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NUCLEAR DATA SERVICES

DOCUMENTATION SERIES OF THE IAEA NUCLEAR DATA SECTION

ENDF/B Format

Jan. 1975, M.A. Khalil

Revised Nov. 1981 and Sept. 1986 by H.D. Lemmel

Abstract: This document is a brief user's description of the format of ENDF/B. This format, originally designed for the US Evaluated Nuclear Data File, is recommended for international use. This summary is an aid to customers of the IAEA Nuclear Data Section when receiving data retrievals in ENDF/B format. For more detailed information the report BNL-NCS-50496 (ENDF 102) should be consulted. An Appendix to the present document gives a summary of the format differences between ENDF/B-4 and ENDF/B-5.

IAEA NUCLEAR DATA SECTION, P.O. BOX 100, A-1400 VIENNA

8.1

Format differences ENDF/B-4 versus ENDF/B-5

Contents

Examples (some are valid for ENDF/B-4):

1452 fission neutron yield nu-bar (E)

1453 radioactive decay scheme

1454 fission product yield data

1455 delayed neutron data

2151 resonance parameter data

3000 neutron cross sections sigma (E)

4000 angular distribution of secondary neutrons

5000 energy distribution of secondary neutrons

ENDF/B Format Documentation

Detailed description see "Data formats and procedures for the Evaluated Nuclear Data File ENDF"

ENDF/B-4: ENDF-102, Oct. 1975 (BNL-NCS-50496), rev. by D. Garber, C. Dunford, S. Pearlstein
A reprint of this document is available as IAEA-NDS-74.

ENDF/B-5: ENDF-102, 2nd ed., Oct. 1979 (BNL-NCS-50496), rev. by R. Kinsey.
A microfiche of this document is available as IAEA-NDS-10/102.

Revision pages to this document were distributed by B.A. Magurno, dated November 1983. A copy of these revision pages is available as IAEA-NDS-73.

The up-to-date Manual, including the revision pages, is available as document IAEA-NDS-75.

The differences between ENDF/B-4 and ENDF/B-5 are summarized in chapter 8 of this document. For more detailed information see

S. Pearlstein: Supplement to the ENDF/B-5 formats and procedures manual for using ENDF/B-4 data.
Report BNL-NCS-28949, Suppl. to ENDF-102 2nd ed., Nov. 1980

Computer Codes

Two packages of ENDF/B related computer codes are available:

- Endf/B-5 Utility Programs, received from the US National Nuclear Data Center in 1984. For details see document IAEA-NDS-29 Rev. 1. These programs are needed for ENDF/B file maintenance, including checking, correcting, creating a summary of the file contents, retrieving specific data. Also included are codes for producing an edited listing and for calculating spectrum-averaged cross-sections, resonance-integrals and other quantities.

- ENDF/B Preprocessing Codes by D.E. Cullen, version of 1986. For details see document IAEA-NDS-39 Rev. 2. This package includes codes for the calculation of cross-sections from resonance-parameters or of Doppler-broadened cross-sections, codes for graphical plotting of data and for graphical comparison of 2 evaluated data sets for the same material, etc.

Users of above codes are urged to verify that they are using the most up-to-date version.

For the graphical comparison of ENDF/B data with experimental data, specifically from EXFOR, see the code PLOTC4 by D.E. Cullen, 1986, document IAEA-NDS-79.

Information on other codes that can be applied on ENDF/B data, should be requested from

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France

File Structure

An ENDF formatted library consists of 80-character records containing data evaluations for several nuclides or "materials". Different materials are identified by four-digit accession-numbers or "MAT numbers". The MAT number is repeated in cols. 67-70 of each record.

The data for each material are grouped into "files" identified by "MF numbers" given in cols. 71-72 of each record; e.g.

MF = 2 means: resonance parameters
MF = 3 means: neutron cross-sections.

The reaction types are defined by reaction type numbers or "MT numbers" given in cols. 73-75 of each record. MF and MT together define the data, e.g.

MF = 3, MT = 1 means: total neutron cross section
MF = 4, MT = 2 means: diff. elastic scattering cross section

The MF and MT numbers are defined in the following tables 4 and 5.

