JAERI-Data/Code
2003-011

THE LIBRARIES FSXLIB AND MATXSLIB BASED ON JENDL-3.3

July 2003

Kazuaki KOSAKO*, Naoki YAMANO*, Tokio FUKAHORI,
Keiichi SHIBATA and Akira HASEGAWA

日本原子力研究所
Japan Atomic Energy Research Institute

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編集兼発行　　日本原子力研究所

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The Libraries FSXLIB and MATXSLIB Based on JENDL-3.3

Kazuaki KOSAKO*, Naoki YAMANO*, Tokio FUKAHORI,
Keiichi SHIBATA and Akira HASEGAWA

Department of Nuclear Energy System
Tokai Research Establishment
Japan Atomic Energy Research Institute
Tokai-mura, Naka-gun, Ibaraki-ken

(Received May 26,2003)

The third revision of JENDL-3 (JENDL-3.3) was released in May 2002. The library is useful for many applications. For users' convenience, we have produced two JENDL-3.3 based libraries FSXLIB-J33 and MATXSLIB-J33 for transport calculation codes such as MCNP and ANISN. These two libraries are available on request.

Keywords: JENDL-3.3, NJOY, Transport Calculation, FSXLIB, MATXSLIB, MCNP, ANISN

* Sumitomo Atomic Energy Industries, Ltd.

JAERI-Data/Code 2003-011

JENDL-3.3 に基づくライブラリーFSXLIB と MATXSLIB

日本原子力研究所東海研究所エネルギーシステム研究部
小迫　和明*・山野　直樹*・深堀　智生・柴田　恵一・長谷川　明

(2003 年 5 月 26 日受理)

JENDL-3 の第 3 改訂版（JENDL-3.3）は 2002 年 5 月に公開された。このライブラリーは種々の分野で利用される。今般、MCNP や ANISN 等の輸送計算コード用に JENDL-3.3 に基づく 2 つのライブラリーFSXLIB-J33 と MATXSLIB-J33 を整備した。これらのライブラリーは、申し込みにより利用可能である。

東海研究所：〒319-1195　茨城県那珂郡東海村白方白根 2-4
*　住友原子力工業（株）

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1. Introduction

The latest version of JENDL general purpose library (JENDL-3.3)[1] was released in May 2002. The major problems with JENDL-3.2[2] were resolved in the latest version. In general, the evaluated data are converted to constants appropriate for specific applications. Recently, many users employ a continuous energy Monte Carlo code MCNP[3] for transport calculations. It is also recognized that conventional discrete ordinate multi-group transport codes such as ANISN[4] are used to save computing time. Considering such a situation, we generated MCNP and MATXS-format libraries based on JENDL-3.3 by using NJOY99 code[5]. These MCNP and MATXS libraries are referred to as **FSXLIB-J33** and **MATXSLIB-J33**, respectively.

2. Processing

JENDL-3.3 was compiled in the ENDF-6 format[6]. The latest version of NJOY99 (NJOY99.67) has been used to produce the MCNP and MATXS libraries.

2.1 Problems with Processing JENDL-3.3

(1) Missing MTs for cascade gamma-rays

In JENDL-3.3, transition probabilities are provided for cascade gamma-rays due to inelastic scattering. In cases where meta-stable states are involved, the gamma-ray transition from the meta-stable states is prohibited. Therefore, there are MTs that do not appear in the transition probabilities. NJOY could not deal with such missing MTs. **Table 1** indicates the nuclides which have a problem of gamma-ray production.

Table 1 List of nuclides whose gamma-ray production data have processing problems

Nuclide	MT	Excitation Energy	Half Life
Nb-93	51	30.4 keV	16.13 y
Hg-199	57	532.5 keV	42.6 m
Pb-207	53	1633.4 keV	0.806 s

(2) Interpolation of particle emission spectra

The unit base interpolation scheme (INT=22) was adopted for neutron emission spectra (MF=5, 6) in JENDL-3.3. NJOY could not process such data properly.

(3) Energy balance

It is difficult to keep energy balance in nuclear data files, since the evaluation is based on a combination of measurements and nuclear model calculations. There are cases where extremely large or negative KERMA (Kinetic Energy Released in Material)

factors are obtained by using the energy-balance method. **Appendix A** lists the nuclide data which may issue problems in the calculation of KERMA factors.

(4) Doppler broadening

A probability table (ptable) for unresolved resonance can be used for MCNP-4C. As the upper limit of Doppler broadening, NJOY uses a minimum of 1 MeV, the upper limit of resonance region, and the lowest threshold energy of inelastic scattering. However, if there is an overlap between unresolved resonance and inelastic scattering, the situation will become complicated. The overlap of unresolved resonance with inelastic channels is listed in **Appendix B**.

2.2 Modification of NJOY

Modifications were made to NJOY99.67. This work was done by using a FORTRAN compiler g77 on RedHat Linux 7.1.

(1) Missing MTs for cascade gamma-rays

The level energies of the missing MTs were inserted for ^{93}Nb, ^{199}Hg and ^{207}Pb. The revised modules are HEATER, ACER, and GROUPR.

(2) Interpolation of particle emission spectra

NJOY cannot deal with INT=22 in MF5 and MF6. GROUPR was modified so as to process data with INT=21-25. ACER was not revised, since it is capable of processing data of INT=22. It should be noted that MCNP processes the data of INT=22 properly. Therefore, this modification was intended for the MATXS library.

(3) I/O for MF=32

I/O routines of MODER were found to be wrong, when evaluated data contained MF32 (covariances of resonance parameters) even though the data were given in the correct ENDF-6 format. The routines were revised to process data properly.

(4) Resonance parameters

The lower limit of unresolved resonance parameters, which can be treated, was changed to 1 eV from 10 eV, since that of ^{148m}Pm is 0.6 eV, which is the lowest value in JENDL-3.3.

(5) KERMA factors

The kinematical method was incorporated to calculate KERMA factors by HEATR in order to avoid negative or large values. Users can select the energy balance or kinematical method.

(6) Doppler broadening of discrete levels

The number of the discrete levels to be Doppler broadened had been limited to 10 for inelastic scattering cross sections. BROADR was modified to allow 40 discrete

levels.

(7) Interpolation of unresolved resonance data in PENDF

The interpolation number was missing in the PENDF file produced by PURR. The bug has been removed.

(8) Enlargement of array size

The following dimensions were adopted for MATXSR and ACER:

dimension b(30000)	in MATXSR
dimension aco(3999),cprob(3999),cumm(3999)	in ACER.

(9) Other modifications

a) Wrong arguments for "call tablio" and "call repoz" were corrected for ACER.

b) The highest order of the Legendre expansion was changed to 64 from 20 in ACER.

c) RECONR was revised so as not to lead to endless loop in the calculation of unresolved resonance cross sections if e=ee=enext.

d) The normalization factor is set to 1.0 in ACER when zero distributions are given with LAW=7.

e) There is a possibility that an endless loop occurs when spectra given with LAW=7 are converted to those with LAW=1/LANG=1. The bug has been removed in GROUPR.

f) Setting "ee=0" was performed in an inappropriate place of GROUPR. The statement was moved to an appropriate place.

g) There are cases where Q-values are undefined in ACER. The bug has been removed.

3. FSXLIB-J33

The revised NJOY99.67 was used to produce a library for MCNP-4C. The specification of processing is given below:

Accuracy of pointwise cross sections	0.1%
Temperature	300 K
Upper limit of thermal region	4.6 eV
Thermal scattering	free gas model
Photon production	detailed type
Probability table for unresolved resonance	σ_0=10^{10},10^4,10^3,300,100, 30,10,1,0.1,10^{-5}
newfor options	1
KERMA calculation	energy balance except for

	$^{33,34,36}S$, $^{42,46,48}Ca$, ^{47}Ti, $^{92,94,95,96,97,98,100}Mo$, $^{151,153}Eu$, $^{174,176,177,178,179,180}Hf$, ^{181}Ta, $^{182,183,184,186}W$, $^{206,207,208}Pb$, ^{209}Bi, whose data were produced by kinematical method.
Suffix of ZAID	42c for ground states of stable isotopes and elements 43c for the first meta-stable states

A sample input for ^{151}Eu is given in **List 1**.

```
moder
  20  -21
reconr
 -21  -22
'pendf tape (in autonj system)' /
6325    0 /
1.000E-03 /
   0 /
broadr
 -21  -22  -23
6325    1    0    0    0 /
1.000E-03 -1.000E+05 /
 300.00 /
   0 /
heatr
 -21  -23  -24 /
6325    5    0    0    0    2    0    1 /
 302  318  402  443  444 /
thermr
   0  -24  -23 /
   0 6325    8    1    1    0    1  221 /
 300.00 /
1.000E-03 4.600E+00 /
purr
 -21  -23  -25 /
6325    1   10   20 1000    1 /
 300.00 /
1.0e10 1.0e4 1000. 300. 100. 30. 10.  1. 0.1 1.0e-5 /
   0 /
acer
 -21  -25    0   91   92 /
   1    1    1 0.42    0 /
' 63-Eu-151  JENDL-3.3 with NJOY99' /
6325  300.00 /
   1    1 /
 /
stop
```

List 1 Sample input data of Eu-151 for generating an MCNP library

We generated type-1 (text) and type-2 (binary, 32 bit x86 CPU) libraries. The list of nuclides is given in **Appendix C**.

