1.6939E+00	6.4294E+00	2.5189E+00	8.6365E-01	J.	2.9366E+00
37	1.3993E-01	1.5578E+00	1.6977E+00	6.6789E+00	2.4980E+00	8.1217E-01	J.	2.9305E+00
38	1.5478E-01	1.5457E+00	1.7005E+00	6.9236E+00	2.4777E+00	7.7064E-01	J.	2.9257E+00
39	1.6844E-01	1.5279E+00	1.6963E+00	7.1746E+00	2.4411E+00	7.2525E-01	J.	2.9214E+00
40	1.7976E-01	1.5095E+00	1.6892E+00	7.4329E+00	2.3888E+00	6.7999E-01	J.	2.9174E+00
41	1.8939E-01	1.4981E+00	1.6875E+00	7.6602E+00	2.2853E+00	6.5240E-01	J.	2.9139E+00
42	1.9755E-01	1.4848E+00	1.6824E+00	7.8863E+00	2.1829E+00	6.3022E-01	J.	2.9105E+00
43	2.0430E-01	1.4815E+00	1.6858E+00	8.1075E+00	2.0864E+00	6.0747E-01	J.	2.9077E+00
44	2.0839E-01	1.4925E+00	1.7009E+00	8.3158E+00	1.9930E+00	5.8547E-01	J.	2.9051E+00
45	2.1357E-01	1.5067E+00	1.7203E+00	8.5198E+00	1.9067E+00	5.6344E-01	J.	2.9027E+00
46	2.2011E-01	1.5241E+00	1.7442E+00	8.7158E+00	1.8250E+00	5.4179E-01	J.	2.9005E+00
47	2.2730E-01	1.5410E+00	1.7683E+00	8.9075E+00	1.7489E+00	5.1957E-01	J.	2.8985E+00
48	2.3463E-01	1.5571E+00	1.7917E+00	9.1038E+00	1.6799E+00	4.9745E-01	J.	2.8968E+00
49	2.4202E-01	1.5720E+00	1.8140E+00	9.3022E+00	1.6170E+00	4.7581E-01	J.	2.8952E+00
50	2.5615E-01	1.6154E+00	1.8716E+00	9.5991E+00	1.4974E+00	4.3998E-01	J.	2.8929E+00
51	2.8025E-01	1.6463E+00	1.9263E+00	1.0048E+01	1.2439E+00	3.8898E-01	J.	2.8901E+00
52	3.1939E-01	1.6969E+00	2.0163E+00	1.0425E+01	1.0049E+00	3.4445E-01	J.	2.8877E+00
53	4.0588E-01	1.7074E+00	2.1142E+00	1.0693E+01	8.1235E-01	3.2920E-01	J.	2.8863E+00
54	4.9753E-01	1.7364E+00	2.2339E+00	1.0878E+01	6.5300E-01	3.2303E-01	J.	2.8847E+00
55	6.1751E-01	1.7484E+00	2.3659E+00	1.1009E+01	5.2479E-01	3.1645E-01	J.	2.8837E+00
56	7.2441E-01	1.8024E+00	2.5268E+00	1.0714E+01	4.0721E-01	3.0914E-01	J.	2.8829E+00
57	8.2230E-01	1.8355E+00	2.6578E+00	1.0863E+01	3.3117E-01	3.0065E-01	J.	2.8822E+00
58	9.6574E-01	1.9515E+00	2.9173E+00	1.1109E+01	2.7360E-01	2.9093E-01	J.	2.8817E+00
59	1.1706E+00	2.0053E+00	3.1769E+00	1.1400E+01	2.1564E-01	2.6422E-01	J.	2.8814E+00
60	1.3769E+00	2.3353E+00	3.7131E+00	1.1922E+01	5.1526E-02	5.7355E-02	J.	2.8811E+00
61	1.8149E+00	2.1621E+00	3.9770E+00	1.2424E+01	3.4953E-02	0.	J.	2.8808E+00
62	2.0633E+00	2.4678E+00	4.5312E+00	1.2554E+01	3.5318E-02	0.	J.	2.8806E+00
63	2.4220E+00	2.8453E+00	5.2673E+00	1.2788E+01	3.5977E-02	0.	J.	2.8805E+00
64	2.7267E+00	3.4833E+00	6.2100E+00	1.2922E+01	3.6354E-02	0.	J.	2.8804E+00
65	3.5123E+00	3.0364E+00	6.5487E+00	1.3173E+01	3.7061E-02	0.	J.	2.8803E+00
66	3.9802E+00	3.5895E+00	7.5697E+00	1.3256E+01	3.7293E-02	0.	J.	2.8802E+00
67	3.1289E+00	5.8278E+00	8.9567E+00	1.2934E+01	3.4587E-02	0.	J.	2.8802E+00
68	4.3284E+00	6.2346E+00	1.0563E+01	1.2961E+01	3.6463E-02	0.	J.	2.8801E+00
69	5.0272E+00	6.3972E+00	1.1424E+01	1.2996E+01	3.6563E-02	0.	J.	2.8801E+00
70	7.1135E+00	6.2381E+00	1.3352E+01	1.3851E+01	3.8967E-02	0.	J.	2.8801E+00

