

# Present Status of JENDL Project (May 2006)

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## General

Japan Atomic Energy Agency (JAEA) was established on October 1, 2005 after the merger of Japan Atomic Energy Research Institute (JAERI) and Japan Nuclear Cycle Development Institute (JNC). The number of employees of JAEA is about 4,400 and the annual budget is about ¥200B at the time of the establishment. JAEA was established as an independent administrative agency which is governed by a law. The work scope of JAEA is prescribed according to the law governing JAEA as follows:

- ① Basic research of nuclear energy.
- ② Application research of nuclear energy.
- ③ Technical establishment of nuclear fuel cycle;
  - i R & D of Fast Breeder Reactor,
  - ii R & D of nuclear fuel for FBR,
  - iii R & D of reprocessing,
  - iv R & D of treatment and disposal of HLW.
- ④ Promotion of application of R & D results of above areas.
- ⑤ Utilization sharing of facility and equipment.
- ⑥ Human resource development of nuclear energy field.
- ⑦ Collection, arrangement and dissemination of nuclear information.
- ⑧ Study and analysis requested by government (including safety regulation, nuclear disaster prevention, international non-proliferation).
- ⑨ Related areas.

Based on the work scope, the missions of JAEA are described as followings: (1) Establishment of nuclear fuel cycles, (2) Research and development of nuclear fusion energy, (3) Contribution to hydrogen economy by nuclear process heat, (4) Quantum beam technology, (5) Research on nuclear safety, (6) Non-proliferation and safeguards technology, (7) Decommissioning of nuclear facilities, treatment and disposal of low level waste, (8) Cooperation with academic and industrial communities/ international collaboration/ human resource development/ atomic energy information and (9) Basic nuclear engineering research, advanced basic research. The nuclear data evaluation activities are included in the mission of (9). As one of the basic nuclear engineering research fields, nuclear data evaluation is performed to support other missions of JAEA.

## Mid-term plant for nuclear data evaluation

As an independent administrative agency, JAEA is supposed to make the mid-term plan which is approved by the Minister of Education, Culture, Sports, Science and Technology.

The mid-term plan is the work list JAEA promises to perform during the mid-term from October 1, 2005 through March 31, 2010. The mid-term plan was issued to the ministry and approved when JAEA was established. In the mid-term plan the nuclear data activities are written in two parts. One is the activities relating to the development of nuclear conversion system including FBR and ADS systems. In the part nuclear data evaluation is written as “Design precision will be enhanced by establishing nuclear data for nuclear conversion target MA and LLFP, establishing nuclear design code, and conducting reactor physics experiment.”. (From the JAEA English home page. <http://www.jaea.go.jp/english/index.shtml>). The second one is that relating to the basic nuclear engineering research. In the part it is written that “With fuel burn-up rate becoming higher, FP and MA nuclide will be playing increasingly important role. Thus, efforts will be made to mainly assess such nuclear data, and to complete JENDL-4, the General-Purpose, Pre-Assessed Nuclear Data Library featuring expansive error data, so to enhance the reliability of nuclear calculation.” (From the JAEA English home page. <http://www.jaea.go.jp/english/index.shtml>). So the missions of Nuclear Data Center are to complete the Japanese Evaluated Nuclear Data Library JENDL-4 (Japanese Evaluated Nuclear Data Library) and to provide the nuclear data for development of nuclear conversion system until the end of the mid-term.

Although we have a mission to provide the necessary nuclear data for development of nuclear conversion system, we consider that the primary purpose of our group is to complete JENDL-4. The main effort to compile the JENDL-4 library focusses on the nuclear data evaluation of minor actinide (MA) nuclides and fission product (FP) nuclides and the provision of more covariance data than those in the present evaluated nuclear data library JENDL-3.3. The planned schedule for the development of JENDL-4 general purpose file is shown in Fig. 1.