4. MATXSLIB-J33

The NJOY99.67 code was also used to generate a MATXS library. The MATXS library can be further converted to a library for discrete ordinate multi-group transport codes by using the TRANSX-2.15 code[7]. Self-shielding factors for unresolved resonance were calculated by PURR module. The photon library EPDL97[8] was employed to make a coupled neutron and photon library. The specification of processing is given below:

Group structure	VITAMIN-J Neutron: 175g Photon: 42g
Legendre expansion	P-6
Accuracy of pointwise cross sections	0.1%
Temperature	300K
Upper limit of thermal region	4.6 eV
Thermal scattering	Free gas model
Self-shielding	σ_0=10^{10},10^4,10^3,300,100, 30,10,1,0.1,10^{-5}
KERMA calculation	energy balance except for ^{33,34,36}S, ^{42,46,48}Ca, ^{47}Ti, ^{92,94,95,96,97,98,100}Mo, ^{151,153}Eu, ^{174,176,177,178,179,180}Hf, ^{181}Ta, ^{182,183,184,186}W, ^{206,207,208}Pb, ^{209}Bi, whose data were produced by kinematical method.

A sample input is given in **List 2** for ^{151}Eu.

```
moder
  20  -21
reconr
 -21  -22
'pendf tape (in autonj system)' /
6325    0 /
1.000E-03 /
   0 /
broadr
 -21  -22  -23
6325    1    0    0    0 /
1.000E-03 -1.000E+05 /
 300.00 /
   0 /
heatr
 -21  -23  -24 /
6325    5    0    0    0    2    0    1 /
 302  318  402  443  444 /
thermr
   0  -24  -23 /
   0 6325    8    1    1    0    1  221 /
 300.00 /
1.000E-03 4.600E+00 /
purr
 -21  -23  -25 /
6325    1   10   20 1000    1 /
 300.00 /
1.0e10 1.0e4 1000. 300. 100. 30. 10.  1. 0.1 1.0e-5 /
   0 /
moder
  30  -31
reconr
 -31  -32 /
'pendf tape (in autonj system)' /
6300    0 /
1.000E-03 /
   0 /
gaminr
 -31  -32    0  -33 /
6300   10    3    6    0 /
'42-group photon  63-eu' /
  -1    0 /
   0 /
groupr
 -21  -25    0  -24 /
6325   17   10   11    6    1   10    1 /
' 63-Eu-151  JENDL-3.3 with NJOY99' /
 300.00 /
1.0e10 1.0e4 1000. 300. 100. 30. 10. 1. 0.1 1.0e-5 /
 3 /
 3  221 'free thermal scattering' /
 3  251 'mubar' /
 3  252 'xi' /
 3  253 'gamma' /
 3  259 '1/v' /
 6 /
 6  221 'free thermal scattering' /
16 /
 0 /
   0 /
```

List 2 Sample input data of Eu-151 for generating a MATXS library

```
matxsr
  -24  -33   90 /
    0 'jaeri & saei' /
    2    4    1    1 /
 'vitamin-j 175-g matxs library' /
 'n' 'g' /
  175   42 /
 'nscat'  'ng'  'gscat'  'ntherm' /
    1    1    2    1 /
    1    2    2    1 /
 'eu151'   6325 6300 /
 stop
```

List 2 (continued)

5. Files

The files available are given as follows:

xsdir.fsxlb331:	a directory for fsxlb331
xsdir.fsxlb332:	a directory for fsxlb332
fsxlb331.gz:	a type-1 (text) library for MCNP compressed by gzip
fsxlb332:	a type-2 (binary, 32 bits x86 CPU) library for MCNP
matxs-j33.tar.gz:	a compressed MATXS library (text)
readme_fsxlb33.txt	a readme file for FSXLIB-J33
readme_matxs-j33.txt	a readme file for MATXSLIB-J33

6. Summary

We produced two libraries FSXLIB-J33 and MATXSLIB-J33 for transport codes. Both libraries are based on JENDL-3.3. We expect these libraries to be used for many applications. Any comments and suggestions on the basis of experience in the practical use of the libraries can be mailed to:

shibata@ndc.tokai.jaeri.go.jp

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7) R. E. MacFarlane: "TRANSX 2: A Code for Interfacing MATXS Cross-section Libraries to Nuclear Transport Codes," LA-12312-MS (1992).
8) D.E. Cullen, et al.: "EPDL97: The Evaluated Photon Data Library '97 Version," UCRL-50400, Vol. 6, Rev. 5 (1997).

Appendix A List of nuclides whose data are problematic in KERMA calculation

(1) KERMA factors will be overestimated when "one-particle recoil approximation" is applied to the reactions MT=16, 22, 28 in MF6 with relatively large cross sections.

【 Ca-40 : MT=28, E > 15 MeV 】
【 Ca-42 : MT=22,28, E > 14 MeV 】
【 Ca-43 : MT=16, E > 15 MeV 】
【 Fe-54 : MT=28, E > 15 MeV 】
【 Cu-63 : MT=28, E > 10 MeV 】
【 Zr-91 : MT=16, E > 12 MeV 】
【 Eu-151 : MT=16, E > 11 MeV 】
【 Eu-153 : MT=16, E > 11 MeV 】
【 Pb-206 : MT=16, E > 10 MeV 】
【 Pb-208 : MT=16, E > 7 MeV 】

(2) Wrong interpolation is performed for the data given in MF=13/MT=3 with INT=1.

【 Mo-92 】
【 Mo-94 】
【 Mo-95 】
【 Mo-96 】
【 Mo-97 】
【 Mo-98 】
【 Mo-100 】

(3) Too small multiplicities are given for MF=12/MT=91.

【 Ti-46 : E = all 】

(4) Energy is not conserved for gamma-ray emission in MT=91.

【 S-32 : E = 6 - 8 MeV 】
【 S-33 : E = 4 - 5 MeV 】
【 S-34 : E = 5 - 11 MeV 】
【 S-36 : E = 6 - 9 MeV 】
【 K-39 : E = 4 - 6 MeV 】
【 Ca-40 : E = 7 - 8 MeV 】
【 Ca-42 : E = 4 - 7 MeV 】
【 Ca-43 : E = 3 - 9 MeV 】
【 Ca-46 : E = 4 - 6 MeV 】
【 Ca-48 : E = 5 - 7 MeV 】
【 Ti-47 : E = all 】
【 Ti-50 : E = 10 - 20 MeV 】
【 Fe-54 : E = all 】
【 Fe-57 : E = all 】
【 Ni-61 : E = 3 - 7 MeV 】
【 Cu-65 : E = 6, 8 - 9 MeV 】
【 Zr-90 : E = 4 - 6 MeV 】
【 Zr-91 : E = 3 - 5 MeV 】
【 Zr-94 : E = all 】
【 Zr-96 : E = 3 - 5 MeV 】
【 Eu-151 : E = all 】
【 Eu-153 : E = 0.5 - 8, 16 - 20 MeV 】
【 Er-167 : E = 0.8 MeV 】
【 Hf-174 : E = 6 - 14, 16 - 20 MeV 】
【 Hf-176 : E = all 】

Appendix A (continued)

[Hf-177 : E > 5 MeV]
[Hf-178 : E > 5 MeV]
[Hf-179 : E > 5 MeV]
[Hf-180 : E > 4 MeV]
[Ta-181 : E = all]
[Hg-196 : E = 3 - 9.0199 MeV]
[Hg-198 : E = 2.5 - 7 MeV]
[Hg-199 : E = 2 - 8 MeV]
[Hg-200 : E = 3 - 8 MeV]
[Hg-201 : E = 2 - 6 MeV]
[Hg-202 : E = 2.5 - 6 MeV]
[Hg-204 : E = 4 - 8 MeV]
[Pb-204 : E = all]
[Pb-206 : E = 3 - 6, 8 - 9, 11 - 20 MeV]
[Pb-207 : E = 3, 6, 8 - 20 MeV]
[Pb-208 : E = 8 - 9, 11 - 12, 14 - 20 MeV]