*** ETOS ***

MULTI- GROUP	CAPTURE	FISSION	ABSORPTION	SCATTERING	ANISOTROPIC SCATTERING	INELASTIC SCATTERING	N-2N	NEUTRONS PER FISSION
71	7.6313E+00	1.4496E+01	2.2128E+01	1.5979E+01	4.4956E-02	0.	0.	2.8801E+00
72	5.6935E+00	1.0110E+01	1.5804E+01	1.2151E+01	3.4214E-02	0.	0.	2.8801E+00
73	8.1221F+00	6.8884E+00	1.5010E+01	1.8778E+01	5.2831E-02	0.	0.	2.8801E+00
74	3.8717E-06	3.2479E+00	3.2479E+00	2.0922E+01	5.8861E-02	0.	0.	2.8801E+00
75	8.1560E-01	1.9214E+00	2.7370E+00	1.2463E+01	3.5064E-02	0.	0.	2.8801E+00
76	8.1329E-01	7.0022E-01	1.5135E+00	2.7393E+01	7.7066E-02	0.	0.	2.8801E+00
77	1.0976F-02	3.8823E+00	3.8932E+00	1.9401E+01	5.4583E-02	0.	0.	2.8801E+00
78	4.7304E-05	2.2134E+00	2.2135E+00	2.1662E+01	5.0945E-02	0.	0.	2.8801E+00
79	8.8491E-05	2.8129E+00	2.8130E+00	2.6417E+01	7.4322E-02	0.	0.	2.8801E+00
80	1.6560F-04	-2.1469E+00	-2.1467E+00	2.3626E+01	5.6469E-02	0.	0.	2.8801E+00
81	3.1005E-04	-2.8769E-01	-2.8738E-01	2.0412E+01	5.7420E-02	0.	0.	2.8801E+00
82	5.8089F-04	4.8923E-03	5.4732E-03	9.4665E+00	2.6633E-02	0.	0.	2.8801E+00
83	1.0892E-03	2.6780E+00	2.6791E+00	1.2017E+01	3.3808E-02	0.	0.	2.8801E+00
84	2.0444E-03	1.1320F+00	1.1341E+00	1.5910E+01	4.4762E-02	0.	0.	2.8801E+00
85	3.8713E+00	5.0611E+00	8.9324E+00	1.5053E+01	4.2378E-02	0.	0.	2.8801E+00
86	7.2358E-03	4.3909E+00	4.3981E+00	1.5024E+01	4.2268E-02	0.	0.	2.8801E+00
87	2.4632E-01	-5.2811E+00	-5.0347E+00	7.9596E+00	2.2393E-02	0.	0.	2.8801E+00
88	4.7411F+00	3.8293E-01	5.1239E+00	1.0470E+01	2.9455E-02	0.	0.	2.8801E+00
89	4.8459E-01	4.2609F+00	4.7454E+00	8.7895E+00	2.4725E-02	0.	0.	2.8801E+00
90	2.1187E-01	5.9864E+00	6.1983E+00	9.5018E+00	2.6732E-02	0.	0.	2.8801E+00
91	1.8132E-01	7.8573F+00	8.0386E+00	9.8953E+00	2.7839F-02	0.	0.	2.8801E+00
92	5.0363F-01	1.0303E+01	1.0906E+01	1.0229E+01	2.8778E-02	0.	0.	2.8801E+00
93	2.1525E+00	1.3517E+01	1.5669E+01	1.0453E+01	2.9436F-02	0.	0.	2.8801E+00
94	4.8379E+00	1.7986E+01	2.2824E+01	1.0745E+01	3.0229E-02	0.	0.	2.8801E+00
95	8.3217E+00	2.4159E+01	3.2481E+01	1.1015E+01	3.0988F-02	0.	0.	2.8801E+00
96	1.4033E+01	3.4612E+01	4.8646E+01	1.1302E+01	3.1797E-02	0.	0.	2.8801E+00
97	2.2573E+01	5.5313E+01	7.7886E+01	1.1681E+01	3.2864E-02	0.	0.	2.8801E+00
98	4.7765E+01	1.0572F+02	1.5348E+02	1.2427E+01	3.4961E-02	0.	0.	2.8801E+00
99	1.4881E+02	2.8387E+02	4.3268E+02	1.3977E+01	3.9322E-02	0.	0.	2.8801E+00

*** ELOG ***

ELASTIC SCATTERING MATRICES

***** BEGINNING OF ISOTROPIC ENERGY RANGE *****

SOURCE GROUP 99

SINK GRPS	P0 CALCULATED	GROUP AVG SYMM. SCATT.	PER CENT ERROR	P1 CALCULATED	GROUP AVG 3* μ *SIGS	PER CENT ERROR	P1 NORMALIZED
99	1.3464E+01	1.3977E+01	-8.1340E-13	1.3464E+01	1.1795E-01	-1.6943E-12	6.2634E-01
100	5.1265F-01	5.1265E-01		-5.0839F-01			-5.0839E-01

SOURCE GROUP 98

SINK GRPS	P2 CALCULATED	GROUP AVG ISOTR. VALUE	PER CENT ERROR	P3 CALCULATED	GROUP AVG ISOTR. VALUE	ABSOLUTE ERROR	P3 NORMALIZED
99	4.4718E-03	2.4949E-04	-3.9112E-12	1.2330E-04	0.	0.	1.2330E-04
100	-4.2223E-03	-4.2223E-03		-1.2330E-04			-1.2330E-04

SOURCE GROUP 98

SINK GRPS	P0 CALCULATED	GROUP AVG SYMM. SCATT.	PER CENT ERROR	P1 CALCULATED	GROUP AVG 3* μ *SIGS	PER CENT ERROR	P1 NORMALIZED
98	1.1990E+01	1.2427E+01	-9.1486E-13	5.3821E-01	1.0487E-01	-1.2704E-12	5.3821E-01
99	4.3635E-01	4.3635E-01		-4.3335E-01			-4.3335E-01

SOURCE GROUP 97

SINK GRPS	P2 CALCULATED	GROUP AVG ISOTR. VALUE	PER CENT ERROR	P3 CALCULATED	GROUP AVG ISOTR. VALUE	ABSOLUTE ERROR	P3 NORMALIZED
98	3.2085E-03	2.2182E-04	-8.3094E-12	9.8349E-05	0.	0.	9.8349E-05
99	-2.9867E-03	-2.9867E-03		-9.8349E-05			-9.8349E-05

SOURCE GROUP 97

SINK GRPS	P0 CALCULATED	GROUP AVG SYMM. SCATT.	PER CENT ERROR	P1 CALCULATED	GROUP AVG 3* μ *SIGS	PER CENT ERROR	P1 NORMALIZED
98	3.2085E-03	3.2085E-03		9.8349E-05	0.	0.	9.8349E-05
99	-2.9867E-03	-2.9867E-03		-9.8349E-05			-9.8349E-05

SINK	P2	GROUP AVG	PER CENT	P2	P3	GROUP AVG	ABSOLUTE	P3
GRPS	CALCULATED	ISOTR. VALUE	ERROR	NORMALIZED	CALCULATED	ISOTR. VALUE	ERROR	NORMALIZED
62	2.4447E-03	2.2408E-04	-5.8561E-12	2.4447E-03	9.0829E-05	0.	0.	9.0829E-05
63	-2.2206E-03			-2.2205E-03	-9.0829E-05			-9.0829E-05

SOURCE GROUP 61

SINK	P0	GROUP AVG	PER CENT	P0	P1	GROUP AVG	PER CENT	P1
GRPS	CALCULATED	SYMM. SCATT.	ERROR	NORMALIZED	CALCULATED	3* μ *SIGS	ERROR	NORMALIZED
61	1.1996E+01	1.2424E+01	-1.3726E-12	1.1996E+01	5.3066E-01	1.0484E-01	-3.1768E-12	5.3066E-01
62	4.2809E-01			4.2809E-01	-4.2582E-01			-4.2582E-01

SINK	P2	GROUP AVG	PER CENT	P2	P3	GROUP AVG	ABSOLUTE	P3
GRPS	CALCULATED	ISOTR. VALUE	ERROR	NORMALIZED	CALCULATED	ISOTR. VALUE	ERROR	NORMALIZED
61	2.4682E-03	2.2177E-04	-5.3778E-12	2.4582E-03	9.2986E-05	0.	0.	9.2986E-05
62	-2.2465E-03			-2.2465E-03	-9.2986E-05			-9.2986E-05

***** END OF ISOTROPIC ENERGY RANGE *****

SOURCE GROUP 60

SINK	P0	GROUP AVG	PER CENT	P1	P3	GROUP AVG	ABSOLUTE	P3
GRPS	CALCULATED	ISOTR. VALUE	ERROR	NORMALIZED	CALCULATED	ISOTR. VALUE	ERROR	NORMALIZED
60	1.1511E+01			5.9299E-01				5.9299E-01
61	4.1089E-01			-4.0842E-01				-4.0842E-01

SINK	P2	GROUP AVG	PER CENT	P3	P3	GROUP AVG	ABSOLUTE	P3
GRPS	CALCULATED	ISOTR. VALUE	ERROR	NORMALIZED	CALCULATED	ISOTR. VALUE	ERROR	NORMALIZED
60	5.4741E-03			4.7169E-05				4.7169E-05
61	-2.4501E-03			-9.0058E-05				-9.0058E-05

