

Present Status of JENDL Project

Akira Hasegawa

Nuclear Data Center

Japan Atomic Energy Research Institute

1. JENDL-3 revision 3 (JENDL-3.3: General Purpose File)

The second revised version of JENDL-3 (JENDL-3.2) was released in June 1994. It contains the data for 340 nuclides in the energy range from 10^{-5} eV to 20 MeV. The ENDF-6 format was adopted for JENDL-3.2. The pointwise files were also constructed at 0 K and 300 K by using RESENDD, RECENT, LINEAR and SIGMA1.

Though JENDL-3.2 gives much better evaluated data than JENDL-3.1, JENDL-3.2 has no covariance matrices. We recognize importance of the covariance matrices. A new working group has been organized in Japanese Nuclear Data Committee (JNDC) for the study of evaluation method of the covariance matrices. Answering the requests from FBR reactor projects, several materials have being compiled by this group.

The benchmark tests have shown that JENDL-3.2 gave much better prediction of various reactor characteristics than JENDL-3.1, though some problems have been pointed out. Up to now a lot of experiences has been piled up. To reflect these feedback information to JENDL-3.3, a new task force was organized to summarize the problems of JENDL-3.2 at April 1996. A report indicating the direction of revision for JENDL-3.2 was submitted to JNDC by the group after one year survey. It was approved by the steering committee of JNDC at March 1997.

The data improvement of JENDL-3.2 has been started at April 1997 for three years project. (See the schedule in Fig.1.) JENDL3.3 will be published as a consolidated new versions of JENDL by JAERI NDC (Nuclear Data center) with the cooperation of JNDC (Japanese Nuclear Data Committee). It's main features are followings: 1) Covariance data supplemented for major elements such as major actinides, structural materials and main coolants for the applications of

FBR, LWR and Fusion reactors, to enable the estimation of quantitative contribution of nuclear data uncertainty to design accuracy or safety margin. No covariance data were supplied up to the JENDL-3.2. 2) New material evaluations such as Er for burnable poisons in LWR high burn-up applications. 3) Adoption of isotope evaluation policy rather than natural element evaluation policy. Up to 3.2 for natural elements JENDL was prepared by natural element evaluation policy, i.e., for the transport calculations in nuclear reactors, natural elements data are recommended to use and for the dosimetry or activation applications isotope evaluations are recommended to use. Among others, addition of gamma-ray production data for the materials needed in Fusion applications. The data will be released after the review process for the reevaluated nuclide is adequately made.

Publications in this period of this category are as follows,

- Chart of Nuclides 1996 (booklet JAERI, February 1997)
- CD-ROM Storing JENDL-3.2 Plots and Data, T. Fukahori, O. Iwamoto, T. Nakagawa, K. Shibata, T. Narita, J. Katakura and A. Hasegawa, JAERI-Data/Code 97-044 (October 1997)
- Descriptive Data of JENDL-3.2 (Part-I: Z=1-50, Part-II: Z=51-100), (Eds.) K. Shibata and T. Narita JAERI-Data/Code 98-006 (February 1998)
- Curves and Tables of Neutron Cross Sections in JENDL-3.2 Part I (Z=1-50), Part II (Z=51-100), (Eds.) K. Shibata, T. Nakagawa, H. Sugano and H. Kawasaki, JAERI-Data/Code 97-003 (February 1998).

2. JENDL Special Purpose Files

The following special purpose files other than JENDL-3.3 general purpose file are being developed in Japan. Their status is given below.

JENDL Fusion File

JENDL Fusion File(JFF) was released at March 1996 to provide precise double-differential neutron and charged particle emission data by using MF6 representation of the ENDF-6 format. The evaluation was made for the data of H, D, Li, Be, C, N, O, ^{19}F , ^{27}Al , Si, Ca, Ti, Cr, ^{55}Mn , Fe, ^{59}Co , Ni, Cu, ^{75}As , Zr, ^{93}Nb , Mo, Sn, Sb, W, Pb and ^{209}Bi . For H, D, Li, N and O, the data of JENDL-3.2 are directly adopted. The revision works for some nuclides except light mass nuclei have been performed by the SINCROS-II code system which consists of GNASH, DWUCK, CASTHY and several auxiliary programs. Those results are examined by comparing with DDX measured at Tohoku and Osaka Universities. For the data of light mass nuclei, individual evaluation has been done. A lot of nuclides are adopted as FENDL-2 from this file (see Table-1). Complete version of JFF96 will be released in the FY98.