File Number (MF)	Class of Data
1	General information
2	Resonance parameter data
3	Neutron cross sections
4	Angular distributions of secondary neutrons
5	Energy distributions of secondary neutrons
6	Energy-angular distributions of secondary neutrons
7	Thermal neutron scattering law data
8	Radioactive decay and fission product yield data
9	Multiplicities for production of radioactive nuclides
10	Cross sections for production of radioactive nuclides
12	Multiplicities for photons (from neutron reactions)
13	Cross sections for photons (from neutron reactions)
14	Angular distributions of photons (from neutron reactions)
15	Energy distributions of photons (from neutron reactions)
16	Energy-angular distributions of photons (from reactions)
17	Time dependent discrete photon production data
18	Time dependent continuum photon production data
19	Electron multiplicities and transition probability arrays
20	Electron production cross sections
21	Electron angular distributions
22	Continuous electron energy spectra
23	Photon interaction cross sections
24	Angular distributions of photons (from photon reactions)
25	Energy distributions of photons (from photon reactions)
26	Energy-angular distributions of photons (from photon reactions)
27	Atomic form factors (for photon interactions)
31	Data covariance matrices for $\bar{\nu}$
32	Data covariance matrices for resonance parameters
33	Data covariance matrices for neutron cross sections

MT	Description
1	Total cross section (redundant, equal to the sum of all partial cross sections)
2	Elastic scattering cross section
3	Nonelastic cross section (redundant, equal to the sum of all partial cross sections except elastic scattering)
4	Total inelastic cross section (redundant, equal to the sum of MT = 51, 52, 53, ..., 90, 91)
6	(n,2n) cross section for first excited state (describes first neutron)
7	(n,2n) cross section for second excited state (describes first neutron)
8	(n,2n) cross section for third excited state (describes first neutron)
9	(n,2n) cross section for fourth excited state (describes first neutron)
16	direct (n,2n) cross section [total (n,2n) cross section is sum of MT = 6, 7, 8, 9, and 16]
17	(n,3n) cross section
18	Total fission cross section (sum of MT = 19, 20, 21, 38)
19	(n,f) cross section (first chance fission)
20	(n,n'f) cross section (second chance fission)
21	(n,2nf) cross section (third chance fission)
22	(n,n'α) cross section
23	(n,n'3α) cross section
24	(n,2nα) cross section
25	(n,3nα) cross section
26	(n,2n) isomeric state cross section
27	Absorption cross section (sum of MT = 18 and 101) (includes particle reactions)
28	(n,n'p) cross section

MT	Description
29	(n,n'2α) cross section
30	(n,2n,2α) cross section
32	(n,n'd) cross section
33	(n,n't) cross section
34	(n,n'^{3}He)
35	(n,n'd2α) cross section
36	(n,n't2α) cross section
37	(n,4n) cross section
38	(n,3nf) cross section (fourth chance fission)
46	cross section for describing the second neutron form (n,2n) reaction for first excited state
47	cross section for describing the second neutron from (n,2n) reaction for second excited state
48	cross section for describing the second neutron from (n,2n) reaction for third excited state
49	cross section for describing the second neutron from (n,2n) reaction for fourth excited state (Note: MT = 46, 47, 48 and 49 should not be included in the sum for the total (n,2n) cross section)
51	(n,n') to the first excited state
52	(n,n') to the second excited state
.	
.	
.	
90	(n,n') to the 40th excited state
91	(n,n') to the continuum
101	neutron disappearance (sum of all cross sections in which a neutron is not in the exit channel) = sum of MT 102 to 114
102	(n,γ) radiative capture cross section
103	(n,p) cross section
104	(n,d) cross section

MT	Description
105	(n,t) cross section
106	(n,^{3}He) cross section
107	(n,α) cross section
108	(n,2α) cross section
109	(n,3α) cross section
111	(n,2p) cross section
112	(n,pα) cross section
113	(n,t2α) cross section
114	(n,d2α) cross section
120	Target destruction = nonelastic less total (n,n'γ)
151	General designation for resonance information
203	Total hydrogen production
204	Total deuterium production
205	Total tritium production
206	Total ^{3}He production
207	Total ^{4}He production
251	$\bar{\mu}_L$, the average cosine of the scattering angle (laboratory system) for elastic scattering
252	ξ, the average logarithmic energy decrement for elastic scattering
253	γ, the average of the square of the logarithmic energy decrement for elastic scattering, divided by twice the average logarithmic decrement for elastic scattering
301-450	Energy release rate parameters, E*σ, for total and partial cross sections. Subtract 300 from this number to obtain the specific reaction type identification. For example, MT = 302 = (300 + 2) denotes elastic scattering
451	Heading or title information (given only in File 1)
452	$\bar{\nu}$, average total (prompt plus delayed) number of neutrons released per fission event