SOURCE GROUP 59

SINK	PC	GROUP AVG	PER CENT	P1	P1	GROUP AVG	ABSOLUTE	P1
GRPS	CALCULATED	ISOTR. VALUE	ERROR	NORMALIZED	CALCULATED	ISOTR. VALUE	ERROR	NORMALIZED
59	1.1011E+01			1.0261E+00				1.0261E+00

60 3.8878E-01

-3.7919E-01

SINK	P2
GRPS	CALCULATED
59	3.2550E-02
60	-9.5188E-03

P3
CALCULATED
5.8894E-04
-1.5670E-04

SOURCE GROJP 58

SINK	P3
GRPS	CALCULATED
58	1.0739E+01
59	3.7023E-01

P1
CALCULATED
1.1745E+00
-3.5378E-01

SINK	P2
GRPS	CALCULATED
58	6.7496E-02
59	-1.5747E-02

P3
CALCULATED
2.7116E-03
-7.5332E-04

SOURCE GROJP 57

SINK	P0
GRPS	CALCULATED
57	1.0503E+01
58	3.5072E-01

F1
CALCULATED
1.3346E+00
-3.4117E-01

SINK	P2
GRPS	CALCULATED
57	1.0574E-01
58	-1.8219E-02

P3
CALCULATED
5.2615E-03
-1.3409E-03

SOURCE GROJP 56

SINK	P0
GRPS	CALCULATED

P1
CALCULATED

SINK P0
GRPS CALCULATED
3 2.5691E+00
4 3.2762E-02

P1
CALCULATED
6.9207E+00
3.6876E-02

SINK P2
GRPS CALCULATED
3 1.0083E+01
4 1.6629E-02

P3
CALCULATED
1.2424E+01
8.3362E-03

SOURCE GROJP 2

SINK P0
GRPS CALCULATED
2 2.5954E+00
3 3.3772E-02

P1
CALCULATED
7.0313E+00
4.0612E-02

SINK P2
GRPS CALCULATED
2 1.0259E+01
3 2.0582E-02

P3
CALCULATED
1.2584E+01
4.3799E-03

SOURCE GROJP 1

SINK P0
GRPS CALCULATED
1 2.6986E+00
2 3.3067E-02

P1
CALCULATED
7.3880E+00
4.4881E-02

SINK P2
GRPS CALCULATED
1 1.0853E+01
2 2.8456E-02

P3
CALCULATED
1.3302E+01
5.7792E-03

*** ETOG ***

TIMING NOTES

SECTION	ELAPSED SEC	CP SEC	PP SEC
OVERLAY (ETOG,4,0)	6.481	55.907	0.000
	0.000	0.000	0.000
TRAN	6.481	55.906	0.000
TOTAL TIME USED	203.721	0.000	

*** ETOG ***

N,2N PROBABILITY MATRIX
BEFORE RENORMALIZATION

EXIT
GROUP

1	0.									
2	0.	0.								
3	0.	0.	0.							
4	0.	0.	0.	0.						
5	0.	0.	0.	0.	0.					
6	2.7534E-05	0.	0.	0.	0.	0.				
7	3.5748E-04	0.	0.	0.	0.	0.	0.			
8	7.7743E-04	2.6875E-04	0.	0.	0.	0.	0.	0.		
9	1.5417E-03	1.1050E-03	0.	0.	0.	0.	0.	0.	0.	
10	2.8120E-03	2.1000E-03	9.4384E-04	0.	0.	0.	0.	0.	0.	
11	4.7547E-03	3.6853E-03	2.8073E-03	0.	0.	0.	0.	0.	0.	
12	7.5062E-03	6.0173E-03	4.7489E-03	1.5054E-03	0.	0.	0.	0.	0.	
13	1.1135E-02	9.2032E-03	7.4998E-03	6.0344E-03	0.	0.	0.	0.	0.	
14	1.5615E-02	1.3267E-02	1.1130E-02	9.2330E-03	2.8213E-03	0.	0.	0.	0.	
15	2.0808E-02	1.8127E-02	1.5613E-02	1.3315E-02	1.1305E-02	0.	0.	0.	0.	
16	2.6477E-02	2.3594E-02	2.0811E-02	1.8198E-02	1.5859E-02	0.	0.	0.	0.	
17	3.2310E-02	2.9389E-02	2.6488E-02	2.3693E-02	2.1141E-02	4.0541E-03	0.	0.	0.	
18	3.7963E-02	3.5178E-02	3.2331E-02	2.9519E-02	2.6908E-02	2.4847E-02	0.	0.	0.	
19	4.3101E-02	4.0617E-02	3.7996E-02	3.5342E-02	3.2846E-02	3.0946E-02	0.	0.	0.	
20	4.7440E-02	4.5392E-02	4.3148E-02	4.0816E-02	3.8604E-02	3.7040E-02	0.	0.	0.	

*** ETC5 ***

N,2N MATRIX

EXIT GROUP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	0.																			
	0.																			
	0.																			
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	2.7129E-05	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	3.5221E-05	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	7.6597E-05	4.0780E-05	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	1.5190E-04	1.6767E-04	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	0.	3.1955E-04	1.5069E-04	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	0.	5.5913E-04	4.4819E-04	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	0.	7.3955E-04	9.1304E-04	7.5816E-04	2.3696E-04	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	1.0971E-03	1.3965E-03	1.1974E-03	9.4989E-04	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	1.5385E-03	2.0131E-03	1.7769E-03	1.4534E-03	4.2734E-06	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	2.0501E-03	2.7505E-03	2.4926E-03	2.0959E-03	1.7123E-03	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	2.6086E-03	3.5800E-03	3.3225E-03	2.8646E-03	2.4021E-03	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	3.1833E-03	4.4593E-03	4.2288E-03	3.7295E-03	3.2021E-03	5.6496E-04	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	3.7403E-03	5.3378E-03	5.1616E-03	4.6467E-03	4.0758E-03	3.4540E-03	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	4.2466E-03	6.1631E-03	6.0661E-03	5.5633E-03	4.9752E-03	4.3020E-03	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	4.6741E-03	6.8876E-03	6.8886E-03	6.4249E-03	5.8473E-03	5.1490E-03	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

