

Present Status of the JENDL Project (May, 2013) WPEC Meeting, Paris, France, 23-24 May, 2013

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Organization of Japanese Nuclear Data Committee

The Japanese Nuclear Data Committee (JNDC) is a research committee for JAEA research activities. Prof. T. Ohsawa of Kinki University chaired the committee until March 2013 and has been switched with Prof. N. Yamano of Fukui University on April 2013. The committee has two subcommittees: Subcommittee on Nuclear Data and Subcommittee on Reactor Constants. The following listed working groups are those of the last fiscal year (2012.4 - 2013.3).

Subcommittee on Nuclear Data (chaired by K. Shibata, JAEA¹)

High Energy Nuclear Data Evaluation WG (chaired by S. Kunieda, JAEA)

ENSDF Group (chaired by H. Iimura, JAEA)

Japanese Nuclear Data Management Network (chaired by Y. Watanabe, Kyushu Univ.)

Subcommittee on Reactor Constants (chaired by N. Yamano, Fukui Univ.)

Reactor Integral Test WG (chaired by G. Chiba, Hokkaido Univ.)

Shielding Integral Test WG (chaired by C. Konno, JAEA)

Decay Heat Evaluation WG (chaired by T. Yoshida, Tokyo Tech.)

WG on Evaluation of Nuclide Generation (chaired by K. Okumura, JAEA)

Covariance Utilization WG (chaired by T. Iwasaki, Tohoku Univ.)

The *Decay Heat Evaluation WG* and the *WG on Evaluation of Nuclide Generation* merged into a *WG on Evaluation of Nuclide Generation and Decay Heat* on April 2013. A new WG related to nuclear data processing and a new advisory subcommittee on development of JENDL will be organized in 2013.

Nuclear Data Evaluation

JENDL-4.0 Updated Files and JENDL-4.0 Plus

The JENDL-4.0 Updated Files (JENDL-4.0u) have been produced to take care of errors which were found after the release of JENDL-4.0. The JENDL-4.0u includes the nuclides whose nuclear data partly revised from important and/or trivial error(s). The JENDL-4.0 plus files (JENDL-4.0+) contain newly evaluated data and fully revised ones which have been remained in JENDL-4.0 such as being carried over or minimum revision from JENDL-3.3. Nineteen files for JENDL-4.0u were released in 2012. Important update was made on items:

¹ switched with H. Harada, JAEA, on April 2013

- covariance data of major actinides of $^{233, 235, 238}\text{U}$ and ^{239}Pu in resonance region,
- interpolation option of the elastic scattering which caused a problem on processing by NJOY-99,
- unphysical oscillations in the elastic scattering cross sections of ^{10}B ,
- capture cross section at low energy of ^{156}Eu which gave unfavorable influence on results of PIE analyses.

The JENDL-4.0u is available from the JAEA web site.²

Benchmarking for fission reactor applications

1) Criticality for thermal systems:

Two MISTRAL experiments at EOLE facility, CEA, were analyzed with JENDL-4.0. One is MISTRAL 1, which is UO₂-fueled core, and the other is MISTRAL 4, MOX-fueled. For MISTRAL 1, the C/E difference of criticality between JENDL-4.0 and JENDL-3.3 is significant (+0.28%dk), but it is small for MISTRAL 4 (-0.06%dk). From sensitivity analysis, the increase in keff in JENDL-4.0 for the MISTRAL core 1 is mainly attributed to the decreases in the capture cross sections of ^{238}U . On the other hand, the major contributions in MISTRAL core 4 to decrease keff are the decreases in ν of ^{239}Pu and the increase in ^{241}Am capture cross-section, but they are compensated with other nuclides' fission cross-sections.

(Ref.) T.Sakai and T.Yamamoto: "Neutron cross section sensitivity analysis on UO₂ and MOX cores in the MISTRAL program", Japan Nuclear Energy Safety Organization, Proceedings of the 2012 Symposium on Nuclear Data, Nov. 15-16, 2012, Kyoto University Research Reactor Institute, Japan, to be published.

2) Adjusted library for fast systems

Based on JENDL-4.0, an adjusted library, ADJ2010, with 70-group structure for fast reactor analysis was released in July 2012. The number of integral experiments used for adjustment is totally 488, including various facilities such as ZPPR, ZEBRA, JOYO, MONJU, BFS, SEFOR and Los Alamos. The nuclear data adjusted are 155 reactions of 27 nuclides including fission spectrum and μ -bar, delayed neutron data of 11 fissile nuclides, pseud-fission product data of 4 fissiles and self-shielding factor of ^{238}U . The performance of ADJ2010 is quite excellent for both Pu-fueled and enriched uranium-fueled cores from small to large core -sizes such as the C/E values of criticality within $\pm 0.2\%$ dk and those of sodium void reactivity within 10%.

(Ref.) K.Sugino, M.Ishikawa, et al.: "Development of a Standard Data Base for FBR Core Design (XIV) - Analyses of Extensive FBR Core Characteristics Based on JENDL-4.0 -", JAEA-Research 2012-013, July 2012, in Japanese.