(5) Energy is not conserved for gamma-ray emission in MT=16.
[Ca-48 : E = 11 - 14 MeV]
[Ti-47 : E = 10 MeV]
[Ti-48 : E = 12 - 13 MeV]
[Ti-49 : E = 17, 20 MeV]
[Ti-50 : E = 12 - 13, 19 - 20 MeV]
[Mn-55 : E = 11 - 12, 14 - 16 MeV]
[Fe-54 : E = 17 - 19 MeV]
[Fe-56 : E > 15 MeV]
[Fe-57 : E = 8 - 9, 16 - 20 MeV]
[Fe-58 : E = all]
[Cu-63 : E = 15, 18 MeV]
[Cu-65 : E = 11, 13 - 14, 16 - 18, 20 MeV]
[Eu-153 : E = 9 - 10 MeV]
[Hf-174 : E > 9 MeV]
[Hf-176 : E = 9, 10, 13, 14 MeV]
[Hf-177 : E = 13 - 18 MeV]
[Hf-178 : E = 12 - 17 MeV]
[Hf-179 : E = 7 - 9, 12 - 17 MeV]
[Hf-180 : E = 9, 14 - 16 MeV]
[Hg-196 : E = 9.0199 - 12 MeV]
[Hg-198 : E = 9.0351 - 10 MeV]
[Hg-199 : E = 8 MeV]
[Hg-200 : E = 9 - 10 MeV]
[Hg-201 : E = 7.0744 - 9 MeV]
[Hg-202 : E = 8 - 12 MeV]
[Hg-204 : E = 8 - 10 MeV]

(6) Energy is not conserved for gamma-ray emission in MT=17.
[Zr-94 : E = all]
[Hf-177 : E = 20 MeV]
[Hf-178 : E > 15 MeV]
[Hf-179 : E > 14 MeV]
[Hf-180 : E > 14 MeV]
[Ta-181 : E = 15 - 18 MeV]
[Hg-196 : E > 15 MeV]
[Hg-198 : E = 16 - 19 MeV]
[Hg-199 : E = 16 - 18 MeV]
[Hg-200 : E = 15 - 19 MeV]

Appendix A (continued)

【 Hg-201 : E = 15 - 17 MeV 】
【 Hg-202 : E = 15 - 18 MeV 】
【 Hg-204 : E = 14 - 16 MeV 】
【 Pb-204 : E = 16 - 17 MeV 】

(7) Averaged gamma-ray energy is relatively large for MT=91.
【 Pb-207 : E = 8 - 12 MeV 】

(8) For Mo isotopes, the gamma-ray production cross sections (MF=13/MT=3) are based on experimental data on the element. Therefore, energy is not conserved.
【 Mo-92 : E > 0.42 MeV 】
【 Mo-94 : E > 0.42 MeV 】
【 Mo-95 : E > 0.42 MeV 】
【 Mo-96 : E > 0.42 MeV 】
【 Mo-97 : E > 0.42 MeV 】
【 Mo-98 : E > 0.42 MeV 】
【 Mo-100 : E > 0.42 MeV 】

(9) For W isotopes, the gamma-ray production cross sections (MF=13/MT=3) were taken from elemental data in JENDL-3.2. Energy is not conserved.
【 W-182 : lower E = 0.4 MeV ——> 1.88238 MeV (MT=91) 】
【 W-183 : lower E = 0.4 MeV ——> 0.62744 MeV (MT=91) 】
【 W-184 : lower E = 0.4 MeV ——> 1.43985 MeV (MT=91) 】
Negative KERMA values are found.
【 W-182 : E = 0.5 - 2.5 MeV 】
【 W-183 : E = 0.5 - 2.5, 7 - 11 MeV 】
【 W-184 : E = 0.5 - 1.4 MeV 】
【 W-186 : E = 1.4 - 2.5, 8 - 11, 15 - 17 MeV 】

(10) Negative KERMA values are found for Bi-209.
【 Bi-209 : E = 2.2 - 4 MeV 】
This is due to too wide energy bins for gamma-ray spectra (MF=15/MT=3) in the region from 10^{-5} eV to 3 MeV. The MF=12/MT=3 data were temporarily adjusted so as not to yield negative KERMA values.

Appendix B Overlap of resonance region with inelastic scattering

```
Ac225.dat
          no resonance parameter
Ac226.dat
          no resonance parameter
Ac227.dat
          no resonance parameter
Ag107.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-9.3000E+04    thresh.= 9.3877E+04 [eV]
Ag109.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-8.8000E+04    thresh.= 8.8815E+04 [eV]
Ag110m.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 53  qi=-1.1000E+03    thresh.= 1.1101E+03 [eV]
            2  mt= 54  qi=-7.3600E+04    thresh.= 7.4276E+04 [eV]
            3  mt= 55  qi=-7.4000E+04    thresh.= 7.4679E+04 [eV]
            4  mt= 56  qi=-8.1100E+04    thresh.= 8.1844E+04 [eV]
Al027.dat
          no overlap between resonance and inelastic
Am241.dat
          no overlap between resonance and inelastic
Am242.dat
          no overlap between resonance and inelastic
Am242m.dat
          upper energy of unresolved resonance = 2.7283E+04 [eV]
            1  mt= 52  qi= 4.5300E+03    thresh.= 2.0000E+04 [eV]
            2  mt= 53  qi=-4.2700E+03    thresh.= 4.2878E+03 [eV]
Am243.dat
          no overlap between resonance and inelastic
Am244.dat
          no resonance parameter
Am244m.dat
          no resonance parameter
Ar040.dat
          no overlap between resonance and inelastic
As075.dat
          no overlap between resonance and inelastic
B010.dat
          no resonance parameter
B011.dat
          no resonance parameter
```

Appendix B (continued)

```
Ba130.dat
        no overlap between resonance and inelastic
Ba132.dat
        no overlap between resonance and inelastic
Ba134.dat
        no overlap between resonance and inelastic
Ba135.dat
        no overlap between resonance and inelastic
Ba136.dat
        no overlap between resonance and inelastic
Ba137.dat
        no overlap between resonance and inelastic
Ba138.dat
        no overlap between resonance and inelastic
Ba140.dat
        no overlap between resonance and inelastic
Be009.dat
        no resonance parameter
Bi209.dat
        no overlap between resonance and inelastic
Bk247.dat
        no overlap between resonance and inelastic
Bk249.dat
        upper energy of unresolved resonance = 3.0000E+04 [eV]
          1  mt= 51  qi=-8.8000E+03    thresh.= 8.8356E+03 [eV]
Bk250.dat
        no overlap between resonance and inelastic
Br079.dat
        no overlap between resonance and inelastic
Br081.dat
        no overlap between resonance and inelastic
C000.dat
        no resonance parameter
Ca040.dat
        no overlap between resonance and inelastic
Ca042.dat
        no overlap between resonance and inelastic
Ca043.dat
        no overlap between resonance and inelastic
Ca044.dat
        no overlap between resonance and inelastic
Ca046.dat
        no resonance parameter
```

Appendix B (continued)

```
Ca048.dat
          no overlap between resonance and inelastic
Cd106.dat
          no overlap between resonance and inelastic
Cd108.dat
          no overlap between resonance and inelastic
Cd110.dat
          no overlap between resonance and inelastic
Cd111.dat
          no overlap between resonance and inelastic
Cd112.dat
          no overlap between resonance and inelastic
Cd113.dat
          no overlap between resonance and inelastic
Cd114.dat
          no overlap between resonance and inelastic
Cd116.dat
          no overlap between resonance and inelastic
Ce140.dat
          no overlap between resonance and inelastic
Ce141.dat
          no overlap between resonance and inelastic
Ce142.dat
          no overlap between resonance and inelastic
Ce144.dat
          no overlap between resonance and inelastic
Cf249.dat
          no overlap between resonance and inelastic
Cf250.dat
          no overlap between resonance and inelastic
Cf251.dat
          upper energy of unresolved resonance = 3.0000E+04 [eV]
            1  mt= 51  qi=-2.4825E+04    thresh.= 2.4925E+04 [eV]
Cf252.dat
          no overlap between resonance and inelastic
Cf254.dat
          no resonance parameter
Cl035.dat
          no overlap between resonance and inelastic
Cl037.dat
          no overlap between resonance and inelastic
Cm240.dat
          no overlap between resonance and inelastic
```

Appendix B (continued)

```
Cm241.dat
          no overlap between resonance and inelastic
Cm242.dat
          no overlap between resonance and inelastic
Cm243.dat
          no overlap between resonance and inelastic
Cm244.dat
          no overlap between resonance and inelastic
Cm245.dat
          no overlap between resonance and inelastic
Cm246.dat
          no overlap between resonance and inelastic
Cm247.dat
          no overlap between resonance and inelastic
Cm248.dat
          no overlap between resonance and inelastic
Cm249.dat
          no overlap between resonance and inelastic
Cm250.dat
          no overlap between resonance and inelastic
Co059.dat
          no overlap between resonance and inelastic
Cr050.dat
          no overlap between resonance and inelastic
Cr052.dat
          no overlap between resonance and inelastic
Cr053.dat
          no overlap between resonance and inelastic
Cr054.dat
          no overlap between resonance and inelastic
Cs133.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-8.1000E+04   thresh.= 8.1615E+04 [eV]
Cs134.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-1.1200E+04   thresh.= 1.1284E+04 [eV]
            2  mt= 52  qi=-6.0000E+04   thresh.= 6.0452E+04 [eV]
Cs135.dat
          no overlap between resonance and inelastic
Cs136.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 91  qi=-5.0000E+04   thresh.= 5.0371E+04 [eV]
Cs137.dat
          no overlap between resonance and inelastic
```