Angular Distribution of Secondary Neutrons

MT	Description
453	Radioactive nuclide production
454	Independent fission product yield data
455	Delayed neutrons from fission
456	Prompt neutrons from fission
457	Radioactive decay data
458	Energy Release in fission
459	Cumulative fission product yield data
501	Total photon interaction cross section
502	Photon coherent scattering
504	Photon incoherent scattering
515	Pair production, electron field
516	Pair production, nuclear and electron field (i.e. pair plus triplet production)
517	Pair production, nuclear field
518	Photofission (γ,f)
532	Photoneutron (γ,n)
533	Total photonuclear
602	Photoelectric
700	(n,p_0) cross section (cross section for leaving the residual nucleus in the ground state)
701	(n,p_1) cross section for 1st excited state
702	(n,p_2) " " " 2nd " "
703	(n,p_3) " " " 3rd " "
.	
.	
.	
718	(n,p_c) " " " continuum excited state
719	(n,p_c') cross section for continuum specifically not included in σ total (redundant, used for describing outgoing proton)

MT	Description
720	(n,d_0) cross section for ground state
721	(n,d_1) cross section for 1st excited state
722	(n,d_2) cross section for 2nd excited state
.	
.	
.	
738	(n,d_c) cross section for continuum excited state
739	(n,d_c') cross section for continuum specifically not included in σ total (redundant, used for describing outgoing deuteron)
740	(n,t_0) cross section for ground state
741	(n,t_1) " " " 1st excited state
742	(n,t_2) " " " 2nd " "
.	
.	
.	
750	(n,t_c) " " " continuum excited state
759	(n,t_c') cross section for continuum specifically not included in σ total (redundant, used for describing outgoing triton)
760	$(n,{}^3He_0)$ cross section for ground state
761	$(n,{}^3He_1)$ cross section for 1st excited state
.	
.	
.	
778	$(n,{}^3He_c)$ cross section for continuum
779	$(n,{}^3He_c)$ cross section for continuum specifically not included in σ total (redundant, used for describing outgoing ${}^3He$)
780	(n,α_0) cross section for ground state
781	(n,α_1) cross section for 1st excited state
.	
.	
.	
798	(n,α_c) cross section for continuum
799	(n,α_c') cross section for continuum specifically not included in σ_T (redundant, used to describe outgoing α)

When LTT = 2 LVT = 0

MF/MT = 1451

Descriptive Information and Index

The first section of each evaluation is identified by "1451" in cols. 72-75. It consists of

- structured descriptive information
- free text descriptive information
- index of the data types included

Structured descriptive information

ENDF/B-4 format:

Field 1	Field 2	Field 3	Field 4	Field 5	Field 6
ZA	AWR	LRP	LFI	blank	NXC
blank	blank	LDD	LFP	NWD	blank

ENDF/B-5 format:

ZA	AWR	LRP	LFI	NLIB	NMOD
ELIS	STA	LIS	LISO	0	0
0.0	0.0	0	0	NWD	NXC
ZSYMA	ALAB	EDATE	AUTH (33 char.)		
REF (22 char.)		DDATE	RDATE	blank	ENDATE

ALAB = mnemonic of originating laboratory
AUTH = main author(s) of evaluation
AWR = ratio of nuclear mass to that of the neutron
DDATE = date of original distribution
EDATE = date of evaluation
ELIS = excitation energy of the target nucleus relative to 0.0 for the ground state
ENDATE = date of entry into the library
LDD = 0 (no decay data given); 1 (decay data given in MF/MT=1454)
LFI = 0 (not fissionable); 1 (fissionable)
LFP = 0 (no fission product data); 1 (fission product data given in MF/MT=1454)
LIS = 0 (ground state); 1 (first excited state); etc
LISO = 0 (ground state); 1 (first isomeric state); etc
LRP = 0 (no resonance parameters given); 1 (resolved and/or unresolved resonance parameter given in MF=2)
NLIB = 0; may eventually be used to identify different libraries
NMOD = 0 (ENDF/B-4 and ENDF/B-5 are identical); 1 (new or revised evaluation; 2 etc (successive modification)
NWD = number of free-text records within MF/MT=1454
NXC = number of sections within the evaluation = number of records of the index within MF/MT=1454
RDATE = number and date of last revision of evaluation under same MAT number
REF = bibliographic reference
STA = 0.0 (stable); 1.0 (unstable); decay data given in MF/MT=8457
ZA = target nucleus given in the form 9.42410+04 for 94-PU-241
ZSYMA = target nucleus given in the form 94-PU-241