JENDL Actinide File

This file will provide the data of about 90 nuclei in the actinide region from 10^{-5} eV to 20 MeV. Data for about 60 nuclei will be taken from JENDL-3.2 with some modification. We need new evaluation work for about 30 nuclei, among which the evaluation have been completed for ^{235}Np , ^{237}Pu , ^{244}Pu and ^{246}Pu . Since 1994, International Science and Technology Center (ISTC) project for Measurements and Evaluation of minor actinide nuclei has been started at Institute of Physics and Power Engineering (IPPE, Obninsk Russia, #304.), V.I. Khlopin Radium Institute (KRI, StPetersburg Russia, #183.) and Radiation Physics and Chemistry Problem Institute (RPCPI, Minsk Belarus, #b-03). Recently the forth project started to measure fission cross-sections of minor actinides in medium energy range, i.e., 1 to 200 MeV by StPetersburg Nuclear Physics Institute (PNPI St.Petersburg, #609.) The results obtained by these projects are destined to be reflected in JENDL Actinide File. The file release will be envisaged in FY99. (See Appendix A)

JENDL Dosimetry File

The working group on dosimetry in JNDC which is working for JENDL Dosimetry File is now engaging update of the file. The cross section data for more than 20 reactions will be revised and their covariance matrices will be replaced with new ones. Integral tests will be carried out after the data reviewed.

JENDL Activation Cross Section File

Evaluation and compilation work for JENDL Activation Cross Section File has been completed. Its first version stores the data for 233 nuclei and 1246 reactions. The working group for this file has reviewed the data in the file. The first version of the file, JENDL Activation Cross Section File 96, was released in March 1996 .

JENDL High Energy Files

The evaluation of data for high energy neutrons and protons has been initiated in JNDC. They will make data files for neutrons and protons up to 50 MeV and about 3 GeV.

The former files will be used for the IFMIF project which JAERI participates. The evaluation of neutron data up to 50 MeV has been made for almost all necessary nuclides. The evaluations results for neutron are being reviewed. After review, the data will be combined with JENDL Fusion File or JENDL-3.2 below 20 MeV. The file release will be envisaged in FY98.

The latter files will be used for design of accelerators, transmutation systems of high-level waste, medical applications and so on. The evaluations of Al, Si, Cr, Ni, Cu, Pb and Bi isotopes were made for neutron and proton induced reactions up to 1 GeV. The neutron nuclear data for hydrogen are also finished. These data will be reviewed. The file release will be envisaged starting at FY99.

JENDL PKA/KERMA File

This file stores the spectra of primary knock-on atoms (PKA) and KERMA factors. The data to be stored are created from the data files (JENDL High Energy File) up to 50 MeV made for the IFMIF project. A couple of processing codes to create the file from evaluated nuclear data file, by using the effective single particle emission approximation, have been developed and tested.

The test compilation has been performed from JENDL Fusion File for the 69 isotope data except light mass nuclei below 20 MeV. The file release will be envisaged in FY98.

JENDL Photonuclear Data File

The evaluation has been finished for 46 isotopes; ^2D , ^{12}C , ^{14}N , ^{16}O , ^{23}Na , $^{24,25,26}\text{Mg}$, ^{27}Al , $^{28,29,30}\text{Si}$, $^{40,48}\text{Ca}$, ^{46}Ti , ^{51}V , ^{52}Cr , ^{55}Mn , $^{54,56}\text{Fe}$, ^{59}Co , $^{58,60}\text{Ni}$, $^{63,65}\text{Cu}$, ^{90}Zr , ^{93}Nb , $^{92,94,96,98,100}\text{Mo}$, ^{133}Cs , ^{160}Gd , $^{182,183,184,186}\text{W}$, ^{197}Au , $^{206,207,208}\text{Pb}$, ^{209}Bi and $^{235,238}\text{U}$ in the gamma-ray energy range up to 140 MeV. Their compilation in the ENDF-6 format and the critical review are in progress. The file will be released in FY98.