Appendix B (continued)

```
Cu063.dat
          no overlap between resonance and inelastic
Cu065.dat
          no overlap between resonance and inelastic
Er162.dat
          no overlap between resonance and inelastic
Er164.dat
          no overlap between resonance and inelastic
Er166.dat
          no overlap between resonance and inelastic
Er167.dat
          no overlap between resonance and inelastic
Er168.dat
          no overlap between resonance and inelastic
Er170.dat
          no overlap between resonance and inelastic
Es254.dat
          no resonance parameter
Es255.dat
          no resonance parameter
Eu151.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-2.1500E+04    thresh.= 2.1644E+04 [eV]
Eu152.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-4.8500E+04    thresh.= 4.8822E+04 [eV]
            2  mt= 52  qi=-6.8200E+04    thresh.= 6.8653E+04 [eV]
            3  mt= 53  qi=-7.2300E+04    thresh.= 7.2780E+04 [eV]
            4  mt= 54  qi=-8.9900E+04    thresh.= 9.0497E+04 [eV]
            5  mt= 55  qi=-9.2300E+04    thresh.= 9.2913E+04 [eV]
Eu153.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-8.3400E+04    thresh.= 8.3955E+04 [eV]
            2  mt= 52  qi=-9.7400E+04    thresh.= 9.8048E+04 [eV]
Eu154.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-6.8200E+04    thresh.= 6.8647E+04 [eV]
            2  mt= 52  qi=-9.5700E+04    thresh.= 9.6327E+04 [eV]
            3  mt= 53  qi=-9.7100E+04    thresh.= 9.7736E+04 [eV]
Eu155.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-7.8600E+04    thresh.= 7.9112E+04 [eV]
```

Appendix B (continued)

```
Eu156.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-2.2600E+04    thresh.= 2.2746E+04 [eV]
          2  mt= 52  qi=-4.7800E+04    thresh.= 4.8109E+04 [eV]
          3  mt= 53  qi=-8.7200E+04    thresh.= 8.7764E+04 [eV]
F019.dat
        no overlap between resonance and inelastic
Fe054.dat
        no overlap between resonance and inelastic
Fe056.dat
        no overlap between resonance and inelastic
Fe057.dat
        upper energy of resolved resonance = 2.0000E+05 [eV]
          1  mt= 51  qi=-1.4400E+04    thresh.= 1.4655E+04 [eV]
          2  mt= 52  qi=-1.3650E+05    thresh.= 1.3892E+05 [eV]
Fe058.dat
        no overlap between resonance and inelastic
Fm255.dat
        no resonance parameter
Ga069.dat
        no overlap between resonance and inelastic
Ga071.dat
        no overlap between resonance and inelastic
Gd152.dat
        no overlap between resonance and inelastic
Gd154.dat
        no overlap between resonance and inelastic
Gd155.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-6.0000E+04    thresh.= 6.0391E+04 [eV]
          2  mt= 52  qi=-8.6500E+04    thresh.= 8.7063E+04 [eV]
Gd156.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-8.9000E+04    thresh.= 8.9576E+04 [eV]
Gd157.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-5.4500E+04    thresh.= 5.4850E+04 [eV]
          2  mt= 52  qi=-6.4000E+04    thresh.= 6.4411E+04 [eV]
Gd158.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-7.9500E+04    thresh.= 8.0008E+04 [eV]
Gd160.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-7.5300E+04    thresh.= 7.5775E+04 [eV]
```

Appendix B (continued)

Ge070.dat
no overlap between resonance and inelastic
Ge072.dat
no overlap between resonance and inelastic
Ge073.dat
no overlap between resonance and inelastic
Ge074.dat
no overlap between resonance and inelastic
Ge076.dat
no overlap between resonance and inelastic
H001.dat
no resonance parameter
H002.dat
no resonance parameter
He003.dat
no resonance parameter
He004.dat
no resonance parameter
Hf174.dat
no overlap between resonance and inelastic
Hf176.dat
no overlap between resonance and inelastic
Hf177.dat
no overlap between resonance and inelastic
Hf178.dat
no overlap between resonance and inelastic
Hf179.dat
no overlap between resonance and inelastic
Hf180.dat
no overlap between resonance and inelastic
Hg196.dat
no overlap between resonance and inelastic
Hg198.dat
no overlap between resonance and inelastic
Hg199.dat
no overlap between resonance and inelastic
Hg200.dat
no overlap between resonance and inelastic
Hg201.dat
no overlap between resonance and inelastic
Hg202.dat
no overlap between resonance and inelastic
Hg204.dat
no resonance parameter

Appendix B (continued)

```
I127.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-5.7600E+04    thresh.= 5.8058E+04 [eV]
I129.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-2.7800E+04    thresh.= 2.8018E+04 [eV]
I131.dat
        no overlap between resonance and inelastic
In113.dat
        no overlap between resonance and inelastic
In115.dat
        no overlap between resonance and inelastic
K039.dat
        no overlap between resonance and inelastic
K040.dat
        no resonance parameter
K041.dat
        no overlap between resonance and inelastic
Kr078.dat
        no overlap between resonance and inelastic
Kr080.dat
        no overlap between resonance and inelastic
Kr082.dat
        no overlap between resonance and inelastic
Kr083.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-9.4000E+03    thresh.= 9.5144E+03 [eV]
          2  mt= 52  qi=-4.1600E+04    thresh.= 4.2106E+04 [eV]
Kr084.dat
        no overlap between resonance and inelastic
Kr085.dat
        no overlap between resonance and inelastic
Kr086.dat
        no overlap between resonance and inelastic
La138.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-7.2600E+04    thresh.= 7.3131E+04 [eV]
La139.dat
        no overlap between resonance and inelastic
Li006.dat
        no resonance parameter
Li007.dat
        no resonance parameter
```

Appendix B (continued)

```
Mg024.dat
        no overlap between resonance and inelastic
Mg025.dat
        no overlap between resonance and inelastic
Mg026.dat
        no overlap between resonance and inelastic
Mn055.dat
        no overlap between resonance and inelastic
Mo092.dat
        no overlap between resonance and inelastic
Mo094.dat
        no overlap between resonance and inelastic
Mo095.dat
        no overlap between resonance and inelastic
Mo096.dat
        no overlap between resonance and inelastic
Mo097.dat
        no overlap between resonance and inelastic
Mo098.dat
        no overlap between resonance and inelastic
Mo099.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-9.8000E+04   thresh.= 9.8999E+04 [eV]
Mo100.dat
        no overlap between resonance and inelastic
N014.dat
        no resonance parameter
N015.dat
        no resonance parameter
Na023.dat
        no overlap between resonance and inelastic
Nb093.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-3.0400E+04   thresh.= 3.0730E+04 [eV]
Nb094.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-4.1000E+04   thresh.= 4.1440E+04 [eV]
          2  mt= 52  qi=-5.8700E+04   thresh.= 5.9330E+04 [eV]
          3  mt= 53  qi=-7.8700E+04   thresh.= 7.9545E+04 [eV]
Nb095.dat
        no overlap between resonance and inelastic
Nd142.dat
        no overlap between resonance and inelastic
```

Appendix B (continued)

```
Nd143.dat
          no overlap between resonance and inelastic
Nd144.dat
          no overlap between resonance and inelastic
Nd145.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-6.7100E+04    thresh.= 6.7567E+04 [eV]
            2  mt= 52  qi=-7.2200E+04    thresh.= 7.2702E+04 [eV]
Nd146.dat
          no overlap between resonance and inelastic
Nd147.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-4.9900E+04    thresh.= 5.0243E+04 [eV]
Nd148.dat
          no overlap between resonance and inelastic
Nd150.dat
          no overlap between resonance and inelastic
Ni058.dat
          no overlap between resonance and inelastic
Ni060.dat
          no overlap between resonance and inelastic
Ni061.dat
          no overlap between resonance and inelastic
Ni062.dat
          no overlap between resonance and inelastic
Ni064.dat
          no overlap between resonance and inelastic
Np235.dat
          no resonance parameter
Np236.dat
          no resonance parameter
Np237.dat
          upper energy of unresolved resonance = 3.5000E+04 [eV]
            1  mt= 51  qi=-3.3100E+04    thresh.= 3.3241E+04 [eV]
Np238.dat
          no resonance parameter
Np239.dat
          no resonance parameter
O016.dat
          no resonance parameter
P031.dat
          no overlap between resonance and inelastic
```

