Next Version of JENDL General Purpose File

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The latest version JENDL General Purpose File, JENDL-3.3, was released in 2002. JENDL-3.3 is regarded as one of the major libraries in the world for its quality and size. The next version has been discussed at an *ad hoc* committee in the Japanese Nuclear Data Committee.

1. Introduction

JENDL-3.3[1)] was released in May 2002. It is the latest version of JENDL-3 series which have been developed since 1980s. The Steering Committee in the Japanese Nuclear Data Committee (JNDC) set up an *ad hoc* committee, which is referred to as the Committee on Next JENDL, in order to discuss the next version of JENDL General Purpose File. The Committee on Next JENDL consisted of evaluators, experimentalists, and users. It was agreed in the Committee that we should develop JENDL-4 with a giant leap from JENDL-3.3 instead of performing minor modifications.

We discussed the demands for JENDL-4 by inviting many specialists for various applications. Considered were the technologies for light water and fast breeder reactors, the development of accelerator-driven systems (ADS), shielding, criticality safety, fusion neutronics, radiation damage, neutron therapy, the production of radioactive material for medical use, and astrophysics. As a result, the Committee recognized strong needs for JENDL-4.

This report deals with the purposes, rough specifications, key subjects and issues for JENDL-4.

2. Demands for JENDL-4

The demands for JENDL-4 were collected by interviewing with the specialists for various applications.

LWR and FBR technologies

- More accurate minor actinide and FP data are required.
- FP yield data should be re-examined.
- Evaluation of spontaneous fission neutron spectra is required.
- Gamma-ray production data are needed for all nuclei.
- More covariances are needed.

Development of ADS

- More accurate minor actinide data are required.
- FP yield data should be re-examined.

Criticality Safety

- More accurate minor actinide and FP data are required.
- Gamma-ray production data are needed.

Radiation Damage Study

- ^{59}Ni data should be evaluated, since its contribution is significant but there exist no data in JENDL-3.3.
- Charged-particle and PKA spectra, and KERMA factors are requisite for a radiation damage study.

High Energy Accelerator Shielding

- All the data are covered by the JENDL High Energy Files, which are being developed.

Fusion Neutronics

- The problems with JENDL-3.3 should be resolved by comparing with benchmark experiments at FNS and OKTAVIAN.
- Charged-particle spectra are required for light nuclei.
- Covariances are needed for further analyses.
- The data for IFMIF are required. These data will be produced as activities on JENDL High Energy Files.
- Light charged-particle (p, d, t, ^{3}He, ^{4}He) induced-reaction data are required. The demand might be covered by a special purpose file instead of JENDL-4.

Boron Neutron Capture Therapy

- Data are required for neutron sources such as Li(p,n) and Ta(p,n), for moderator materials such as Li, F, Al, for tissue-equivalent materials such as H, C, N, O, and for ^{10}B(n, α) reaction. These data will be prepared by JENDL High Energy Files, which are being developed.

Other Demands

In the beginning of FY2002, the demands for Next JENDL were collected by internet. The items, which are not overlapped with the ones mentioned above, are given as follows:

- Nuclear model codes should be developed in Japan to accumulate evaluation expertise.

- International cooperation should be promoted because of man power shortage in Japan.
- Inner-shell electron ionization data should be evaluated for medical use. Unfortunately, it is impossible to achieve this task by considering the present framework of JNDC.
- The information on JENDL should be extended to various fields other than nuclear energy applications.

3. Purposes of JENDL-4

The Committee agreed that JENDL-4 should be developed for researches on innovative reactors such as a reduced-moderation water reactor and an ADS, high burn-up and the use of MOX fuels for LWR, criticality safety with burn-up credit, medical use and astrophysics. JENDL-4 should be regarded as a system including reactor constants. Quality assurance of JENDL-4 is important so that it can be used as a standard nuclear data library in Japan.

4. Specifications of JENDL-4

4.1 Incident particles

Up to JENDL-3.3, the incident particles are limited to neutrons. JENDL-4 will include charged-particle and photon induced reaction data as well as spontaneous fission data in addition to neutron-induced reaction data.

4.2 Maximum incident energies

The range from 10^{-5} eV to 20 MeV is mandatory. However, the maximum energy can be extended to a larger value than 20 MeV depending on data needs.

4.3 Nuclides to be considered

We discussed how many nuclides should be included in JENDL-4. Some people stated that more than a thousand nuclides would be required for burn-up calculations. We reached a conclusion that there are no needs to increase the number of nuclides drastically. There is a possibility that the nuclides required for burn-up calculations might be prepared by the Working Group on Evaluation of Astrophysics Data in JNDC.

So far, the data contained in JENDL have been evaluated by ourselves. For example, JENDL-3.3 does not contain ^{197}Au data, since the data were not evaluated in JNDC. However, from the viewpoints of users, a library should contain all data required for applications. In JENDL-4, we may take the whole data on particular nuclides from other libraries, if the data are necessary.

4.4 Data format

We are going to adopt the ENDF-7 format[2)], which will be determined later. Requirements for format change should be given to CSEWG.

5. Key Subjects

5.1 Incident particles and maximum energy

JENDL-4 will include neutron, charged-particle, and photon induced reaction data as well as spontaneous fission spectral data. Limited is the number of nuclides for charged-particle-, photon-induced reaction data and spontaneous fission.

5.2 Problems with JENDL-3.3

It is necessary to solve problems with JENDL-3.3 by considering benchmark analyses and users' experiences.