Index

Each of the index records at the end of the 1451-section has the format

blank/blank/MF/MT/number of records/MOD

MF and MT together define the data given, e.g. MF/MT = 3/1 means: total cross-section

MOD = blank in ENDF/B-4; in ENDF/B-5 = 0 (ENDF/B-5 and ENDF/B-4 are identical); 1 (new or revised evaluation); 2 etc (successive modification).

Data tables

The numerical data table for each data type starts with a Head record and one or more Control records, typically in the following form.

	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6
Head:	ZA	AWR	N1.3	N1.4	N1.5	N1.6
Control:	N2.1	N2.2	N2.3	N2.4	N2.5	N2.6
Control:	N3.1	N3.2	etc			
Data:	energy 1	sigma 1	energy 2	sigma 2	energy 3	sigma 3
	energy 4	sigma 4	etc			
End:	0.0	0.0	0	0	0	0

ZA = target nucleus given in the form 9.42410 + 04 for 94-PU-241
AWR = ratio of nuclear mass to that of the neutron
Nn.n = numbers of which the meaning depends on the data type.

Some examples are given in the following. (These examples were written up by M.A. Khalil in 1975. Some of them apply to ENDF/B-4 only and not necessarily to ENDF/B-5.)

Format differences ENDF/B-4 versus ENDF/B-5

The following is a summary of the format differences between Versions IV and V ENDF/B tapes. ENDF/B Version V was released about June 1979.

File 1

1. The HEAD card of MT=451 has been changed. NXC, the number of dictionary entries, has been moved to the sixth field of the Hollerith LIST record of MT=451. Field 5 now contains NLIB, the library identifier, and Field 6 now contains NMOD, the material modification number.

2. Following the HEAD card of MT=451 is a new CONT card which contains information about the excitation energy, stability, state number, and isomeric state number of the target nucleus.

3. In the LIST record of MT=451, the LDD and LFP flags have been abolished. The number of dictionary entries, NXC, is now in the sixth field of the first card in this LIST record.

4. The fourth field on each dictionary card in MT=451 is now used to indicate the modification status (MOD) for the section described by the card.

5. Radioactive decay data (MT=453 and 457) has been removed from File 1. Entirely new formats have been devised and the radioactive decay data is given in MF=8, MT=457.

6. The fission product yields section (MT=454) has been removed from File 1. Fission product yield information is now given in File 8 using new formats.

7. A new section to describe energy release in fission (MF=1, MT=458) has been implemented.

File 2

1. The Reich-Moore resonance parameter representation is no longer permitted in ENDF/B, only in ENDF/A.

File 3

1. Total "gas production" MT's have been defined for H(203), D(204), T(205), He-3(206), and He-4(207).

2. The non-eleastic cross section (MT=3) is now optional and no longer required since total gamma ray production must be entered in File 13 and never as multiplicities in File 12.

File 4

1. A simplified format using a new flag, LI, has been introduced to indicate that all angular distributions for an MT are all isotropic.

File 5

1. Only the distribution laws given for LF=1, 5, 7, 9, and 11 are now allowed. LF=11 is a new format for an energy dependent Watt spectrum.

File 8

1. Information may be given for any MT specifying a reaction in which the end product is radioactive. The MT section contains information about the end product and how it decays. File 9 and 10 may be used to given the cross section for the production of the end product.

2. Fission product yield information is given under MT=454 and 459. The format has been modified to include the 1σ uncertainty of the yields. MT=454 is for the independent yields and MT=459 is for the cumulative yields.

3. The spontaneous radioactive decay data is given in MT=457. This is an entirely new format.

Files 9 and 10

1. Isomer production is described in the new File 9 or File 10. In File 9 the cross sections are obtained by the use of multiplicities. In File 10, the absolute cross section is given.