JENDL PROJECT

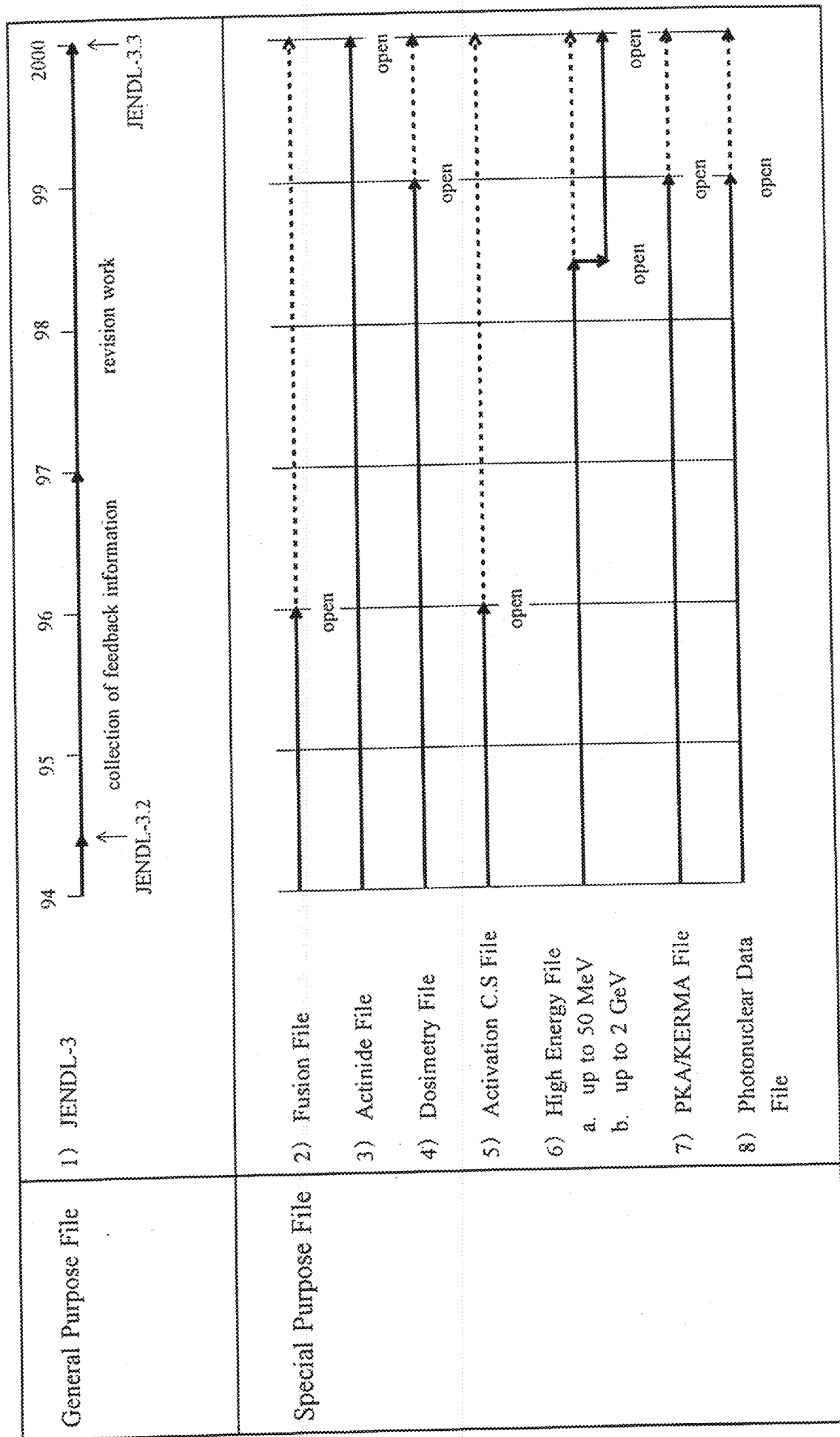


Table 4. Selected evaluated nuclear data libraries for FENDL/E-1.0 and -2.0.