Appendix B (continued)

```
Pa231.dat
        upper energy of unresolved resonance = 4.0000E+04 [eV]
          1  mt= 51  qi=-9.3000E+03    thresh.= 9.3406E+03 [eV]
Pa232.dat
        no resonance parameter
Pa233.dat
        upper energy of unresolved resonance = 4.0000E+04 [eV]
          1  mt= 51  qi=-6.7000E+03    thresh.= 6.7290E+03 [eV]
Pb204.dat
        no overlap between resonance and inelastic
Pb206.dat
        no overlap between resonance and inelastic
Pb207.dat
        no overlap between resonance and inelastic
Pb208.dat
        no overlap between resonance and inelastic
Pd102.dat
        no overlap between resonance and inelastic
Pd104.dat
        no overlap between resonance and inelastic
Pd105.dat
        no overlap between resonance and inelastic
Pd106.dat
        no overlap between resonance and inelastic
Pd107.dat
        no overlap between resonance and inelastic
Pd108.dat
        no overlap between resonance and inelastic
Pd110.dat
        no overlap between resonance and inelastic
Pm147.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-9.1100E+04    thresh.= 9.1726E+04 [eV]
Pm148.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-7.5700E+04    thresh.= 7.6216E+04 [eV]
Pm148m.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 52  qi= 6.1300E+04    thresh.= 8.0000E+03 [eV]
          2  mt= 91  qi=-6.3000E+04    thresh.= 6.3430E+04 [eV]
Pm149.dat
        no overlap between resonance and inelastic
```

Appendix B (continued)

```
Pr141.dat
        no overlap between resonance and inelastic
Pr143.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-5.7400E+04    thresh.= 5.7805E+04 [eV]
Pu236.dat
        no overlap between resonance and inelastic
Pu237.dat
        no resonance parameter
Pu238.dat
        no overlap between resonance and inelastic
Pu239.dat
        upper energy of unresolved resonance = 3.0000E+04 [eV]
          1  mt= 51  qi=-7.8600E+03    thresh.= 7.8932E+03 [eV]
Pu240.dat
        no overlap between resonance and inelastic
Pu241.dat
        no overlap between resonance and inelastic
Pu242.dat
        no overlap between resonance and inelastic
Pu244.dat
        no overlap between resonance and inelastic
Pu246.dat
        no resonance parameter
Ra223.dat
        no resonance parameter
Ra224.dat
        no resonance parameter
Ra225.dat
        no resonance parameter
Ra226.dat
        no overlap between resonance and inelastic
Rb085.dat
        no overlap between resonance and inelastic
Rb087.dat
        no overlap between resonance and inelastic
Rh103.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-3.9750E+04    thresh.= 4.0140E+04 [eV]
          2  mt= 52  qi=-9.3035E+04    thresh.= 9.3947E+04 [eV]
Rh105.dat
        no overlap between resonance and inelastic
Ru096.dat
        no overlap between resonance and inelastic
```

Appendix B (continued)

```
Ru098.dat
        no overlap between resonance and inelastic
Ru099.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-8.9400E+04    thresh.= 9.0312E+04 [eV]
Ru100.dat
        no overlap between resonance and inelastic
Ru101.dat
        no overlap between resonance and inelastic
Ru102.dat
        no overlap between resonance and inelastic
Ru103.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-2.7000E+03    thresh.= 2.7265E+03 [eV]
Ru104.dat
        no overlap between resonance and inelastic
Ru106.dat
        no overlap between resonance and inelastic
S032.dat
        no overlap between resonance and inelastic
S033.dat
        no overlap between resonance and inelastic
S034.dat
        no overlap between resonance and inelastic
S036.dat
        no resonance parameter
Sb121.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-3.7100E+04    thresh.= 3.7410E+04 [eV]
Sb123.dat
        no overlap between resonance and inelastic
Sb124.dat
        upper energy of unresolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-1.0700E+04    thresh.= 1.0787E+04 [eV]
          2  mt= 91  qi=-4.0800E+04    thresh.= 4.1132E+04 [eV]
Sb125.dat
        no overlap between resonance and inelastic
Sc045.dat
        upper energy of resolved resonance = 1.0000E+05 [eV]
          1  mt= 51  qi=-1.2400E+04    thresh.= 1.2678E+04 [eV]
Se074.dat
        no overlap between resonance and inelastic
Se076.dat
        no overlap between resonance and inelastic
```

Appendix B (continued)

```
Se077.dat
          no overlap between resonance and inelastic
Se078.dat
          no overlap between resonance and inelastic
Se079.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-9.5700E+04   thresh.= 9.6923E+04 [eV]
Se080.dat
          no overlap between resonance and inelastic
Se082.dat
          no overlap between resonance and inelastic
Si028.dat
          no overlap between resonance and inelastic
Si029.dat
          no overlap between resonance and inelastic
Si030.dat
          no overlap between resonance and inelastic
Sm144.dat
          no overlap between resonance and inelastic
Sm147.dat
          no overlap between resonance and inelastic
Sm148.dat
          no overlap between resonance and inelastic
Sm149.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-2.2500E+04   thresh.= 2.2652E+04 [eV]
Sm150.dat
          no overlap between resonance and inelastic
Sm151.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-4.8000E+03   thresh.= 4.8321E+03 [eV]
            2  mt= 52  qi=-6.5800E+04   thresh.= 6.6240E+04 [eV]
            3  mt= 53  qi=-6.9700E+04   thresh.= 7.0166E+04 [eV]
            4  mt= 54  qi=-9.1500E+04   thresh.= 9.2112E+04 [eV]
Sm152.dat
          no overlap between resonance and inelastic
Sm153.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-7.5000E+03   thresh.= 7.5495E+03 [eV]
            2  mt= 52  qi=-3.5800E+04   thresh.= 3.6036E+04 [eV]
            3  mt= 53  qi=-5.3500E+04   thresh.= 5.3853E+04 [eV]
            4  mt= 54  qi=-6.5500E+04   thresh.= 6.5932E+04 [eV]
            5  mt= 55  qi=-9.0900E+04   thresh.= 9.1500E+04 [eV]
            6  mt= 56  qi=-9.8400E+04   thresh.= 9.9049E+04 [eV]
```

Appendix B (continued)

```
Sm154.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-8.2000E+04    thresh.= 8.2537E+04 [eV]
Sn112.dat
          no overlap between resonance and inelastic
Sn114.dat
          no overlap between resonance and inelastic
Sn115.dat
          no overlap between resonance and inelastic
Sn116.dat
          no overlap between resonance and inelastic
Sn117.dat
          no overlap between resonance and inelastic
Sn118.dat
          no overlap between resonance and inelastic
Sn119.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-2.3900E+04    thresh.= 2.4103E+04 [eV]
            2  mt= 52  qi=-8.9500E+04    thresh.= 9.0259E+04 [eV]
Sn120.dat
          no overlap between resonance and inelastic
Sn122.dat
          no overlap between resonance and inelastic
Sn123.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-2.4600E+04    thresh.= 2.4802E+04 [eV]
Sn124.dat
          no overlap between resonance and inelastic
Sn126.dat
          no overlap between resonance and inelastic
Sr086.dat
          no overlap between resonance and inelastic
Sr087.dat
          no overlap between resonance and inelastic
Sr088.dat
          no overlap between resonance and inelastic
Sr089.dat
          no overlap between resonance and inelastic
Sr090.dat
          no overlap between resonance and inelastic
Ta181.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-6.2000E+03    thresh.= 6.2346E+03 [eV]
```

Appendix B (continued)

```
Tb159.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-5.8000E+04    thresh.= 5.8368E+04 [eV]
Tc099.dat
          no overlap between resonance and inelastic
Te120.dat
          no overlap between resonance and inelastic
Te122.dat
          no overlap between resonance and inelastic
Te123.dat
          no overlap between resonance and inelastic
Te124.dat
          no overlap between resonance and inelastic
Te125.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-3.5500E+04    thresh.= 3.5787E+04 [eV]
Te126.dat
          no overlap between resonance and inelastic
Te127m.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi= 8.8260E+04    thresh.= 1.0000E+01 [eV]
            2  mt= 52  qi= 2.7140E+04    thresh.= 8.0000E+04 [eV]
Te128.dat
          no overlap between resonance and inelastic
Te129m.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 52  qi=-7.5300E+04    thresh.= 7.5889E+04 [eV]
Te130.dat
          no overlap between resonance and inelastic
Th227.dat
          no resonance parameter
Th228.dat
          no overlap between resonance and inelastic
Th229.dat
          no overlap between resonance and inelastic
Th230.dat
          no overlap between resonance and inelastic
Th232.dat
          upper energy of unresolved resonance = 5.0000E+04 [eV]
            1  mt= 51  qi=-4.9000E+04    thresh.= 4.9213E+04 [eV]
Th233.dat
          no resonance parameter
Th234.dat
          no resonance parameter
```