*** ETOS ***

INELASTIC SCATTERING PROBABILITY MATRIX
BEFORE RENORMALIZATION

EXIT GROUP										
1	8.4907E-01									
2	9.5711E-02	5.8492E-01								
3	5.1452E-07	5.5830E-02	4.4994E-01							
4	1.9766E-06	6.8759E-05	5.7400E-02	4.5088E-01						
5	5.5885E-06	2.0837E-05	1.5776E-05	6.3715E-02	5.2918E-01					
6	1.4058E-05	5.5818E-05	4.5160E-05	2.4807E-05	7.7824E-02	5.5429E-01				
7	3.1807E-05	1.3371E-04	1.1489E-04	6.7247E-05	3.3311E-05	7.8327E-02	4.9971E-01			
8	6.5379E-05	2.8940E-04	2.6260E-04	1.6282E-04	8.5495E-05	5.0353E-05	6.8590E-02	4.0281E-01		
9	1.2319E-04	5.7144E-04	5.4479E-04	3.5588E-04	1.9700E-04	1.2235E-04	9.3050E-05	5.6006E-02		
10	3.0774E-01									
	2.1452E-04	1.0382E-03	1.0352E-03	7.0894E-04	4.1169E-04	2.6832E-04	2.1464E-04	1.7870E-02		
	4.5544E-02	2.7154E-01								
11	3.4781E-04	1.7492E-03	1.8163E-03	1.2984E-03	7.8744E-04	5.3610E-04	4.4898E-04	3.9226E-02		
	3.1900E-04	4.6979E-02	2.6589E-01							
12	5.2861E-04	2.7527E-03	2.9652E-03	2.2036E-03	1.3900E-03	9.8452E-04	8.5954E-04	7.8447E-02		
	6.6793E-04	4.9031E-04	4.8995E-02	2.5245E-01						
13	7.5765E-04	4.0718E-03	4.5346E-03	3.4905E-03	2.2815E-03	1.6749E-03	1.5184E-03	1.4418E-02		
	1.2798E-03	9.8145E-04	7.0299E-04	5.1803E-02	2.6068E-01					
14	1.0298E-03	5.6948E-03	6.5363E-03	5.1940E-03	3.5062E-03	2.6590E-03	2.4942E-03	2.4548E-02		
	2.2627E-03	1.8054E-03	1.3482E-03	1.0024E-03	5.4773E-02	2.5817E-01				
15	1.3341E-03	7.5705E-03	8.9299E-03	7.3036E-03	5.0765E-03	3.9646E-03	3.8356E-03	3.8997E-02		
	3.7194E-03	3.0762E-03	2.3854E-03	1.8405E-03	1.4149E-03	5.7896E-02	2.5324E-01			
16	1.6547E-03	9.6122E-03	1.1622E-02	9.7569E-03	6.9634E-03	5.5849E-03	5.5565E-03	5.8182E-02		
	5.7235E-03	4.8901E-03	3.9240E-03	3.1312E-03	2.4884E-03	1.9513E-03	6.1069E-02	2.5037E-02		
17	1.9730E-03	1.1707E-02	1.4475E-02	1.2443E-02	9.0958E-03	7.4732E-03	7.6262E-03	8.2009E-02		
	8.2966E-03	7.3005E-03	6.0423E-03	4.9705E-03	4.0709E-03	3.2945E-03	2.6400E-03	6.6433E-02		
	2.5701E-01									
18	2.2701E-03	1.3731E-02	1.7325E-02	1.5215E-02	1.1366E-02	9.5448E-03	9.9663E-03	1.0979E-02		
	1.1393E-02	1.0296E-02	8.7638E-03	7.4110E-03	6.2374E-03	5.1937E-03	4.2879E-03	3.4744E-02		
	7.5321E-02	2.6715E-01								
19	2.5289E-03	1.5565E-02	2.0003E-02	1.7911E-02	1.3645E-02	1.1587E-02	1.2460E-02	1.4029E-02		
	1.4896E-02	1.3791E-02	1.2041E-02	1.0440E-02	9.0063E-03	7.6355E-03	6.5272E-03	5.4402E-02		
	4.8676E-03	8.5092E-02	2.7184E-01							
20	2.7361E-03	1.7107E-02	2.2353E-02	2.0370E-02	1.5797E-02	1.3774E-02	1.4964E-02	1.7185E-02		
	1.8631E-02	1.7630E-02	1.5751E-02	1.3969E-02	1.2323E-02	1.0779E-02	9.3690E-03	8.0110E-02		
	6.9306E-03	1.0128E-02	9.8728E-02	2.7439E-01						

*** ET06 ***

TIMING NOTES

SECTION	ELAPSED SEC	CP SEC	PP SEC
OVERLAY (ET06,5,0)	6.559	56.883	0.000
	0.000	0.000	0.000
(N,2N) MATRIX	.309	3.173	0.000
INELASTIC MATRIX	6.173	63.674	0.000
TAPE MANIPULATIONS	.077	.036	0.000

TOTAL TIME USED 270.610 0.000

*** ETOS ***

THE FOLLOWING CARDS HAVE BEEN PUNCHED

ENDF/B TAPE NO.= 308	MATERIAL NO.= 1159						1159	
2.1000E+01	1.2100E+02	0.					1159	1
2.3699E+02	1.0200E+01	0.	1.2100E+02	5.0000E+00	0.		1159	2
0.	0.	0.					1159	3
7.8130E+00	1.2886E-03	4.1100E-02	4.4900E-02	0.		5.0000E-01	1159	4
1.0941E+01	2.9108E-03	4.6300E-02	1.5100E-01	0.		5.0000E-01	1159	5
1.1890E+01	1.5206E-03	4.0800E-02	2.4200E-02	0.		5.0000E-01	1159	6
1.4310E+01	9.4571E-04	3.7800E-02	6.3200E-02	0.		5.0000E-01	1159	7
1.4695E+01	2.8779E-03	3.7300E-02	2.9700E-02	0.		5.0000E-01	1159	8
1.5470E+01	1.0030E-03	3.3000E-02	6.8330E-01	0.		5.0000E-01	1159	9
1.7650E+01	2.7560E-03	3.9200E-02	3.2800E-02	0.		5.0000E-01	1159	10
2.2266E+01	4.0581E-03	4.9000E-02	6.7000E-02	0.		5.0000E-01	1159	11
2.3905E+01	1.2712E-04	3.1000E-02	3.7000E-02	0.		5.0000E-01	1159	12
2.6255E+01	2.2494E-03	4.0200E-02	4.0866E-02	0.		5.0000E-01	1159	13
2.7260E+01	2.0984E-04	3.9000E-02	2.0900E-03	0.		5.0000E-01	1159	14
3.2390E+01	4.2543E-04	4.6000E-02	1.2000E-01	0.		5.0000E-01	1159	15
3.5460E+01	4.0612E-04	4.1800E-02	5.2000E-03	0.		5.0000E-01	1159	16
4.1430E+01	6.4366E-03	4.2000E-02	4.0000E-03	0.		5.0000E-01	1159	17
4.1685E+01	1.9369E-03	6.9000E-02	4.4000E-02	0.		5.0000E-01	1159	18
4.4500E+01	1.0340E-02	3.9000E-02	3.9000E-03	0.		5.0000E-01	1159	19
4.4764E+01	2.2777E-03	3.9000E-02	2.2000E-01	0.		5.0000E-01	1159	20
4.9700E+01	1.9035E-03	6.1800E-02	7.4600E-01	0.		5.0000E-01	1159	21
5.0113E+01	4.5722E-03	4.3500E-02	1.1000E-02	0.		5.0000E-01	1159	22
5.2520E+01	1.6421E-02	4.5000E-02	7.4000E-03	0.		5.0000E-01	1159	23
5.5660E+01	2.2028E-03	3.7000E-02	1.8500E-02	0.		5.0000E-01	1159	24
5.7550E+01	5.3103E-03	4.5000E-02	5.8000E-01	0.		5.0000E-01	1159	25
5.7900E+01	4.8699E-03	3.9000E-02	9.5000E-01	0.		5.0000E-01	1159	26
5.9254E+01	7.3885E-03	3.9000E-02	1.0000E-01	0.		5.0000E-01	1159	27
6.0970E+01	1.1712E-02	5.2999E-02	6.7350E+00	0.		5.0000E-01	1159	28
6.3110E+01	1.1361E-03	6.0000E-02	9.2000E-02	0.		5.0000E-01	1159	29
6.5550E+01	1.9955E-03	3.0000E-02	1.0000E-01	0.		5.0000E-01	1159	30
6.5790E+01	1.7931E-02	6.1200E-02	5.4000E-02	0.		5.0000E-01	1159	31
7.4087E+01	5.0783E-03	4.0000E-02	3.0000E-02	0.		5.0000E-01	1159	32
7.5003E+01	3.2910E-02	3.7500E-02	7.6500E-02	0.		5.0000E-01	1159	33
8.1600E+01	2.2854E-03	3.9000E-02	1.2000E+00	0.		5.0000E-01	1159	34
8.2650E+01	1.9092E-03	3.9000E-02	1.2000E+00	0.		5.0000E-01	1159	35
8.2710E+01	4.6209E-04	3.9000E-02	0.	0.		5.0000E-01	1159	36
8.5270E+01	2.5302E-02	3.9000E-02	2.2650E+00	0.		5.0000E-01	1159	37
8.5535E+01	1.2228E-02	4.1000E-02	1.1000E-02	0.		5.0000E-01	1159	38
9.0770E+01	2.1845E-02	3.3000E-02	7.7000E-03	0.		5.0000E-01	1159	39
9.2980E+01	1.1571E-03	4.9000E-02	8.5000E-03	0.		5.0000E-01	1159	40
9.5430E+01	2.7353E-03	3.5000E-02	1.3550E-02	0.		5.0000E-01	1159	41
								42