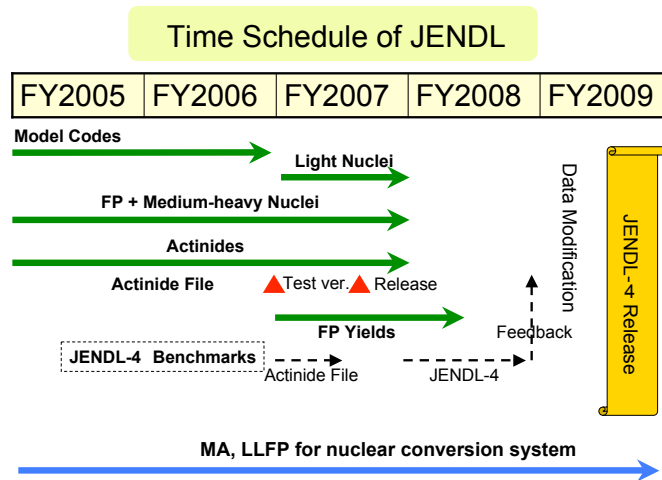


Fig. 1 Planned schedule for development of JENDL-4

## Recent Development

### Evaluation of minor actinide nuclides

In order to update the JENDL-3.3 data for MA nuclides, evaluation work is in progress. In the last several months, we performed the evaluation of the fission cross sections based on available experimental data. The fitting code GMA was used for this purpose. Experimental data were retrieved from EXFOR database. The GMA analyses were performed for 23 MA nuclides;  $^{230,232}\text{Th}$ ,  $^{231}\text{Pa}$ ,  $^{232,234,236}\text{U}$ ,  $^{237}\text{Np}$ ,  $^{236,238,242,244}\text{Pu}$ ,  $^{241,242m,243}\text{Am}$ ,  $^{242,243,244,245,246,247,248}\text{Cm}$ ,  $^{249,252}\text{Cf}$ . Examples of the GMA analyses are shown in Fig. 2. In this figure the fission cross section of  $^{243}\text{Cm}$  is shown. The left hand side shows the comparison of the cross section and the right hand side the ratios to the values of JENDL-3.3.

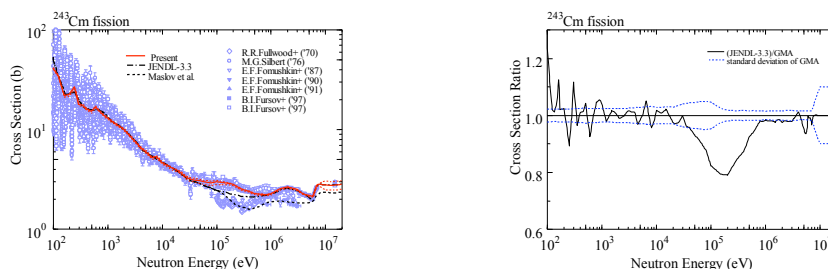


Fig. 2 GMA analysis for  $^{243}\text{Cm}$

The present results are almost the same as the evaluated data in JENDL-3.3. Large and important discrepancies were not observed. Covariance data of the present results were obtained simultaneously. They will be utilized to create covariance files of new evaluated data.

### Evaluation of FP nuclides

Resolved resonance parameters of JENDL-3.3 FP nuclides were examined for JENDL-4 by taking into account recent measurements. As a result, the parameters for 89 FP nuclides were updated. Moreover, the parameters for additional 13 nuclides were newly evaluated for JENDL-4. The data of total 212 FP nuclides will be included in JENDL-4.

In the fast-neutron energy region, optical model parameters were searched for by using the coupled-channel optical model code OPTMAN. The systematics of neutron and proton optical model parameters has been obtained by comparing with experimental data on Fe, Ni, Cu, Zr, Nb, Mo, Sn, W, Au, Pb, Bi, Th, and U in the energy region from 1 keV to 200 MeV. Figure 3 shows s-wave and p-wave neutron strength functions calculated with the obtained optical model parameters. It is found from the figure that the coupled-channel calculations using the parameters presently obtained reproduce experimental data better than the spherical optical model calculations.

### JENDL High Energy Files

The evaluation of data for intermediate energy neutrons and protons has been initiated in Japanese Nuclear Data Committee. They will make data files for neutrons and protons up to 3 GeV as the JENDL High Energy File (JENDL/HE). After review, the

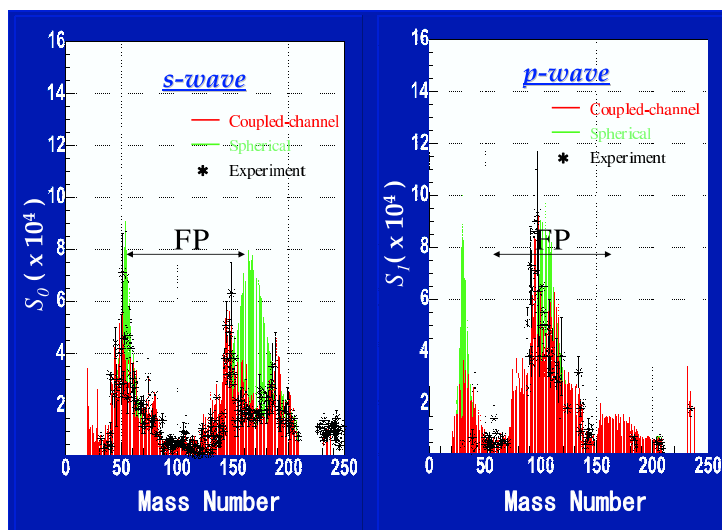


Fig. 3 s-wave and p-wave neutron strength functions.  
The calculations were performed at 10 keV.