Files 17 and 18

1. Formats for time dependent photon production data files have been defined. They may be used in ENDF/A only.

Files 19, 20, 21 and 22

1. The electron production data files have been implemented.

Files 31, 32 and 33

1. The formats for data covariance files first introduced in Version IV have been extensively modified and expanded.

Neutron per Fission $\bar{\nu}(E)$

File 1, MT = 452

LNU = 1

Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Record Type
ZA	AWR	b	LNU=1	b	b	HEAD
b	b	b	b	NC	b	
C_1	C_2	-		C_{NC}		LIST
b	b	b	b	b	b	SEND

b* - blank

Field 7 = MAT
Field 8 = MF = 1

Field 9 = MT = 451 (except SEND card)
Field 10= card sequence number

LNU = 2

Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Record Type
ZA	AWR	b	LNU=2	b	b	HEAD
b	b	b	b	NR	NP	
NBT_1	INT_1	-	-	NBT_{NR}	INT_{NR}	
E_1	$\bar{\nu}(E_1)$	-	-	E_{NP}	$\bar{\nu}(E_{NP})$	TAB1
b	b	b	b	b	b	SEND

LNU = 1, Polynomial representation
      2, $\bar{\nu}(E_1)$ is tabulated
NC = No. of terms used in the polynomial expansion
C_1, C_2, C_3, C_4 = coefficients of the polynomial
NR = No. of interpolations ranges used
NP = total No. of energy points used in the tabulations
NBT(1), INT(1) = interpolation scheme for $\bar{\nu}(E)$
E_i = the energy (i^{th} point) of the neutrons causing fission

Radioactive Decay Scheme

File 1; MT= 453

1	2	3	4	5	6	Record Type
ZA	AWR	b	b	NS	b	HEAD
ZA	AWR	LIS	b	NE	NPR	(ground state)
ES(1)	ES(2)	ES(3)	-	-	ES(NE)	LIST 1
$EREL_{NPR}$	Q_{NPR}	LFS_{NPR}	b	NE+3	b	
$RTYP_{NPR}$	ZA_{NPR}	DC_{NPR}	BR(1)	-	BR(NE)	LIST 2

(Structure is repeated for each original nuclide state until all NS states have been given. Start each state with the first LIST record)

NS = No. of excited states for the original nuclide (target nucleus)
LIS = 0 for ground state, etc.
NE = No. of incident energy points
NPR = total No. of product nuclide states
ES(N) = Incident energy point (N^{th} point)
EREL = total energy released by specified decay mode (includes gamma rays and particles)
Q = reaction Q-value
LFS = state of the product nuclide (0 = ground state, etc)
RTYP = floating point values of MT number
= 0.0 for spontaneous decay of the original nuclide
DC = decay constant (sec^{-1})
BR(N) = branching ratio at the N^{th} energy point

Fission Product Yield Data

File 1; MT = 454

1	2	3	4	5	6	Record Type
ZA	AWR	LE+1	b	NS	b	HEAD
E_1 $ZAFP_1$ -	b FPS_1 -	LE YLD_1 -	b $ZAFP_2$ $ZAFP_{NFP}$	N_1 FPS_2 FPS_{NFP}	NFP YLD_2 YLD_{NFP}	(N1 = 3*NFP) LIST
E_2 $ZAFP_1$ -	b FPS_1 -	I_2 YLD_2 -	b - $ZAFP_{NFP}$	N_1 - FPS_{NFP}	NFP - YLD_{NFP}	 LIST
E_N $ZAFP_1$ -	b FPS_1 -	I_N YLD_1 -	b - $ZAFP_{NFP}$	N_1 - FPS_{NFP}	NFP - YLD_{NFP}	 (N = LE+1) LIST

NFP = No. of fission products to be specified at the ith incident neutron energy point (sets of 3 parameters: ZAFP, FPS, YLD)
E_i = incident energy causing fission
LE = o, no energy dependence
>o, means that (LE+1) sets of fission product yield are given
I_i = interpolation scheme to be used between E_i-1 and E_i energy points
ZAFP = the (ZA) identifier for a particular fission product
YLD = fractional yield for a particular fission product
FPS = o.o (ground state of fission product)
= 1.o (ist excited state, etc)

Delayed Neutron Data, ν_d

File 1; MT = 455

1	2	3	4	5	6	Record Type
ZA	AWR	b	1	b	b	HEAD
b λ_1	b λ_2	b -	b -	NNF -	b λ_{NNF}	LIST
b CD_1	b CD_2	b -	b -	NCD -	b CD_{NCD}	LIST
b	b	b	b	b	b	SEND