1.71990E+00 1.69595E+00 1.68309E+00 1.68589E+00 1.68915E+00 1.69391E+00 1159 137
1.69775E+00 1.70051E+00 1.69633E+00 1.69321E+00 1.68748E+00 1.68239E+00 1159 138
1.68577E+00 1.70590E+00 1.72031E+00 1.74420E+00 1.76630E+00 1.79171E+00 1159 139
1.81413E+00 1.87159E+00 1.92628E+00 2.01531E+00 2.11425E+00 2.23390E+00 1159 140
2.36591E+00 2.52684E+00 2.65780E+00 2.91730E+00 3.17692E+00 3.71315E+00 1159 141
3.97698E+00 4.53115E+00 5.26726E+00 6.20998E+00 6.54873E+00 7.56965E+00 1159 142
8.95671E+00 1.05630E+01 1.14244E+01 1.33516E+01 2.21278E+01 1.59036E+01 1159 143
1.50105E+01 3.24788E+00 2.73700E+00 1.51351E+00 3.89323E+00 2.21345E+00 1159 144
2.81298E+00 -2.14674E+00 -2.87379E-01 5.47315E-03 2.67912E+00 1.13406E+00 1159 145
8.93241E+00 4.39809E+00 -5.03475E+00 5.12394E+00 4.74537E+00 6.19826E+00 1159 146
8.03863E+00 1.09063E+01 1.56692E+01 2.28237E+01 3.24810E+01 4.86456E+01 1159 147
7.78860E+01 1.57483E+02 4.32677E+02 0.0. 0. 0. 1159 148
SIGMA FISSION
2.54556E+00 2.34048E+00 2.14616E+00 2.16877E+00 2.30536E+00 2.35499E+00 1159 149
2.30170E+00 2.12258E+00 1.82492E+00 1.67424E+00 1.66594E+00 1.69208E+00 1159 150
1.71885E+00 1.76005E+00 1.80230E+00 1.85421E+00 1.95087E+00 2.03040E+00 1159 151
2.05136E+00 2.05757E+00 2.05317E+00 2.03735E+00 1.98664E+00 1.83562E+00 1159 152
1.83063E+00 1.78120E+00 1.73804E+00 1.70326E+00 1.70205E+00 1.69340E+00 1159 153
1.65411E+00 1.61937E+00 1.59995E+00 1.58528E+00 1.57667E+00 1.56849E+00 1159 154
1.55732E+00 1.54573E+00 1.52789E+00 1.50673E+00 1.49809E+00 1.48444E+00 1159 155
1.48146E+00 1.49251E+00 1.50673E+00 1.52409E+00 1.54100E+00 1.55788E+00 1159 156
1.57290E+00 1.61543E+00 1.64603E+00 1.69592E+00 1.70737E+00 1.73637E+00 1159 157
1.74840E+00 1.80243E+00 1.83550E+00 1.95156E+00 2.00632E+00 2.23627E+00 1159 158
2.16210E+00 2.46784E+00 2.84527E+00 3.48329E+00 3.03649E+00 3.59946E+00 1159 159
5.82776E+00 5.23458E+00 6.39717E+00 6.23813E+00 1.44962E+01 1.01102E+01 1159 160
6.88937E+00 3.24788E+00 1.92140E+01 7.00220E-01 3.88225E+00 2.21341E+00 1159 161
2.81293E+00 -2.14693E+00 -2.87689E-01 4.89226E-03 2.67803E+00 1.13201E+00 1159 162
5.06110E+00 4.39085E+00 -5.28105E+00 3.82931E-01 4.26078E+00 5.99633E+00 1159 163
7.85732E+00 1.03026E+01 1.35167E+01 1.79854E+01 2.41593E+01 3.46121E+01 1159 164
5.53128E+01 1.05717E+02 2.83870E+02 0.0. 0. 0. 1159 165
NU-SIGMA FISSION
4.90348E+00 4.76032E+00 4.59948E+00 4.45041E+00 4.30714E+00 4.17164E+00 1159 166
4.04624E+00 3.92785E+00 3.82045E+00 3.72196E+00 3.63499E+00 3.55617E+00 1159 167
3.48494E+00 3.42112E+00 3.36466E+00 3.31345E+00 3.26829E+00 3.22809E+00 1159 170
3.19327E+00 3.16092E+00 3.13247E+00 3.10790E+00 3.08502E+00 3.06542E+00 1159 171
3.04709E+00 3.03046E+00 3.01545E+00 3.00236E+00 2.99088E+00 2.98053E+00 1159 172
2.97119E+00 2.96270E+00 2.95502E+00 2.94804E+00 2.94168E+00 2.93599E+00 1159 173
2.93048E+00 2.92570E+00 2.92136E+00 2.91742E+00 2.91387E+00 2.91065E+00 1159 174
2.90772E+00 2.90508E+00 2.90269E+00 2.90054E+00 2.89858E+00 2.89682E+00 1159 175
2.89520E+00 2.89289E+00 2.89099E+00 2.88775E+00 2.88604E+00 2.88470E+00 1159 176
2.88368E+00 2.88287E+00 2.88223E+00 2.88174E+00 2.88135E+00 2.88105E+00 1159 177
2.88092E+00 2.88064E+00 2.88055E+00 2.88039E+00 2.88030E+00 2.88024E+00 1159 178
2.88018E+00 2.88014E+00 2.88011E+00 2.88009E+00 2.88007E+00 2.88005E+00 1159 179
2.88004E+00 2.88003E+00 2.88002E+00 2.88002E+00 2.88002E+00 2.88001E+00 1159 180
2.88001E+00 2.88001E+00 2.88001E+00 2.88001E+00 2.88000E+00 2.88000E+00 1159 181
2.88000E+00 2.88000E+00 2.88000E+00 2.88000E+00 2.88000E+00 2.88000E+00 1159 182
2.88000E+00 2.88000E+00 2.88000E+00 2.88000E+00 2.88000E+00 2.88000E+00 1159 183

