IAEA-NDS- 62 (Rev. 0)

INTERNATIONAL ATOMIC ENERGY AGENCY

NUCLEAR DATA SERVICES

DOCUMENTATION SERIES OF THE IAEA NUCLEAR DATA SECTION

ENDF/B-5

Fission Product Yields File

Summary Documentation of contents and format

Abstract: The ENDF/B-5 Fission Product Yields File contains a complete set of independent and cumulative fission product yields, representing the final data from ENDF/B-5 as received at the IAEA Nuclear Data Section in June 1985. Yields for 11 fissioning nuclides at one or more neutron incident energies are included. The data are available costfree on magnetic tape from the IAEA Nuclear Data Section.

O. Schwerer

October 1985

ENDF/B-5 Fission Product Yields File

Contents of present document

I. Summary of file contents

ENDF/B-5 contains independent and cumulative fission-product yields for 11 fissioning nuclides at one or more neutron incident energies. A total of 20 yield sets of each type (independent and cumulative) are given. Depending on the fission system, there are 1100 to 1200 nuclides included for each type. Uncertainties are also given for each yield. The independent yields apply before, and cumulative yields apply after, delayed neutron emission. The data are based on Ref.(1), but have been extended where necessary to include all nuclides in the decay files and/or nuclides that are at least four charge units on the neutron rich side of the most probable charge per mass chain. In a few cases, the isomeric state identifier has been revised to agree with the decay files and second isomeric states added. Where possible, data are based on evaluated measured data and on yield distribution models otherwise. An exposition of the specific evaluation process is included in Ref.(2) and possibly more extensively in Ref.(3).

See also the introductory text within the data files (reprinted on the next page).

Chain yields, together with other summary data on fission products, extracted from the ENDF/B-5 files for easy reference, were published in (4).

The file contains 31487 80-character records. It is available costfree from the IAEA Nuclear Data Section.

The following introduction applies to all of the 11 fissioning nuclides included in the file.

ENDF/B-V,7/78 T. R. ENGLAND, LOS ALAMOS
TH232 YIELD DATA

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ENDF/B-V YIELD DATA
FISSION PRODUCT YIELD DATA FOR PHASE ONE REVIEW
SET 5E,7/78. VALUES OBTAINED FROM THE RECOMMENDATIONS OF THE
YIELDS SUBCOMMITTEE, T R ENGLAND (CHAIRMAN), D M GILLIAM,
Y HARKER, J R LIAW, W J MAECK, D G MADLAND, V MCLANE MAY,
P L REEDER, B F RIDER, R E SCHENTER, B I SPINRAD, J P UNIK,
A WAHL, W WALKER, B W WEHRING, K WOLFSBERG

UNCERTAINTIES ARE BASED ON THE TOTAL YIELD TO EACH ZA.
WHEN THERE IS AN ISOMERIC STATE,THE INDEPENDENT NUCLIDE
YIELD TO EACH STATE HAS A LARGER UNCERTAINTY THAN THE TOTAL
YIELD IN STATE DISTRIBUTIONS (UNCERTAINTIES AVERAGE
APPROXIMATELY 50 PERCENT BUT CAN BE LARGER),ANY YIELD
HAVING A LARGER UNCERTAINTY (45-64 PERCENT) MAY BE A MODEL
ESTIMATE OR A VALUE ASSIGNED TO THE YIELDS ON THE WINGS OR
VALLEY OF THE MASS YIELD DISTRIBUTION. THESE SMALL YIELDS
MAY ONLY BE ACCURATE TO WITHIN A FACTOR OF 2.

MT454 CONTAINS DIRECT YIELDS BEFORE DELAYED NEUTRON EMISSION

MT459 CONTAINS CUMULATIVE YIELDS ALONG EACH ISOBARIC CHAIN
AFTER DELAYED NEUTRON EMISSION.

DIRECT AND CUMULATIVE YIELDS ARE NORMALIZED BY THE SAME FACTORS
BASED ON B.F.RIDER EVALUATION. THE ISOMERIC STATE MODEL,
LA-6595-MS (ENDF-241), AND DELAYED NEUTRON EMISSION BRANCHINGS
(PN VALUES) FOR 102 EMITTERS, LA-UR-78-688, AND A PAIRING
EFFECTS,LA-6430-MS (ENDF-240), HAVE BEEN INCORPORATED.

DATA PREPARED FOR FILES BY T.R.ENGLAND (LASL LTR. T-2-L-2891)

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REFERENCES

1. B.F. Rider and M.E. Meek, "Compilation of Fission Product Yields," General Electric Co. report NEDO-12154-2E(E) (June 1976).

2. B.F. Rider, T.R. England, D.G. Madland, J.R. Liaw, and R.E. Schenter, "Evaluation of Fission Product Yields for the U.S. National Nuclear Data Files," Proc. Conf. on Nuclear Data Evaluation Methods and Procedures, Brookhaven National Laboratory, September 22-25, 1980, BNL-NCS-51363 (March 1981).