Nuclide	FENDL/E-1.0	FENDL/E-2.0	Nuclide	FENDL/E-1.0	FENDL/E-2.0
1-H -1	ENDF-VI	ENDF-VI	25-Mn-55	ENDF-VI	ENDF-VI
1-H -2	ENDF-VI	JENDL-FF+BROND-2	26-Fe-54	ENDF-VI.1	ENDF-VI.1
1-H -3	ENDF-VI	ENDF-VI	26-Fe-56	ENDF-VI.1	EFF-3/ENDF-VI.1
2-He-3	ENDF-VI.1	ENDF-VI.1	26-Fe-57	ENDF-VI.1	ENDF-VI.1
2-He-4	ENDF-VI	ENDF-VI	26-Fe-58	ENDF-VI.1	ENDF-VI.1
3-Li-6	ENDF-VI.1	ENDF-VI.1	27-Co-59	ENDF-VI.2	ENDF-VI.2
3-Li-7	ENDF-VI	ENDF-VI	28-Ni-58	ENDF-VI.1	ENDF-VI.1
4-Be-9	ENDF-VI	JENDL-FF	28-Ni-60	ENDF-VI.1	ENDF-VI.1
5-B -10	ENDF-VI.1	ENDF-VI.1	28-Ni-61	ENDF-VI.1	ENDF-VI.1
5-B -11	ENDF-VI.1	ENDF-VI.1	28-Ni-62	ENDF-VI.1	ENDF-VI.1
6-C -12	ENDF-VI.1	JENDL-FF+ENDF-VI.1	28-Ni-64	ENDF-VI.1	ENDF-VI.1
7-N -14	BROND-2	JENDL-FF+BROND-2	29-Cu-63	ENDF-VI.2	ENDF-VI.2
7-N -15	BROND-2	BROND-2	29-Cu-65	ENDF-VI.2	ENDF-VI.2
8-O -16	ENDF-VI	JENDL-FF	31-Ga-nat	-----	JENDL-3.2
9-F -19	ENDF-VI	ENDF-VI	40-Zr-nat	BROND-2	JENDL-FF
11-Na-23	JENDL-3.1	JENDL-3.1	41-Nb-93	BROND-2	JENDL-FF
12-Mg-nat	JENDL-3.1	JENDL-3.1	42-Mo-nat	JENDL-3.1	JENDL-FF
13-Al-27	JENDL-3.1	EFF-3/JENDL-FF	50-Sn-nat	BROND-2	BROND-2
14-Si-nat	BROND-2	ENDF-VI/JENDL-FF	56-Ba-138	ENDF-VI	ENDF-VI
15-P -31	ENDF-VI	ENDF-VI	73-Ta-181	JENDL-3.1	JENDL-3.1
16-S -nat	ENDF-VI	ENDF-VI	74-W -182	ENDF-VI	JENDL-FF
17-Cl-nat	ENDF-VI	ENDF-VI	74-W -183	ENDF-VI	JENDL-FF
19-K -nat	ENDF-VI	ENDF-VI	74-W -184	ENDF-VI	JENDL-FF
20-Ca-nat	JENDL-3.1	JENDL-3.1	74-W -186	ENDF-VI	JENDL-FF
22-Ti-nat	JENDL-3.1	JENDL-3.1	82-Pb-204	ENDF-VI.1	ENDF-VI.1
23-V -51	ENDF-VI	JENDL-FF	82-Pb-206	ENDF-VI	ENDF-VI
24-Cr-50	ENDF-VI	ENDF-VI	82-Pb-207	ENDF-VI.1	ENDF-VI.1
24-Cr-52	ENDF-VI	ENDF-VI	82-Pb-208	ENDF-VI	ENDF-VI
24-Cr-53	ENDF-VI	ENDF-VI	83-Bi-209	JENDL-3.1	JENDL-3.1
24-Cr-54	ENDF-VI	ENDF-VI			

f + +

+: Data in both evaluations are merged.

/: One of them is selected after benchmark testing.

ISTC Project summary

Objective:

- Improvement of minor actinide data for transmutation projects using actinide burner reactors or accelerator driven spallation neutron sources.
- The data needed are for $^{237}, ^{238}\text{Np}$, $^{238}, ^{242}\text{Pu}$, $^{241}, ^{242g}, ^{242m}, ^{243}\text{Am}$ and $^{242}, ^{243}, ^{244}, ^{245}, ^{246}\text{Cm}$.
- The corresponding data for most important cross sections should be obtained on the basis of ISTC.

ISTC projects:

- "Measurements of the fission neutron spectra for minor actinides"
V.I.Khlopin Radium Institute (KRI St.Petersburg Russia, # 183-p)
1995-1997
 - high precision measurements of the fission neutron spectra for spontaneous fission of Cm-244, -246, Pu-240 -242, and that for thermal induced fission of Cm-243, -245
- "Measurements and analysis of basic nuclear data for minor actinides"
Institute of Physics and Power Engineering (IPPE Obninsk, #304-p)
1995-1996
 - precise measurements of the fission cross sections of Cm-243, -244, -245, -246, -247, -248m, Am-242m, Pu-238.
 - measurements of fission product yields for Np-237
 - measurements of inelastic scattering and prompt fission neutron spectra for Np-237
 - measurements of delayed neutron yields and it's 6-group constants for Np-237 fast neutron fission
 - critical comparison between evaluated data for BROND-2, JENDL-3 and ENDF/B-VI and deduction of recommended values
- "Evaluation of actinide nuclear data"
Radiation Physics and Chemistry Problems Institute

(RPCPIMinsk Belarus, # b-03)

1995-1997

- complete new evaluations of neutron cross sections for Cm-243, -245 -246, Am-241, 242, 242m, 243, Np-238, Pu-238, -242.

- "Neutron induced fission cross-sections of some actinides heavy nuclei in energy region 1-200 MeV

Petersburg Nuclear Physics Institute (PNPI St.Petersburg, #609)

1996-1998

- measurements of neutron fission cross-section of U-233, U-238, Np-237, Th-232, Pu-239, Pb and Bi in the energy range up to 200 MeV.
Relative measurements to U-235 fission with accuracy 3-10%.
- evaluation of above listed cross section for neutron and proton induced fissions in the energy range 20-200 MeV.