8.706235E-04 5.43174E-04 3.42308E-04 2.12383E-04 1.31113E-04 8.06256E-05 11591171
4.94299E-05 3.02313E-05 1.84559E-05 1.12508E-05 6.85193E-06 4.16808E-06 11591172
2.53412E-06 1.53989E-06 0. 0. 0. 0. 11591173
0. 0. 0. 0. 0. 0. 11591174
0. 0. 0. 0. 0. 0. 11591175
0. 0. 3.95974E-03 5.86531E-03 6.45469E-03 6.90562E-03 11591176
7.20459E-03 7.34465E-03 7.33301E-03 7.18462E-03 6.92016E-03 6.56327E-03 11591177
6.13837E-03 5.66882E-03 5.17559E-03 4.67656E-03 4.18621E-03 3.71561E-03 11591178
3.27269E-03 2.96260E-03 2.48923E-03 2.15050E-03 1.84908E-03 1.58252E-03 11591179
1.34868E-03 1.14502E-03 9.68763E-04 8.17081E-04 6.87202E-04 5.76491E-04 11591180
4.82499E-04 4.85149E-04 5.58374E-04 3.49191E-04 2.16902E-04 1.34322E-04 11591181
8.24721E-05 5.05882E-05 3.09535E-05 1.89329E-05 1.15263E-05 7.02009E-06 11591182
4.27166E-06 2.59741E-06 1.57850E-06 0. 0. 0. 11591183
0. 0. 0. 0. 0. 0. 11591184
0. 0. 0. 0. 0. 0. 11591185
0. 0. 0. 0. 0. 0. 11531186
0. 4.10244E-04 6.35587E-03 6.41038E-03 5.33850E-03 6.15604E-03 11591187
5.88256E-03 5.53924E-03 5.14709E-03 4.72547E-03 4.29141E-03 3.85930E-03 11591188
3.43934E-03 3.04068E-03 2.66366E-03 2.32673E-03 2.01651E-03 1.73822E-03 11591189
1.49101E-03 1.27331E-03 1.08304E-03 9.17960E-04 7.75324E-04 6.92990E-04 11591190
5.48464E-04 4.59558E-04 4.44437E-04 3.3761E-04 3.34321E-04 2.07913E-04 11591191
1.28593E-04 7.91899E-05 4.86028E-05 2.97521E-05 1.81755E-05 1.10858E-05 11591192
6.75323E-06 4.10996E-06 2.49941E-06 1.51309E-06 9.22850E-07 0. 11591193
0. 0. 0. 0. 0. 0. 11591194
0. 0. 0. 0. 0. 0. 11591195
0. 0. 0. 0. 0. 0. 11591196
0. 0. 0. 0. 0. 0. 11591197
0. 0. 0. 0. 0. 0. 11591198
3.14409E-03 2.81538E-03 2.49966E-03 2.20230E-03 1.92682E-03 1.67520E-03 11591199
1.44813E-03 1.24540E-03 1.06604E-03 9.08560E-04 7.71553E-04 6.52867E-04 11591200
5.50708E-04 4.63218E-04 3.89628E-04 3.15430E-04 2.53252E-04 2.84401E-04 11591201
1.77118E-04 1.09662E-04 6.75887E-05 4.15198E-05 2.54231E-05 1.55371E-05 11591202
9.47953E-06 5.77611E-06 3.51595E-06 2.13948E-06 1.29987E-06 7.89747E-07 11591203
4.79637E-07 2.91213E-07 0. 0. 0. 0. 11591204

*** ETOG ***

TIMING NOTES

SECTION	ELAPSED SEC	CP SEC	PP SEC
OVERLAY (ETOG,6,C)	.154	1.156	0.000
TOTAL TIME USED		271.772	0.000

CHAPTER 4

PROGRAMMER'S INFORMATION

As explained in the main report, this computer program is intended for many installations. The programmer facing the task of implementing ETOG at his installation should have little difficulty. This claim is, however, a relative one. Version 3 exploits certain modern computer features which may pose a severe difficulty in adaptation on some computers.

4.1 PHILOSOPHY

Programming ideals are not changed for the new version.

4.2 LABELED COMMON VARIABLES

An immediate problem in moving from a CDC-6600 Computer to a CDC-7600 Computer involved reduction of memory requirements for ETOG. One result of this is that part of the common block /DENS/ no longer exists in the program, being replaced by access to fast random storage. This is called "Large Core Storage" (LCS) locally and will be discussed further in Chapter 5. (Use of serial storage was tried (locally a disk) and found to be 50 times slower.) The label /LARCØR/ is applied to the LCS area used (length 17000). The name "Extended Core Storage" (ECS) is sometimes used. On the CDC 7600, only "Small Core" (150K_g) is available for a program. "Large Core" (\equiv Extended Core) can be used in Fortran by explicit transfers ("READEC" and "WRITEC," etc.).

In addition, it was necessary to consider the recommendation for a "disk paging" system for ENDF service programs, resulting from recent enlargements of format limits on ENDF/B tabulations, etc. Consequently, in order to "shrink ETOG into the CDC 7600," it was decided to make a paging system of "A storage" in the common block /DENS/ to provide some additional, generally applicable, relief of storage problems in the ENDF family of computer codes. This was arranged so that it was easy to change from "extended-core paging" to "disk paging."

The /DENS/ storage system can include many different stored "records" of all the official ENDF/B types. Consequently, access to the "A array" is through the special service routines STØRE, DELETE, FETCH, FPDS, IPDS,

LRIDS. All references to content of A were automatically programmed by FUNCTION subroutines A and LA (integer equivalent to A). All program statements with A or LA references left of the equal sign (Fortran) were rewritten with calls to a subroutine "WRITA." Additional service routines SETA (for setting file content to zero) and LOADA are used. There is a special COMMON/PAGEA/. All this is an imitation, as far as possible, of the system set up for X and Y of the common block /RECS/ in the new CHECKER^[14] program.

For "disk paging," system difficulties experienced on the PDP 10 and CDC 7600 (namely, the failure of a WRITE if done on a disk file when the prior operation on the file was a READ) led to the use of one disk file for READ's and another file for WRITE's. All READ operations are stepped with page WRITE operations so that changes of A content, if any, are moved into the WRITE file. When a "lower page number" must be accessed, both files are "rewound" and interchanged (the WRITE file becomes the new READ file, while the READ file becomes the new WRITE file).

Extended core paging might be transmuted to high-efficiency disk paging by "Random Access."

4.3 OVERLAY STRUCTURE AND ROUTINE LIST

Following is a list of the programs, subroutines, and functions used by ETOG-3. "LCS" in parentheses used after some subroutines is explained in Section 4.2 above.

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.