data will be combined with JENDL-3.3 below 20 MeV. The JENDL/HE-2004 has been released partly in March, 2004. The released data contains 66 nuclides, which are  $^1\text{H}$ ,  $^{12,13}\text{C}$ ,  $^{14}\text{N}$ ,  $^{16}\text{O}$ ,  $^{24,25,26}\text{Mg}$ ,  $^{27}\text{Al}$ ,  $^{28,29,30}\text{Si}$ ,  $^{39,41}\text{K}$ ,  $^{40,42,43,44,46,48}\text{Ca}$ ,  $^{46,47,48,49,50}\text{Ti}$ ,  $^{51}\text{V}$ ,  $^{50,52,53,54}\text{Cr}$ ,  $^{55}\text{Mn}$ ,  $^{54,56,57,58}\text{Fe}$ ,  $^{59}\text{Co}$ ,  $^{58,60,61,62,64}\text{Ni}$ ,  $^{63,65}\text{Cu}$ ,  $^{64,66,67,68,70}\text{Zn}$ ,  $^{90,91,92,94,96}\text{Zr}$ ,  $^{93}\text{Nb}$ ,  $^{180,182,183,184,186}\text{W}$  and  $^{196,198,199,200,201,202,204}\text{Hg}$ . The data for some nuclides are now in evaluation and they (totally over 100 nuclides) will be released in early 2007.

#### JENDL Photonuclear Data File

The evaluation and compilation for photon-induced nuclear data up to 140 MeV has been finished for 68 nuclides. They are  $^2\text{H}$ ,  $^3\text{He}$ ,  $^{6,7}\text{Li}$ ,  $^9\text{Be}$ ,  $^{10,11}\text{B}$ ,  $^{12}\text{C}$ ,  $^{14}\text{N}$ ,  $^{16}\text{O}$ ,  $^{19}\text{F}$ ,  $^{23}\text{Na}$ ,  $^{23,25,26}\text{Mg}$ ,  $^{27}\text{Al}$ ,  $^{28,29,30}\text{Si}$ ,  $^{31}\text{P}$ ,  $^{40,48}\text{Ca}$ ,  $^{46}\text{Ti}$ ,  $^{51}\text{V}$ ,  $^{52}\text{Cr}$ ,  $^{55}\text{Mn}$ ,  $^{54,56}\text{Fe}$ ,  $^{59}\text{Co}$ ,  $^{58,60}\text{Ni}$ ,  $^{63,65}\text{Cu}$ ,  $^{64}\text{Zn}$ ,  $^{90}\text{Zr}$ ,  $^{93}\text{Nb}$ ,  $^{92,94,96,98,100}\text{Mo}$ ,  $^{133}\text{Cs}$ ,  $^{152,154,155,156,157,158,160}\text{Gd}$ ,  $^{181}\text{Ta}$ ,  $^{182,184,186}\text{W}$ ,  $^{197}\text{Au}$ ,  $^{196,198,199,200,201,202,204}\text{Hg}$ ,  $^{206,207,208}\text{Pb}$ ,  $^{209}\text{Bi}$ ,  $^{235,238}\text{U}$  and  $^{237}\text{Np}$ . These data have been released as JENDL Photonuclear Data File (JENDL/PD-2004). The evaluated data for 107 nuclides from KAERI Photonuclear Data File will be planned to be included. All the data are now being checked and revised and they will be released in early 2007.

#### JENDL PKA/KERMA File

This file stores the spectra of primary knock-on atoms (PKA), damage energy spectra, DPA cross sections 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 process 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.

## Code Development

We are developing new theoretical calculation codes for the evaluation of cross section and particle emission spectrum for which can not be estimated from only experimental data. The codes consist of the parts of coupled-channel optical model, pre-equilibrium exciton model and Hauser-Feshbach statistical model with Moldauer width fluctuation correction. They are fully new codes which are written by C++ programming language in object-oriented way. Using global model parameters, reproducibility of the calculated results for cross sections and emission spectra have been checked by comparison with experimental data for stable isotopes.

## **Other Activities**

### Development of Data Utilization System

We are developing the Combined System for Nuclear Data Utilization, Circulation and Transfer (CONDUCT). This is conducted by the research contract with the Ministry of Education, Culture, Sports, Science and Technology (MEXT) as one of Innovative Nuclear Energy System Development Projects. The contract is scheduled to continue until the end of March 2006. The CONDUCT system provides two functions: 1) retrieval of original data, 2) processing of data for applications. It is planned to carry out simple benchmark calculations for feedback to evaluations. The system will be completed in FY2006 and accessed by registered users via internet. The development of the retrieval system has been almost finished. The data processing system will be continued until the end of March 2006.

### 2005 Symposium on Nuclear Data

The 2005 Symposium on Nuclear Data was first scheduled to be held in November 2005. Because of the establishment of new organization and the change of the budget system, it was difficult to held it in November. The symposium, then, actually was held at 2th and 3th February 2006. The number of attendees is 91. Topics of the symposium are 1) Nuclear Data for Innovative Reactor Developments and Further Developments of Current Reactors, 2) Past and Future of Nuclear Data Research, 3) Status and Performance of Latest Evaluated Nuclear Data Files, and 4) Latest Nuclear Data Measurements. In the symposium 16 papers were presented in the oral session and 23 papers in the poster session. The proceedings will be published shortly.