Appendix B (continued)

```
Ti046.dat
        no overlap between resonance and inelastic
Ti047.dat
        no overlap between resonance and inelastic
Ti048.dat
        no overlap between resonance and inelastic
Ti049.dat
        no overlap between resonance and inelastic
Ti050.dat
        no overlap between resonance and inelastic
U232.dat
        no overlap between resonance and inelastic
U233.dat
        no overlap between resonance and inelastic
U234.dat
        upper energy of unresolved resonance = 5.0000E+04 [eV]
          1  mt= 51  qi=-4.3480E+04    thresh.= 4.3667E+04 [eV]
U235.dat
        upper energy of resolved resonance = 2.2500E+03 [eV]
          1  mt= 51  qi=-7.7000E+01    thresh.= 7.7330E+01 [eV]
        upper energy of unresolved resonance = 3.0000E+04 [eV]
          1  mt= 52  qi=-1.3040E+04    thresh.= 1.3096E+04 [eV]
U236.dat
        no overlap between resonance and inelastic
U237.dat
        upper energy of unresolved resonance = 3.0000E+04 [eV]
          1  mt= 51  qi=-1.1390E+04    thresh.= 1.1438E+04 [eV]
U238.dat
        upper energy of unresolved resonance = 1.5000E+05 [eV]
          1  mt= 51  qi=-4.4910E+04    thresh.= 4.5100E+04 [eV]
          2  mt= 52  qi=-1.4841E+05    thresh.= 1.4904E+05 [eV]
V000.dat
        no overlap between resonance and inelastic
W182.dat
        no overlap between resonance and inelastic
W183.dat
        no overlap between resonance and inelastic
W184.dat
        no overlap between resonance and inelastic
W186.dat
        no overlap between resonance and inelastic
Xe124.dat
        no overlap between resonance and inelastic
```

Appendix B (continued)

```
Xe126.dat
          no overlap between resonance and inelastic
Xe128.dat
          no overlap between resonance and inelastic
Xe129.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-3.9600E+04    thresh.= 3.9910E+04 [eV]
Xe130.dat
          no overlap between resonance and inelastic
Xe131.dat
          upper energy of unresolved resonance = 1.0000E+05 [eV]
            1  mt= 51  qi=-8.0200E+04    thresh.= 8.0818E+04 [eV]
Xe132.dat
          no overlap between resonance and inelastic
Xe133.dat
          no overlap between resonance and inelastic
Xe134.dat
          no overlap between resonance and inelastic
Xe135.dat
          no overlap between resonance and inelastic
Xe136.dat
          no overlap between resonance and inelastic
Y089.dat
          no overlap between resonance and inelastic
Y091.dat
          no overlap between resonance and inelastic
Zr090.dat
          no overlap between resonance and inelastic
Zr091.dat
          no overlap between resonance and inelastic
Zr092.dat
          no overlap between resonance and inelastic
Zr093.dat
          no overlap between resonance and inelastic
Zr094.dat
          no overlap between resonance and inelastic
Zr095.dat
          no overlap between resonance and inelastic
Zr096.dat
          no overlap between resonance and inelastic
```

Appendix C List of nuclides in FSXLIB-J33

nuclide	ZAID	GPD	ptable	nu
1-H - 1	1001.42c	yes		
1-H - 2	1002.42c	no		
2-He- 3	2003.42c	yes		
2-He- 4	2004.42c	no		
3-Li- 6	3006.42c	yes		
3-Li- 7	3007.42c	yes		
4-Be- 9	4009.42c	yes		
5-B - 10	5010.42c	yes		
5-B - 11	5011.42c	yes		
6-C - 0	6000.42c	yes		
7-N - 14	7014.42c	yes		
7-N - 15	7015.42c	yes		
8-O - 16	8016.42c	yes		
9-F - 19	9019.42c	yes		
11-Na- 23	11023.42c	yes		
12-Mg- 24	12024.42c	yes		
12-Mg- 25	12025.42c	yes		
12-Mg- 26	12026.42c	yes		
13-Al- 27	13027.42c	yes		
14-Si- 28	14028.42c	yes		
14-Si- 29	14029.42c	yes		
14-Si- 30	14030.42c	yes		
15-P - 31	15031.42c	yes		
16-S - 32	16032.42c	yes		
16-S - 33	16033.42c	yes		
16-S - 34	16034.42c	yes		
16-S - 36	16036.42c	yes		
17-Cl- 35	17035.42c	no		
17-Cl- 37	17037.42c	no		
18-Ar- 40	18040.42c	no		
19-K - 39	19039.42c	yes		
19-K - 40	19040.42c	yes		
19-K - 41	19041.42c	yes		
20-Ca- 40	20040.42c	yes		
20-Ca- 42	20042.42c	yes		
20-Ca- 43	20043.42c	yes		
20-Ca- 44	20044.42c	yes		
20-Ca- 46	20046.42c	yes		
20-Ca- 48	20048.42c	yes		
21-Sc- 45	21045.42c	no		
22-Ti- 46	22046.42c	yes		
22-Ti- 47	22047.42c	yes		
22-Ti- 48	22048.42c	yes		

Appendix C (continued)

nuclide	ZAID	GPD	ptable	nu
22-Ti- 49	22049.42c	yes		
22-Ti- 50	22050.42c	yes		
23-V - 0	23000.42c	yes		
24-Cr- 50	24050.42c	yes		
24-Cr- 52	24052.42c	yes		
24-Cr- 53	24053.42c	yes		
24-Cr- 54	24054.42c	yes		
25-Mn- 55	25055.42c	yes		
26-Fe- 54	26054.42c	yes		
26-Fe- 56	26056.42c	yes		
26-Fe- 57	26057.42c	yes		
26-Fe- 58	26058.42c	yes		
27-Co- 59	27059.42c	yes		
28-Ni- 58	28058.42c	yes		
28-Ni- 60	28060.42c	yes		
28-Ni- 61	28061.42c	yes		
28-Ni- 62	28062.42c	yes		
28-Ni- 64	28064.42c	yes		
29-Cu- 63	29063.42c	yes		
29-Cu- 65	29065.42c	yes		
31-Ga- 69	31069.42c	no		
31-Ga- 71	31071.42c	no		
32-Ge- 70	32070.42c	no		
32-Ge- 72	32072.42c	no		
32-Ge- 73	32073.42c	no		
32-Ge- 74	32074.42c	no		
32-Ge- 76	32076.42c	no		
33-As- 75	33075.42c	no	yes	
34-Se- 74	34074.42c	no	yes	
34-Se- 76	34076.42c	no	yes	
34-Se- 77	34077.42c	no	yes	
34-Se- 78	34078.42c	no	yes	
34-Se- 79	34079.42c	no	yes	
34-Se- 80	34080.42c	no	yes	
34-Se- 82	34082.42c	no	yes	
35-Br- 79	35079.42c	no	yes	
35-Br- 81	35081.42c	no	yes	
36-Kr- 78	36078.42c	no	yes	
36-Kr- 80	36080.42c	no	yes	
36-Kr- 82	36082.42c	no	yes	
36-Kr- 83	36083.42c	no	yes	
36-Kr- 84	36084.42c	no	yes	

Appendix C (continued)

nuclide	ZAID	GPD	ptable	nu
36-Kr- 85	36085.42c	no	yes	
36-Kr- 86	36086.42c	no		
37-Rb- 85	37085.42c	no	yes	
37-Rb- 87	37087.42c	no	yes	
38-Sr- 86	38086.42c	no	yes	
38-Sr- 87	38087.42c	no	yes	
38-Sr- 88	38088.42c	no		
38-Sr- 89	38089.42c	no	yes	
38-Sr- 90	38090.42c	no	yes	
39-Y - 89	39089.42c	no	yes	
39-Y - 91	39091.42c	no	yes	
40-Zr- 90	40090.42c	yes		
40-Zr- 91	40091.42c	yes	yes	
40-Zr- 92	40092.42c	yes	yes	
40-Zr- 93	40093.42c	no	yes	
40-Zr- 94	40094.42c	yes	yes	
40-Zr- 95	40095.42c	no	yes	
40-Zr- 96	40096.42c	yes		
41-Nb- 93	41093.42c	yes	yes	
41-Nb- 94	41094.42c	no	yes	
41-Nb- 95	41095.42c	no	yes	
42-Mo- 92	42092.42c	yes	yes	
42-Mo- 94	42094.42c	yes	yes	
42-Mo- 95	42095.42c	yes	yes	
42-Mo- 96	42096.42c	yes	yes	
42-Mo- 97	42097.42c	yes	yes	
42-Mo- 98	42098.42c	yes	yes	
42-Mo-100	42100.42c	yes	yes	
43-Tc- 99	43099.42c	no	yes	
44-Ru- 96	44096.42c	no	yes	
44-Ru- 98	44098.42c	no	yes	
44-Ru- 99	44099.42c	no	yes	
44-Ru-100	44100.42c	no	yes	
44-Ru-101	44101.42c	no	yes	
44-Ru-102	44102.42c	no	yes	
44-Ru-103	44103.42c	no	yes	
44-Ru-104	44104.42c	no	yes	
44-Ru-106	44106.42c	no	yes	
45-Rh-103	45103.42c	no	yes	
45-Rh-105	45105.42c	no	yes	
46-Pd-102	46102.42c	no	yes	
46-Pd-104	46104.42c	no	yes	