Overlay (0,0)

ETOG3	controls flow of main program
ERR	prints error message
ERROR	prints error message*
STORE	stores record in dense storage*
SETA	zero current page (LCS)
WRITA	write into page (LCS)
A	read from page (LCS)-reals
LA	read from page (LCS)-integers
L O ADA	move page to or from LCS
FETCH	fetches record from dense storage*
DELETE	deletes record from dense storage*
ECSI	computes integral of $y(x)$ *
GRATE	integrates TAB1 function*
COMB	combines two TAB1 functions*
COMBP	combines one panel of two TAB1 functions*
ADD	combining function for addition*
SUB	combining function for subtraction*
MULT	combining function for multiplication*
DIV	combining function for division*
TERP	interpolates between two points*
TERP1	interpolates one point*
TERP2	forms new table by interpolation*
LRIDS	locates record in dense storage*
FPDS	fetches point from dense storage*
IPDS	interpolates point in dense storage*

*This subroutine (or function) is part of the package of Retrieval Subroutines for the ENDF/B System written by H. C. Honeck (Reference 14).

HOLL reads hollerith material description
 CONT reads control (CONT) record
 LIST reads LIST record
 TAB1 reads TAB1 record
 TAB2 reads TAB2 record

 TPOS positions ENDF/B tape to file (MF) and reaction (MT)
 XTND extends data array
 SAVE writes or reads a scratch tape
 TERPO interpolates a data array

 GPAV averages over selected groups
 AVRG averages over a selected energy range
 OUT3 prints output (File 3 data)
 XSP4 converts data to excess-50 format, punches MUFT-4 and MUFT-5
 TIMEIT provides timing information (example on p.3-13)
 ETIME calls system time routines

Overlay (1,0)

ETOG10 controls flow of program in overlay (1,0)

 ININ reads input
 OUTO lists input options selected
 ZERO initializes variables
 EU constructs group structure, weight, and weight averages
 GENT1 generates TAB1 function
 FISS generating function for fission spectrum
 TRID reads ENDF/B tape I. D.
 TMAT positions ENDF/B tape to material (MAT)
 TMF1 reads ENDF/B File 1
 OUT1 prints output (input)

Overlay (2,0)

ETOG20 controls flow of program in overlay (2,0)

 INF2 initializes variables
 TMF2 reads ENDF/B File 2
 RESO calculates resonance parameters for GAM-I and GAM-II
 RESS calculates resolved resonance scattering and some capture or fission
 FACTR calculates penetration and shift factors and phase shift
 RESR calculates resolved resonance parameters and low resonance effect

 SESTAR serves for some resonance arithmetic
 RESU calculates unresolved resonance contribution
 URP unpacks unresolved data, gets interpolations
 ANW does resonance arithmetic, especially for average neutron width
 in unresolved region
 URI sums fluctuation integrals for unresolved resonances
 PHASE gives phase needed for potential and for negative scattering term
 (unresolved)

Overlay (3,0)

ETOG30 controls flow of program in overlay (3,0)
TMF3 reads ENDF/B File 3
CROS calculates smooth cross sections
RESI calculates infinitely dilute resonance integrals

Overlay (4,0)

ETOG40 controls flow of program in overlay (4,0)
TRAN controls calculation of transfer elements, prints elastic scattering matrices
GRID sets up lethargy mesh for integration
MVAL evaluates inner integrand at an energy mesh value
DINT performs double integration for matrix element
SINT performs double integration for in-group matrix element (special case)
GADD retrieves scattering cross sections and Legendre coefficients
TMF4 reads ENDF/B File 4
LECOM establishes Legendre coefficients in center-of-mass coordinate system
LEGEND fits Legendre coefficients to tabulated angular distributions

Overlay (5,0)

ETOG50 controls flow of program in overlay (5,0)
REEDE reads a scratch tape
INF5 initializes File 5
TMF5 reads ENDF/B File 5
IMAT calculates contributions to inelastic matrix
IP2DS interpolates in dense storage (from TAB2 records)
JUMP supplies a section of IMAT (improperly nested in older version) for secondary energy mesh.
ERFU calculates error function erf (x).
CWAX combines weight and cross section
PUTW restores weight to proper place
OUT5 prints output (File 5 data)
RENO renormalizes inelastic matrix
SPEC calculates source (fission) spectrum

Overlay (6,0)

ETOG60 controls flow of program in overlay (6,0)
POUT punches output for MUFT
GOUT prints and punches output for GAM
OPAR handles array/output

Overlay (7,0)

ETOG70 controls flow of program in overlay (7,0)

ANOUT prints output for ANISN

ANPUN punches output for ANISN

ANPUNF punches last card

Overlay (10,0) (Interpreted in octal; result is 8_{10})

ETOG100 controls flow of program in overlay (10,0)

LOUT punches output for LASER

OPAR handles array output

CHAPTER 5

ENVIRONMENT INFORMATION

The amount of core storage required by ETOG-3, associated system library functions, and the CDC 7600 SCOPE 2.0 operating system is approximately 42,000₁₀ locations plus 17,000₁₀ locations of extended core (or equivalent 17,000₁₀ of random access storage). ETOG-3 uses four scratch files in addition to the user-supplied library file. Standard system input, output and punch units are required.

The memory figures above reflect the use of a CDC compiler called FTN, with optimization chosen at "level 2". The quickest compilation occurs with a "level 0" choice, but there is a lower efficiency in the core storage use, as well as in execution time.

ETOG-3 is written in FORTRAN IV. All "Non-ANSI" flagging by the compiler has been remedied. The program is expected to compile and execute properly in any installation which provides the configuration capacity outlined above.

CHAPTER 6

COMMENTS AND CONCLUSIONS

Not all of the improvement needs mentioned in Chapter 6 of the main report have been met. Some reaction schemes have been added for exploitation of ENDF/B File 3 high energy content. Resolved resonance treatment is still a concern, in regard to accuracy of pointwise cross sections used. The use of almost all of ENDF/B Version III was assured by adding the Breit-Wigner multi-level formula to the programming. Transfer matrices have been improved since ETOG version 1, from two points of view. More ENDF/B formats can be handled, and calculations are more accurate.

A survey regarding accuracy is tabulated in Reference 19 (resonance integrals). (The change mentioned on Page 3-2 in unresolved resonance treatment was made in late June, 1973, but it refers only to scattering. The results shown in Reference 19 do not involve scattering cross sections.) A revision from the table given in that paper is shown on Page 6-3.

Comparison of library-processing-code treatment of ENDF/B U-238 data was requested by CSEWG in November, 1972. A look at some results from this effort (Pages 6-4 and 6-5) gives a clear impression of the effect of the correction to unresolved resonance scattering mentioned on Page 3-2. Page 6-4 is "before" and Page 6-5 is "after." Attention should be focussed on the first column of results, in Groups 22 through 32. The possibility of the need for this correction was pointed out by R. Q. Wright of Oak Ridge National Laboratory. I am grateful to him and to R. B. Kidman of

Westinghouse-Hanford Engineering Development Laboratory for permission to show their SUPERTOG^[20] and ETOX^[21] results, respectively.