1	2	3	4	5	6	Record Type
ZA	AWR	b	LND=2	b	b	HEAD
b λ_1	b λ_2	b λ_3	b -	NNF -	b λ_{NNF}	LIST
b NBT_1 E_1	b INT_1 $\nu_d(E_1)$	b - -	b - -	NR NBT_{NR} E_{NP}	NP INT_{NR} $\nu_d(E_{NP})$	TAB1
b	b	b	b	b	b	SEND

LND = 1, polynomial expansion
 = 2, tabulated values of ν_d
NNF = No. of precursor families given
λ_i = decay constant of the ith precursor (sec^{-1})
NCD = No. of terms in the polynomial expansion
CD_1, CD_2,... = coefficients for the polynomial

Resonance Parameters Data

File 2; MT = 151

This special case (LRP = 0, i.e. no resonance parameters are given) will be described here. The only data given is effective scattering radius. The general description of resonance parameters data (LRP = 1) will be discussed in a separate sheet.

1	2	3	4	5	6	Record Type
ZA	AWR	b	b	NIS=1	b	HEAD
ZAI	ABN	b	LFW=o	NER=1	b	CØNT
EL	EH	LRU=o	LRF=o	b	b	CØNT
SPI	AP	b	b	NLS=o	b	CØNT
b	b	b	b	b	b	SEND
b	b	b	b	b	b	FEND

ZAI = is the (Z,A) designation for an isotope
ABN = Abundance (weight fraction) of an isotope
EL = Lower limit for the energy range
EH = Upper limit " " " "
SP1 = Nuclear spin of the target nucleus, I.
AP = Spin-independent effective scattering radius (in units of 10^{-12}cm)
LRU = Test for resolved (=1) or unresolved (=2) resonance parameters
LRF = Test for the type of resonance formula

Field 7 = MAT
Field 8 = MF = 2 (except FEND card
Field 9 = MT = 151 (except SEND card)
Field 10 = card sequence number
b = blank

Neutron Cross Section σ(E)

File 3

1	2	3	4	5	6	Record Type
ZA	AWR	LIS	LFS	b	b	HEAD
T NBT_1 E_1	Q INT_1 $\sigma(E_1)$	LT - -	b - -	NR NBT_{NR} E_{NP}	NP INT_{NR} $\sigma(E_{NP})$	TAB1
b	b	b	b	b	b	SEND

LFS = indicator that specifies the final excited state of the residual nucleus
LFS = 3, means 3rd state

Neutron cross sections (in barns) are given as a function of incident neutron energy E (in L-system). The threshold energy for a reaction is:

$$E_{th} = \left(\frac{AWR + 1.0}{AWR}\right) \quad |Q|$$

Angular Distribution of Secondary Neutrons

File 4

Definitions

LTT	=	1 (Legendre coefficients)
	=	2 (Tabulated distributions)
LVT	=	0 (not given)
	=	1 (Transformation matrix given)
LCT	=	1 (Laboratory system)
	=	2 (center of mass system)
NK	=	No. of elements in the transformation matrix
NM	=	Maximum order Legendre polynomial (in CM or LAB system)
$U_{\ell,m}$	=	Elements of the transformation matrix
NR	=	No. of interpolation ranges for the distribution
NE	=	No. of energy points at which distribution will be given
NP	=	No. of cosine values for a particular distribution
NBT_i and INT_i	=	Interpolation scheme (to interpolate distribution between given energy points, or the coefficients, f_ℓ between given values)
E_i	=	Energy of the i^{th} point
NL	=	The order of the Legendre expansion at particular energy point
$f_\ell(E_i)$	=	value of the ℓ^{th} coefficient for the i^{th} point
μ_j	=	value of cosine at point j
$P(\mu_j,E_i)$	=	Normalized angular probability at μ_j for energy point E_i

When LTT = 1;   LVT = o

1	2	3	4	5	6	Record Type
ZA	AWR	LVT=o	LTT=1	b	b	HEAD
b	AWR	b	LCT	NK=o	NM=o	CØNT
b NBT_1	b INT_1	b –	b –	NR NBT_{NR}	NE INT_{NR}	TAB2
T $f_1(E_{NE})$	E_{NE} $f_2(E_{NE})$	LT –	b –	NL –	b $f_{NL}(E_{NE})$	(1-NE energy points) LIST
b	b	b	b	b	b	SEND