Appendix C (continued)

nuclide	ZAID	GPD	ptable	nu
46-Pd-105	46105.42c	no	yes	
46-Pd-106	46106.42c	no	yes	
46-Pd-107	46107.42c	no	yes	
46-Pd-108	46108.42c	no	yes	
46-Pd-110	46100.42c	no	yes	
47-Ag-107	47107.42c	yes	yes	
47-Ag-109	47109.42c	yes	yes	
47-Ag-110m	47110.43c	no	yes	
48-Cd-106	48106.42c	yes	yes	
48-Cd-108	48108.42c	yes	yes	
48-Cd-110	48110.42c	yes	yes	
48-Cd-111	48111.42c	yes	yes	
48-Cd-112	48112.42c	yes	yes	
48-Cd-113	48113.42c	yes	yes	
48-Cd-114	48114.42c	yes	yes	
48-Cd-116	48116.42c	yes	yes	
49-In-113	49113.42c	no	yes	
49-In-115	49115.42c	no	yes	
50-Sn-112	50112.42c	no	yes	
50-Sn-114	50114.42c	no	yes	
50-Sn-115	50115.42c	no	yes	
50-Sn-116	50116.42c	no	yes	
50-Sn-117	50117.42c	no	yes	
50-Sn-118	50118.42c	no	yes	
50-Sn-119	50119.42c	no	yes	
50-Sn-120	50120.42c	no	yes	
50-Sn-122	50122.42c	no	yes	
50-Sn-123	50123.42c	no	yes	
50-Sn-124	50124.42c	no	yes	
50-Sn-126	50126.42c	no	yes	
51-Sb-121	51121.42c	no	yes	
51-Sb-123	51123.42c	no	yes	
51-Sb-124	51124.42c	no	yes	
51-Sb-125	51125.42c	no	yes	
52-Te-120	52120.42c	no	yes	
52-Te-122	52122.42c	no	yes	
52-Te-123	52123.42c	no	yes	
52-Te-124	52124.42c	no	yes	
52-Te-125	52125.42c	no	yes	
52-Te-126	52126.42c	no	yes	
52-Te-127m	52127.43c	no	yes	
52-Te-128	52128.42c	no	yes	

Appendix C (continued)

nuclide	ZAID	GPD	ptable	nu
52-Te-129m	52129.43c	no	yes	
52-Te-130	52130.42c	no	yes	
53-I -127	53127.42c	no	yes	
53-I -129	53129.42c	no	yes	
53-I -131	53131.42c	no	yes	
54-Xe-124	54124.42c	no	yes	
54-Xe-126	54126.42c	no	yes	
54-Xe-128	54128.42c	no	yes	
54-Xe-129	54129.42c	no	yes	
54-Xe-130	54130.42c	no	yes	
54-Xe-131	54131.42c	no	yes	
54-Xe-132	54132.42c	no	yes	
54-Xe-133	54133.42c	no	yes	
54-Xe-134	54134.42c	no	yes	
54-Xe-135	54135.42c	no	yes	
54-Xe-136	54136.42c	no		
55-Cs-133	55133.42c	no	yes	
55-Cs-134	55134.42c	no	yes	
55-Cs-135	55135.42c	no	yes	
55-Cs-136	55136.42c	no	yes	
55-Cs-137	55137.42c	no	yes	
56-Ba-130	56130.42c	no	yes	
56-Ba-132	56132.42c	no	yes	
56-Ba-134	56134.42c	no	yes	
56-Ba-135	56135.42c	no	yes	
56-Ba-136	56136.42c	no	yes	
56-Ba-137	56137.42c	no	yes	
56-Ba-138	56138.42c	no		
56-Ba-140	56140.42c	no	yes	
57-La-138	57138.42c	no	yes	
57-La-139	57139.42c	no	yes	
58-Ce-140	58140.42c	no		
58-Ce-141	58141.42c	no	yes	
58-Ce-142	58142.42c	no	yes	
58-Ce-144	58144.42c	no	yes	
59-Pr-141	59141.42c	no	yes	
59-Pr-143	59143.42c	no	yes	
60-Nd-142	60142.42c	no	yes	
60-Nd-143	60143.42c	no	yes	
60-Nd-144	60144.42c	no	yes	
60-Nd-145	60145.42c	no	yes	
60-Nd-146	60146.42c	no	yes	

Appendix C (continued)

nuclide	ZAID	GPD	ptable	nu
60-Nd-147	60147.42c	no	yes	
60-Nd-148	60148.42c	no	yes	
60-Nd-150	60150.42c	no	yes	
61-Pm-147	61147.42c	no	yes	
61-Pm-148	61148.42c	no	yes	
61-Pm-148m	61148.43c	no	yes	
61-Pm-149	61149.42c	no	yes	
62-Sm-144	62144.42c	no	yes	
62-Sm-147	62147.42c	no	yes	
62-Sm-148	62148.42c	no	yes	
62-Sm-149	62149.42c	no	yes	
62-Sm-150	62150.42c	no	yes	
62-Sm-151	62151.42c	no	yes	
62-Sm-152	62152.42c	no	yes	
62-Sm-153	62153.42c	no	yes	
62-Sm-154	62154.42c	no	yes	
63-Eu-151	63151.42c	yes	yes	
63-Eu-152	63152.42c	no	yes	
63-Eu-153	63153.42c	yes	yes	
63-Eu-154	63154.42c	no	yes	
63-Eu-155	63155.42c	no	yes	
63-Eu-156	63156.42c	no	yes	
64-Gd-152	64152.42c	no	yes	
64-Gd-154	64154.42c	no	yes	
64-Gd-155	64155.42c	no	yes	
64-Gd-156	64156.42c	no	yes	
64-Gd-157	64157.42c	no	yes	
64-Gd-158	64158.42c	no	yes	
64-Gd-160	64160.42c	no	yes	
65-Tb-159	65159.42c	no	yes	
68-Er-162	68162.42c	yes		
68-Er-164	68164.42c	yes		
68-Er-166	68166.42c	yes		
68-Er-167	68167.42c	yes	yes	
68-Er-168	68168.42c	yes		
68-Er-170	68170.42c	yes		
72-Hf-174	72174.42c	yes	yes	
72-Hf-176	72176.42c	yes	yes	
72-Hf-177	72177.42c	yes	yes	
72-Hf-178	72178.42c	yes	yes	
72-Hf-179	72179.42c	yes	yes	
72-Hf-180	72180.42c	yes	yes	

Appendix C (continued)

nuclide	ZAID	GPD	ptable	nu
73-Ta-181	73181.42c	yes	yes	
74-W -182	74182.42c	yes		
74-W -183	74183.42c	yes		
74-W -184	74184.42c	yes		
74-W -186	74186.42c	yes		
80-Hg-196	80196.42c	yes		
80-Hg-198	80198.42c	yes		
80-Hg-199	80199.42c	yes		
80-Hg-200	80200.42c	yes		
80-Hg-201	80201.42c	yes		
80-Hg-202	80202.42c	yes		
80-Hg-204	80204.42c	yes		
82-Pb-204	82204.42c	yes		
82-Pb-206	82206.42c	yes		
82-Pb-207	82207.42c	yes		
82-Pb-208	82208.42c	yes		
83-Bi-209	83209.42c	yes		
88-Ra-223	88223.42c	no		t
88-Ra-224	88224.42c	no		
88-Ra-225	88225.42c	no		
88-Ra-226	88226.42c	no		t
89-Ac-225	89225.42c	no		
89-Ac-226	89226.42c	no		
89-Ac-227	89227.42c	no		t
90-Th-227	90227.42c	no		tdp
90-Th-228	90228.42c	no		tdp
90-Th-229	90229.42c	no		tdp
90-Th-230	90230.42c	no		tdp
90-Th-232	90232.42c	no		tdp
90-Th-233	90233.42c	no		tdp
90-Th-234	90234.42c	no		tdp
91-Pa-231	91231.42c	no	yes	tdp
91-Pa-232	91232.42c	no		tdp
91-Pa-233	91233.42c	no	yes	tdp
92-U -232	92232.42c	no		tdp
92-U -233	92233.42c	no	yes	tdp
92-U -234	92234.42c	no	yes	tdp
92-U -235	92235.42c	yes	yes	tdp
92-U -236	92236.42c	no	yes	tdp
92-U -237	92237.42c	no	yes	tdp
92-U -238	92238.42c	yes	yes	tdp
93-Np-235	93235.42c	no		tdp