"ETOG-3 and ETOT-3...." M. Raymund, Trans. Am. Nucl. Soc. 16, 323 (1973):

TABLE I (Corrected)

Calculated (n, γ) Capture Integrals and (n,f) Fission Integrals (barns)^a

ENDF/B-III Material No.	Standard ^b (BNL)	ETOG-2 ^c (MUFT;W)	ETOG-3 ^c (MUFT;W)	$\left(\frac{\% \text{ Difference}}{\text{Std.}} \right) \times 100$ $\left(\frac{(\text{ETOG-3}) - \text{Std.}}{\text{Std.}} \right) \times 100$
N-14	1133	3.38(-2)	3.37(-2)	-.3
Ca	1152	0.226	0.225	-.4
Cr	1121	1.66	1.71	-1.4
Mn-55	1019	15.3	14.9	-3.3
Co-59	1118	72.7	70.8	-2.1
Ni	1123	2.25	2.33	-1.2
Nb-93	1164	9.46	10.6	1.1
Mo	1111	29.3	29.3	-.4
Ag-107	1138	115.	116.	1.3
Ag-109	1139	1.46(+3)	1.45(+3)	-.8
Cd-113	1223	386.	387.	.3
Ta-182	1127	1.07(+3)	1.08(+3)	1.1
W-186	1063	489.	485.	-.7
U-234	1043	627.	631.	.7
U-235	1157	137.2	137.5	.2
		F282.	F284.	.7
U-236	1163	413. ^e	347. ^e	-16.0
		F 2.95	F 2.93	-.4
U-238	1158	280.	278.	-.7
		F 1.66	F 1.66	-.3
Pu-239	1159	200.	199.	-.4
		F304.	F301.	-.8
Pu-240	1105	8.48(+3)	8.25(+3)	.2
		F 9.04	F 8.49	-5.6
Pu-241	1106	116.	117.	.3
Pu-242	1161	F 5.27	F 5.29	.4

a. Integration limits 0.5 eV - 15 MeV; fission integrals are denoted by F.

b. Weighting function varied as 1/E.

c. Weighting function varied as 1/E joined to a fission spectrum.

d. Special ETOG-3 run in ANISN mode gives 9.69 barns.

e. Preliminary results.

5/11/73

COMPARISONS FOR U-238 (ENDF/B VERSION III MAY 1158)

GAM-I STRUCTURE, 0.25 LEHAPGY INTERVALS ELASTIC CROSS SECTIONS IN BARNs

GROUP NO.	ENERGY RANGE (eV)		ETOG-3		ETOX		SUPERTOG	
	LOW	HIGH	WNES	W-H	W-H	ORNL	ORNL	
10	8.21E+05	1.05E+06	4.9114E+00	4.9120E+00	4.9120E+00	4.9121E+00	4.9121E+00	
21	5.25E+04	6.74E+04	1.2430E+01	1.2435E+01	1.2435E+01	1.2435E+01	1.2435E+01	
22	4.09E+04	5.25E+04	1.3173E+01	1.2716E+01	1.2716E+01	1.2565E+01	1.2565E+01	
23	3.18E+04	4.09E+04	1.4033E+01	1.2943E+01	1.2943E+01	1.2943E+01	1.2943E+01	
31	4.31E+03	5.53E+03	1.6110E+01	1.5780E+01	1.5780E+01	1.5779E+01	1.5779E+01	
32	3.35E+03	4.31E+03	2.0593E+01	1.7784E+01	1.7784E+01	1.7563E+01	1.7563E+01	
33	2.61E+03	3.35E+03	1.8506E+01	1.5774E+01	1.5774E+01	1.5603E+01	1.5603E+01	
34	2.03E+03	2.61E+03	2.2276E+01	2.0554E+01	2.0554E+01	2.0327E+01	2.0327E+01	
41	3.54E+02	4.54E+02	1.1622E+01	1.1516E+01	1.1516E+01	1.1586E+01	1.1586E+01	
42	2.75E+02	3.54E+02	1.9944E+01	2.0125E+01	2.0125E+01	1.9833E+01	1.9833E+01	
57	6.48E+00	8.32E+00	4.0683E+01	4.0556E+01	4.0556E+01	4.0798E+01	4.0798E+01	
58	5.04E+00	6.48E+00	3.5652E+00	3.5814E+00	3.5814E+00	3.7551E+00	3.7551E+00	
59	3.93E+00	5.04E+00	7.7651E+00	7.7558E+00	7.7558E+00	7.7757E+00	7.7757E+00	
67	5.32E-01	6.83E-01	8.8704E+00	8.8795E+00	8.8795E+00	8.8795E+00	8.8795E+00	
68	4.14E-01	5.32E-01	8.8329E+00	8.8970E+00	8.8970E+00	8.8970E+00	8.8970E+00	

* Approximated σ_s from P^o punchout.

7/10/73

COMPARISONS FOR U-238 (ENDF/B VERSION III MAY 1158)

GAM-I STRUCTURE, 0.25 LEHARGY INTERVALS

ELASTIC CROSS SECTIONS IN BARNS

GROUP NO.	ENERGY RANGE (EV)		ETOG-3		ETOX		SUPERTOG	
	LOW	HIGH	WNES	W-H	ORNL	ORNL	19NOV72	19NOV72
10	8.21E+05	1.05E+06	4.9114E+00	4.9120E+00	4.9120E+00	4.9120E+00	4.9120E+00	4.9120E+00
21	5.25E+04	6.74E+04	1.2430E+01	1.2435E+01	1.2435E+01	1.2435E+01	1.2435E+01	1.2435E+01
22	4.09E+04	5.25E+04	1.2713E+01	1.2716E+01	1.2716E+01	1.2716E+01	1.2716E+01	1.2716E+01
23	3.18E+04	4.09E+04	1.2955E+01	1.2943E+01	1.2943E+01	1.2943E+01	1.2943E+01	1.2943E+01
31	4.31E+03	5.53E+03	1.5803E+01	1.5780E+01	1.5780E+01	1.5780E+01	1.5779E+01	1.5779E+01
32	3.35E+03	4.31E+03	2.0618E+01	1.7784E+01	1.7784E+01	1.7784E+01	1.7563E+01	1.7563E+01
33	2.61E+03	3.35E+03	1.8506E+01	1.5774E+01	1.5774E+01	1.5774E+01	1.5603E+01	1.5603E+01
34	2.03E+03	2.61E+03	2.2276E+01	2.0654E+01	2.0654E+01	2.0654E+01	2.0327E+01	2.0327E+01
41	3.54E+02	4.54E+02	1.1622E+01	1.1616E+01	1.1616E+01	1.1616E+01	1.1586E+01	1.1586E+01
42	2.75E+02	3.54E+02	1.9944E+01	2.0125E+01	2.0125E+01	2.0125E+01	1.9839E+01	1.9839E+01
57	6.48E+00	8.32E+00	4.0683E+01	4.0656E+01	4.0656E+01	4.0656E+01	4.0798E+01	4.0798E+01
58	5.04E+00	6.48E+00	3.6652E+00	3.6814E+00	3.6814E+00	3.6814E+00	3.7551E+00	3.7551E+00
59	3.93E+00	5.04E+00	7.7651E+00	7.7658E+00	7.7658E+00	7.7658E+00	7.7757E+00	7.7757E+00
57	5.32E-01	6.83E-01	8.8704E+00	8.9795E+00	8.9795E+00	8.9795E+00	8.8795E+00	8.8795E+00
68	4.14E-01	5.32E-01	8.8929E+00	8.8970E+00	8.8970E+00	8.8970E+00	8.8970E+00	8.8970E+00

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*

* Approximated σ_S from P^o punchout.

CHAPTER 7

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