3. T.R. England and B.F. Rider, "Status of Fission Yield Evaluations," Proc. Specialists' Meeting on Yields and Decay Data for Fission Product Nuclides," Brookhaven National Laboratory, October 24-27, 1983 (sponsored by the OECD/NEA Nuclear Data Committee) (report in Conf. 8310104). Los Alamos National Laboratory document LA-UR-83-3531.

4. T.R. England, W.B. Wilson, R.E. Schenter, F.M. Mann, Summary of ENDF/B-V Data for Fission Products and Actinides, report EPRI NP-3787 (ENDF-322 Final Report), December 1984.

OVERVIEW OF CONTENTS OF ENDF/B-V FP YIELDS IN COMPARISON WITH ENDF/B-IV *)

Characteristic Neutron Incident Energy

MAT (ENDF/B-V)	Target Nuclide	Thermal	Fast	High (14 MeV)	Spontaneous
101	^{232}Th		4,5	5	
102	^{233}U	4,5	5	5	
103	^{235}U	4,5	4,5	4,5	
104	^{236}U		5		
105	^{238}U		4,5	4,5	
106	^{237}Np		5		
107	^{239}Pu	4,5	4,5	5	
108	^{240}Pu		5		
109	^{241}Pu	4,5	5		
110	^{242}Pu		5		
111	^{252}Cf				5

*) 10 sets of direct yields in ENDF/B-IV (~ 11 000 yields),
20 sets of direct and cumulative (by A and Z yields) in ENDF/B-V,
now including uncertainties (~ 44 000 yields plus uncertainties).
4 = included in ENDF/B-IV
5 = included in ENDF/B-V

II. ENDF/B Format

The basic layout of the ENDF/B-5 format and the data formats used in the ENDF/B-5 Fission Product Yields File are described in the following pages. A more complete description covering data types for other ENDF/B files can be found in IAEA-NDS-10, Rev. 1 (Nov. 1981).

For the complete ENDF/B-5 Format Manual see the report

ENDF-102, 2nd ed., Oct. 1979 (BNL-NCS-50496),
rev. by R. Kinsey.

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 used in the Fission Product Yield File are

MF = 1 General information
MF = 8 Radioactive decay and fission product yield data

MT = 451 Heading or title information (given only in File 1)
454 Independent fission product yield data
459 Cumulative " " " "

A complete index of all existing MF and MT numbers can be found e.g. in IAEA-NDS-10, Rev. 1.

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

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 for Fission Product Yield Data (File 8, MT=454, 459)

The numerical data table starts with a "Head" record, followed by the actual data table according to the following format:

1	2	3	4	5	6	Record Type
ZA	AWR	LE+1	0	0	0	HEAD
E_1	0.0	LE	0	NN	NFP	(NN = 4 * NFP)
$ZAFP_1$	FPS_1	$Y_1(E_1)$	DY_1	$ZAFP_2$	FPS_2	
$Y_2(E_1)$	DY_2	...	...	...	...	
...	...	$ZAFP_{NFP}$	FPS_{NFP}	$Y_{NFP}(E_1)$	DY_{NFP}	LIST
E_2	0.0	I_2	0	NN	NFP	
$ZAFP_1$	FPS_1	$Y_1(E_2)$	DY_1	...	...	
...	...	$ZAFP_{NFP}$	FPS_{NFP}	$Y_{NFP}(E_2)$	DY_{NFP}	LIST
E_N	0.0	I_N	0	NN	NFP	(N = LE+1)
$ZAFP_1$	FPS_1	$Y_i(E_N)$	DY_1	...	...	
...	...	$ZAFP_{NFP}$	FPS_{NFP}	$Y_{NFP}(E_N)$	DY_{NFP}	LIST

NFP = No. of fission products to be specified at the ith incident neutron energy point (sets of 3 parameters: ZAFP, FPS, yield Y)
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 (see next page)
ZAFP = the (ZA) identifier for a particular fission product
Y = fractional yield for a particular fission product
FPS = o.o (ground state of fission product)
= 1.o (1^{st} excited state, etc)
DY = 1σ uncertainty in Y

Interpolation schemes

Interpolation schemes are provided to obtain values of a function, y(x), from a tabulated series of X(N) and Y(N). The allowed interpolation schemes are:

I	Description
1	y is constant in x (constant) *
2	y is linear in x (linear-linear)
3	y is linear in lnx (linear-log)
4	lny is linear in x (log-linear)
5	lny is linear in lnx (log-log)

* I = 1 (constant) implies that the function is constant and equal to the value given at the lower limit of the interval.

III. ENDF/B files available from IAEA-NDS

Of the ENDF/B evaluated nuclear data file the following parts are available:

ENDF/B-5	Summary documentation	
"Standard" nuclides	see	IAEA-NDS-15
Actinides	see	IAEA-NDS-13
Fission-product yields	see	IAEA-NDS-62
Fission-product cross-sections	see	IAEA-NDS-25
Dosimetry reactions	see	IAEA-NDS-24
Activation reactions	see	IAEA-NDS-38
Gas production cross-sections	see	IAEA-NDS-42

(The ENDF/B-5 "General Purpose" file is not available on magnetic tape.)

ENDF/B-4:		
"General purpose" file	see	IAEA-NDS-23

ENDF/B-3:		
Thermal neutron scattering file	see	rept. GA-8774 Rev.