5.3 Minor actinide and FP data

The importance of minor actinide data is increasing due to high burn-up, use of MOX fuels and ADS. Therefore, the accuracy of minor actinide data should be improved.

FP data should be also improved because of criticality safety with burn-up credit and of the development of innovative reactors.

5.4 Covariances

Covariance data are required to evaluate uncertainties in design calculations using nuclear data. JENDL-3.3 contains covariances for 20 nuclides. However, the quantity is not enough, and further evaluation is necessary.

5.5 FP yields and fission neutron spectra

FP yields should be re-examined. Neutron spectra emitted from neutron-induced and spontaneous fission should be evaluated.

5.6 Gamma-ray production data

Secondary gamma-ray production data should be added when re-evaluation is performed.

5.7 Charged-particle and recoil nucleus spectra

Evaluation of charged-particle and recoil nucleus (PKA) spectra is essential for a research on radiation damage.

5.8 Data consistency

We have to pay attention to consistency of data such as energy balance of spectra.

5.9 Data to be added

JENDL-4 should include ^{59}Ni and ^{197}Au data required by users.

6. Development of JENDL-4

6.1 General remark

The JAERI Nuclear Data Center should take the initiative to carry out evaluation, compilation and benchmarking and to produce reactor constants in cooperation with JNDC. Each working group in JNDC will work on an allocated task for JENDL-4. The Steering Committee in JNDC is responsible for providing each working group with good

circumstances so that it could achieve the mission efficiently.

6.2 Role of each group

JAERI Nuclear Data Center

- Coordination of the whole JENDL-4 project
- In charge of minor actinide data evaluations
- To develop tools for covariances and provide them for evaluators
- In charge of important nuclides such as structural materials and major actinides
- In charge of ^{59}Ni and ^{197}Au data

Evaluation and Calculation Support System WG

- To make a guideline of evaluations, which leads to a textbook
- To consider the use of standards in JENDL
- To develop evaluation tools and provide them for evaluators

FP Nuclide Evaluation WG

- To evaluate FP data
- Covariances for capture cross sections
- Gamma-ray production data

FP Yield Data Evaluation WG

- To evaluate FP yield data and fission neutron spectra
- Consideration of uncertainties in FP yield data

High Energy Nuclear Data Evaluation WG

- To decide on for which nuclide the maximum incident energy should be extended, and to provide the data
- To provide PKA data and proton- and photon-induced reaction data for JENDL-4

Reactor Integral Test, Shielding Integral Test and Evaluation of Nuclide Generation WGs

- Selection of benchmark problems
- To make criteria for data validation
- To carry out benchmark analyses and to feed the results back to evaluators
- To construct databases of input and output of benchmark calculations together with experimental data

Standard Group Constant WG

- To generate standard group constants based on JENDL-4 by considering needs

JENDL Compilation Group

- To compile evaluations and carry out checking
- To make review kits and set up a review system in JNDC. The critical review is necessary for quality assurance.

Steering Committee

- To make arrangements for JENDL-4 evaluations

- Strong link with AESJ Nuclear Data and Reactor Physics Divisions
- To cooperate with AESJ Standard Committee and to make JENDL-4 a standard nuclear data library in Japan

7. Some Issues

7.1 Resonance analysis

The resolved resonance parameters for most of important nuclides contained in JENDL-3.3 were taken from the analyses by the ORNL group using SAMMY code[3]. Such a situation is not preferable by considering the fact that the resonance parameters are most important nuclear data for energy applications. We should have Japanese specialists who can deal with resonance analyses in universities or in research organizations. As the first step, people are encouraged to attend a SAMMY workshop which holds periodically.

7.2 Nuclear model codes

We frequently use nuclear model codes made in foreign countries. However, it is recognized that our own nuclear model codes should be developed in order to improve the reliability of evaluations and to reflect the recent knowledge on nuclear physics.

7.3 Thermal scattering law data

Unfortunately, JENDL does not have thermal scattering law data. This matter should be discussed in JNDC.

7.4 Processing codes

The evaluated data are usually processed for nuclear energy applications. We have to keep a man power to develop and maintain the processing codes.

8. International Cooperation

It is forty years since JNDC was founded. The number of evaluators is steadily decreasing without replacements. To supplement the present situation, we should join international evaluation activities such as NEANSC/WPEC and IAEA/CRP. We should also keep a good relation with KAERI, CEA, and LANL in which nuclear data evaluations are actively performed. We may have some common data in JENDL, ENDF and JEFF. However, we have no intention to make a world-wide unified library at present.

9. Quality Assurance

It is necessary to raise the reliability of JENDL-4 better than that of JENDL-3.3. Thus, we need to make criteria for quality assurance. Extensive benchmark analyses should be performed for various applications before the release of JENDL-4. A database will be produced so that users could refer the input and output of benchmark calculations together with experimental data. For users' convenience, we should make reactor constants based on

JENDL-4 for typical applications such as transport and burn-up calculations. It is believed that these activities make JENDL-4 a standard nuclear data library in Japan.

10. Conclusions

The *ad hoc* Committee on Next JENDL discussed about JENDL-4 and made recommendations and proposals for JENDL-4. On the 22nd of December 2003, the Steering Committee in JNDC decided to start the JENDL-4 project proposed by the present report. We should go forward although there exist some difficulties such as man power shortage.

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次期 JENDL 汎用ファイル

著者

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