Appendix C (continued)

nuclide	ZAID	GPD	ptable	nu
93-Np-236	93236.42c	no		tdp
93-Np-237	93237.42c	no	yes	tdp
93-Np-238	93238.42c	no		tdp
93-Np-239	93239.42c	no		tdp
94-Pu-236	94236.42c	no	yes	tdp
94-Pu-237	94237.42c	no		tdp
94-Pu-238	94238.42c	no	yes	tdp
94-Pu-239	94239.42c	yes	yes	tdp
94-Pu-240	94240.42c	no	yes	tdp
94-Pu-241	94241.42c	no	yes	tdp
94-Pu-242	94242.42c	no	yes	tdp
94-Pu-244	94244.42c	no		tdp
94-Pu-246	94246.42c	no		tdp
95-Am-241	95241.42c	no	yes	tdp
95-Am-242	95242.42c	no	yes	tdp
95-Am-242m	95242.43c	no	yes	tdp
95-Am-243	95243.42c	no	yes	tdp
95-Am-244	95244.42c	no		tdp
95-Am-244m	95244.43c	no		tdp
96-Cm-240	96240.42c	no	yes	tdp
96-Cm-241	96241.42c	no	yes	tdp
96-Cm-242	96242.42c	no	yes	tdp
96-Cm-243	96243.42c	no	yes	tdp
96-Cm-244	96244.42c	no	yes	tdp
96-Cm-245	96245.42c	no	yes	tdp
96-Cm-246	96246.42c	no	yes	tdp
96-Cm-247	96247.42c	no	yes	tdp
96-Cm-248	96248.42c	no	yes	tdp
96-Cm-249	96249.42c	no	yes	tdp
96-Cm-250	96250.42c	no	yes	tdp
97-Bk-247	97247.42c	no		tdp
97-Bk-249	97249.42c	no	yes	tdp
97-Bk-250	97250.42c	no	yes	tdp
98-Cf-249	98249.42c	no	yes	tdp
98-Cf-250	98250.42c	no	yes	tdp
98-Cf-251	98251.42c	no	yes	tdp
98-Cf-252	98252.42c	no	yes	tdp
98-Cf-254	98254.42c	no		tdp
99-Es-254	99254.42c	no		tdp
99-Es-255	99255.42c	no		tdp
100-Fm-255	100255.42c	no		tdp

Appendix C (continued)

GPD : photon-production data; "yes" is included, "no" is not included.
ptable : unresolved resonance range probability table; "yes" is included, blank is not included.
nu : for fissionable material, nu indicates the type of fission nu data available. "t" is total nu data, "d" is delayed nu data, and "p" is prompt nu data.

国際単位系（SI）と換算表

表1　SI基本単位および補助単位

量	名称	記号
長さ	メートル	m
質量	キログラム	kg
時間	秒	s
電流	アンペア	A
熱力学温度	ケルビン	K
物質量	モル	mol
光度	カンデラ	cd
平面角	ラジアン	rad
立体角	ステラジアン	sr

表2　SIと併用される単位

名称	記号
分，時，日	min，h，d
度，分，秒	°，′，″
リットル	l，L
トン	t
電子ボルト	eV
原子質量単位	u

1 eV=1.60218×10^{-19}J

1 u=1.66054×10^{-27}kg

表3　固有の名称をもつSI組立単位

量	名称	記号	他のSI単位による表現
周波数	ヘルツ	Hz	s^{-1}
力	ニュートン	N	m·kg/s^2
圧力，応力	パスカル	Pa	N/m^2
エネルギー，仕事，熱量	ジュール	J	N·m
工率，放射束	ワット	W	J/s
電気量，電荷	クーロン	C	A·s
電位，電圧，起電力	ボルト	V	W/A
静電容量	ファラド	F	C/V
電気抵抗	オーム	Ω	V/A
コンダクタンス	ジーメンス	S	A/V
磁束	ウェーバ	Wb	V·s
磁束密度	テスラ	T	Wb/m^2
インダクタンス	ヘンリー	H	Wb/A
セルシウス温度	セルシウス度	℃	
光束	ルーメン	lm	cd·sr
照度	ルクス	lx	lm/m^2
放射能	ベクレル	Bq	s^{-1}
吸収線量	グレイ	Gy	J/kg
線量等量	シーベルト	Sv	J/kg

表4　SIと共に暫定的に維持される単位

名称	記号
オングストローム	Å
バーン	b
バール	bar
ガル	Gal
キュリー	Ci
レントゲン	R
ラド	rad
レム	rem

1 Å=0.1nm=10^{-10}m

1 b=100fm^2=10^{-28}m^2

1 bar=0.1MPa=10^{5}Pa

1 Gal=1cm/s^2=10^{-2}m/s^2

1 Ci=3.7×10^{10}Bq

1 R=2.58×10^{-4}C/kg

1 rad=1cGy=10^{-2}Gy

1 rem=1cSv=10^{-2}Sv

表5　SI接頭語

倍数	接頭語	記号
10^{18}	エクサ	E
10^{15}	ペタ	P
10^{12}	テラ	T
10^{9}	ギガ	G
10^{6}	メガ	M
10^{3}	キロ	k
10^{2}	ヘクト	h
10^{1}	デカ	da
10^{-1}	デシ	d
10^{-2}	センチ	c
10^{-3}	ミリ	m
10^{-6}	マイクロ	μ
10^{-9}	ナノ	n
10^{-12}	ピコ	p
10^{-15}	フェムト	f
10^{-18}	アト	a

（注）

1．表1－5は「国際単位系」第5版，国際度量衡局1985年刊行による。ただし，1 eVおよび1 uの値はCODATAの1986年推奨値によった。

2．表4には海里，ノット，アール，ヘクタールも含まれているが日常の単位なのでここでは省略した。

3．barは，JISでは流体の圧力を表わす場合に限り表2のカテゴリーに分類されている。

4．EC閣僚理事会指令ではbar，barnおよび「血圧の単位」mmHgを表2のカテゴリーに入れている。

換算表

力	N(=10^{5}dyn)	kgf	lbf
	1	0.101972	0.224809
	9.80665	1	2.20462
	4.44822	0.453592	1

粘度　1 Pa·s(N·s/m^2)=10 P(ポアズ)(g/(cm·s))

動粘度　1m^2/s=10^{4}St(ストークス)(cm^2/s)

圧力	MPa(=10bar)	kgf/cm^2	atm	mmHg(Torr)	lbf/in^2(psi)
	1	10.1972	9.86923	7.50062×10^3	145.038
	0.0980665	1	0.967841	735.559	14.2233
	0.101325	1.03323	1	760	14.6959
	1.33322×10^{-4}	1.35951×10^{-3}	1.31579×10^{-3}	1	1.93368×10^{-2}
	6.89476×10^{-3}	7.03070×10^{-2}	6.80460×10^{-2}	51.7149	1

エネルギー・仕事・熱量	J(=10^7 erg)	kgf·m	kW·h	cal(計量法)	Btu	ft·lbf	eV
	1	0.101972	2.77778×10^{-7}	0.238889	9.47813×10^{-4}	0.737562	6.24150×10^{18}
	9.80665	1	2.72407×10^{-6}	2.34270	9.29487×10^{-3}	7.23301	6.12082×10^{19}
	3.6×10^6	3.67098×10^5	1	8.59999×10^5	3412.13	2.65522×10^6	2.24694×10^{25}
	4.18605	0.426858	1.16279×10^{-6}	1	3.96759×10^{-3}	3.08747	2.61272×10^{19}
	1055.06	107.586	2.93072×10^{-4}	252.042	1	778.172	6.58515×10^{21}
	1.35582	0.138255	3.76616×10^{-7}	0.323890	1.28506×10^{-3}	1	8.46233×10^{18}
	1.60218×10^{-19}	1.63377×10^{-20}	4.45050×10^{-26}	3.82743×10^{-20}	1.51857×10^{-22}	1.18171×10^{-19}	1

1 cal= 4.18605J（計量法）

= 4.184J（熱化学）

= 4.1855J（15℃）

= 4.1868J（国際蒸気表）

仕事率　1 PS(仏馬力)

= 75 kgf·m/s

= 735.499W

放射能	Bq	Ci
	1	2.70270×10^{-11}
	3.7×10^{10}	1

吸収線量	Gy	rad
	1	100
	0.01	1

照射線量	C/kg	R
	1	3876
	2.58×10^{-4}	1

線量当量	Sv	rem
	1	100
	0.01	1

（86年12月26日現在）

The Libraries FSXLIB and MATXSLIB Based on JENDL-3.3