When LTT = 1, LVT = 1

1	2	3	4	5	6	Record Type
ZA	AWR	LVT=1	LTT=1	b	b	HEAD
b	AWR	b	LCT	NK	NM	
$U_{o,o}$	$U_{1,o}$	$U_{2,o}$	-	-	$U_{NM,o}$	
$U_{o,1}$	$U_{1,1}$	$U_{2,1}$	-	-	$U_{NM,1}$	
-	-	-	-	-	-	
$U_{o,NM}$	$U_{1,NM}$	$U_{2,NM}$	-	-	$U_{NM,NM}$	LIST
b	b	b	b	NR	NE	
NET_1	INT_1	-	-	NBT_{NR}	INT_{NR}	TAB2
T	E_{NE}	LT	b	NL	b	(1-NE energy points)
$f_1(E_{NE})$	$f_2(E_{NE})$	-	-	-	$f_{NL}(E_{NE})$	LIST
b	b	b	b	b	b	SEND

When LTT = 2, LVT = 1

1	2	3	4	5	6	Record Type
ZA	AWR	LVT=1	LTT=2	b	b	HEAD
b	AWR	b	LCT	NK	NM	
$U_{o,o}$	$U_{1,o}$	$U_{2,o}$	-	-	$U_{NM,o}$	
-	-	-	-	-	-	
$U_{o,NM}$	$U_{1,NM}$	$U_{2,NM}$	-	-	$U_{NM,NM}$	LIST
b	b	b	b	NR	NE	
NBT_1	INT_1	-	-	NBT_{NR}	INT_{NR}	TAB2
T	E_{NE}	LT	b	NR	NP	
NBT_1	INT_1	-	-	NBT_{NR}	INT_{NR}	(1-NE energy points)
μ_1	$P(\mu_1,E_{NE})$	-	-	μ_{NP}	$P(\mu_{NP},E_{NE})$	TAB1
b	b	b	b	b	b	SEND

When LTT = 2, LVT = o

1	2	3	4	5	6	Record Type
ZA	AWR	LVT=o	b	b	b	HEAD
b	AWR	b	LCT	NK=o	NM=o	CØNT
b	b	b	b	NR	NE	
NBT_1	INT_1	-	-	NBT_{NR}	INT_{NR}	TAB2
T	E_{NE}	LT	b	NR	NP	(1-NE energy points)
NBT_1	INT_1	-	-	NBT_{NR}	INT_{NR}	
μ_1	$P(\mu_1, E_{NE})$	-	-	μ_{NP}	$P(\mu_{NP}, E_{NE})$	TAB1
b	b	b	b	b	b	SEND

Energy Distributions of Secondary Neutrons

File 5

NK = No. of partial energy distributions used for a particular reaction type (MT)
LF = Flag that specifies the type of distribution used
NP = No. of energy points at which fractional probabilities, $P(E_i)$, are given
NF = No. of secondary energy points for a particular distribution
NE = No. of incident energy points at which distributions are given
$g(E \rightarrow E')$ = Normalized probabilities
NBT_i and INT_i = Interpolation scheme

I. Tabulated energy distributions, LF = 1, $f(E \rightarrow E') = g(E \rightarrow E')$:

ZA	AWR	b	b	NK	b	HEAD
T	b	LT	LF=1	NR	NP	
NBT_1	INT_1	-	-	NBT_{NR}	INT_{NR}	
E_1	$P(E_1)$	-	-	E_{NP}	$P(E_{NP})$	TAB1
b	b	b	b	NR	NE	
NBT_1	INT_1	-	-	NBT_{NR}	INT_{NR}	TAB2
T	E_{NE}	LT	b	NR	NF	(1-NE energy points)
NBT_1	INT_1	-	-	NBT_{NR}	INT_{NR}	
E_1	$g(E_{NE} \rightarrow E_1)$	-	-	E_{NF}	$g(E_{NE} \rightarrow E_{NF})$	TAB1
b	b	b	b	b	b	SEND

II. Discrete level excitation, LF = 3

ZA	AWR	b	b	NK	b	HEAD
T	0	LT	LF=3	NR	NP	
NBT_1	INT_1	-	-	NBT_{NR}	INT_{NR}	
E_1	$P(E_1)$	-	-	E_{NP}	$P(E_{NP})$	TAB1
b	b	b	b	b	b	SEND