New Evaluations

The data which are not updated in JENDL-4.0 are continuously considered to be revised, especially for FP region nuclides. Full evaluation for $^{69,71}\text{Ga}$, ^{99}Tc ,⁴

² <http://www.ndc.jaea.go.jp/jendl/j40/update/>

³ K. Shibata, "Evaluation of neutron nuclear data for gallium", *J. Nucl. Sci. Technol.* **50**, 277 (2013)

^{96,98-106}Ru, ^{121,123-126}Sb, ^{141,143}Pr, ^{162,164,166,167,168,170}Er, ⁵ ^{165,166m}Ho, ^{175,176}Lu, ^{185,186,187}Re and ^{191,192,193}Ir isotopes have been done.

For decommissioning of nuclear power plants, evaluation of activation cross sections is planned for 569 reactions with 309 nuclides and is in progress now. Evaluated files of Se, Br, Kr, Rb, Sr, Mo, Ru, Sb, Er, and Hf isotopes have been created. The evaluated data will be released within three years.

As the activity of High Energy Nuclear Data Evaluation WG, development of new JENDL Photonuclear Data File is in progress. Evaluation for 181 nuclides has been finished. It will be released in 2013.

Covariances

New evaluations of covariance data were made for Sm and Pb isotopes. Preliminary evaluated data files are produced. The covariance data for Pb isotopes were used for uncertainty analysis of Accelerator-driven System (ADS). The evaluated data files will be available from the JAEA web site.

Evaluation Tools

The 5 year period from 2010 to 2014 is the second period of mid-term research plan of JAEA. According to the mid-term plan, an objective of nuclear data research is “incident energy extension of JENDL”. For this purpose, the nuclear reaction model code, CCONE has been improved;

- to add the multi-particle emission from the pre-equilibrium stage,
- to add the complex-particle emission from the pre-equilibrium stage, and
- to add the function of calculating photo-induced reactions.

FP Decay Data File

The decay and fission yield data of fission products were compiled as JENDL FP Decay Data File 2011 (JENDL/FPD-2011) and JENDL FP Fission Yields Data File 2011 (JENDL/FPY-2011).⁶ New measured and TAGS data after the release of JENDL/FPD-2000 are reflected. The file contains the decay data of 1284 FP nuclides (of which 142 nuclides are stable). In order to keep the consistency between the decay data file and fission yields file, the JENDL/FPY-2011 file was also compiled. The decay heat calculations for various kinds of fissioning nuclides were performed. The calculated results showed good agreement. The uncertainty analyses of the decay heat calculation show about 10 % at 0.1 s after burst fission. JENDL/FPD-2011 and JENDL/FPY-2011 were released in July 2012. The data files are available from the website: <http://www.ndc.jaea.go.jp/jendl/jendl.html>.

⁴ N. Iwamoto, “Evaluation of neutron nuclear data for Technetium-99,” *J. Nucl. Sci. Technol.* **49**, 244 (2012).

⁵ K. Shibata, “Evaluation of neutron nuclear data for erbium”, *J. Nucl. Sci. Technol.* **49**, 824 (2012)

⁶ J. Katakura, ” JENDL FP decay data file 2011 and fission yields data file 2011,” *JAEA-Data/Code 2011-025*, Japan Atomic Energy Agency (2012).

Other Activities

2012 Symposium on Nuclear Data

The symposium was held on 15 and 16, November, 2012 at Kyoto University Research Reactor Institute, Kumatori-cho, Osaka. There were 83 participants. The symposium was hosted by nuclear data division, Atomic Energy Society of Japan (AESJ)/ Kyoto University Research Reactor Institute (KUR) and JAEA/Nuclear Science and Engineering Directorate. Oral presentations were made on the topics of “Nuclear Power after Fukushima Nuclear Plant Accident”, “Application of Nuclear Data”, “How Should We Deal with Covariances of Nuclear Data?”, and “Validation of JENDL-4.0 and Future”. Totally 35 papers including poster presentations were presented and will be summarized into the proceedings.

Initiation of Conversation on Covariance Data with Users

In 2010, an argument occurred from JENDL users, especially design people of ADS, that is, the difference of k_{eff} values between two libraries (JENDL-3.3 and JENDL-4.0) is much larger than the uncertainty value calculated with JENDL covariance data and sensitivity coefficients. The users expressed strong distrust to the covariance data. A meeting between JENDL evaluators and users was held to discuss about the JENDL covariance data. The major conclusions are:

- 1) About the capture cross sections of ^{241}Am and ^{237}Np , their cross sections and covariance data seems consistent for JENDL-3.3 and JENDL-4.0,
- 2) On the other hand, the standard deviation of inelastic scattering cross sections for JENDL-3.3 seems too small compared with measured data.
- 3) As a conclusion, there are certainly rooms to improve the covariance data of JENDL library, but this never means the covariance data are totally wrong or useless.

The meeting members all agreed that this kind of continuous efforts to make actual data analysis and discussions between evaluators and users would improve the covariance data to be used in ADS or reactor design work.

Along this context, a working group, named as "Use of Covariance WG" in the JENDL committee, has been launched in 2011. Its objectives are: to promote the conversation on the covariance of nuclear data between the users and evaluators, and finally to improve the quality of the covariance data.

Golden Jubilee (since 1963) of JNDC was celebrated.

The year of 2013 is the “Golden Jubilee of Japanese Nuclear Data Committee” and it was celebrated on the occasion of the AESJ annual meeting at Osaka. The 50 odd participants joined to both memorial lectures and party.