Present Status of the JENDL Project (May, 2012)
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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 chairs the committee. 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 (2011.4 - 2012.3).

Subcommittee on Nuclear Data (chaired by K. Shibata, JAEA)
High Energy Nuclear Data Evaluation WG (chaired by Y. Watanabe, Kyushu Univ.)
ENSDF Group (chaired by H. Iimura, JAEA)

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 City Univ.)
WG on Evaluation of Nuclide Generation (chaired by K. Okumura, JAEA)
Covariance Utilization WG (chaired by T. Iwasaki, Tohoku Univ.)

A new WG related to nuclear data measurements will be started from 2012.

Nuclear Data Evaluation

Aftercare of JENDL-4.0

The compilation of the new Japanese Evaluated Nuclear Data Library, JENDL-4.0 was completed in March 2010. After the internal procedure for public release, the JENDL-4.0 was released in May 2010. The DVD-ROM including the original data, point-wise data (0, 300K) and plots also has been published. The files for Maxwellian average cross sections of neutron capture reactions and JENDL-4 merged version of JENDL/HE-2007 were prepared for nuclear astrophysics applications and IAEA/CRP on FENDL-3, respectively.

For the treatment of bugs, the collection of the deficiencies in JENDL-4.0 has been started. Following it, updated files for

- Elastic scattering cross section of ^{10}B
- Comment file of ^{109}Ag
- Fission product yields for ^{241}Pu and ^{242m}Am

have been prepared. The original FPY for ^{242}Am should have been the FPY for ^{242m}Am. Therefore, the wrong MAT number was changed to the correct one. The revised files will be released from JAEA web site.

JENDL-4.0 Updated Files and JENDL-4.0 Plus

The updated and newly evaluated files after the release of JENDL-4.0 will be available from the JAEA web site. They are classified into "JENDL-4.0 Updated" and "JENDL-4.0 Plus" files, respectively.

Benchmarking for fission reactor applications

1) Criticality for thermal systems:

The FUBILA experiments in CEA aimed to study the core physics characteristics related to BWR MOX assemblies with the parameters such as Pu enrichment, void fraction, and existence of Gd or control blade. The C/E values of $\boldsymbol{k}_{\mathrm{eff}}$ for various FUBILA cores calculated by a Monte Carlo code (MVP) with JENDL-4.0 are quite stable with slight overestimations by +200-300 pcm, which are almost same with those of JENDL-3.3. From the sensitivity analysis, this similar C/E values of JENDL-4.0 and JENDL-3.3 are found to be the result of complicated cancellation among various nuclide- and reaction- contributions such as capture cross sections of ^{238,239}Pu, ^{238}U and fission cross section of ^{239}Pu (positive), and capture cross section of ^{241}Am, nu-bar of ^{239}Pu and elastic cross-section of ^{1}H (negative). Further, JEFF-3.1 show similar results with JENDL-4.0, on the other hand, ENDF/B-VII.0 overestimate the $\boldsymbol{k}_{\mathrm{eff}}$ values by +400-700 pcm.

2) Post-irradiation experiments for thermal systems:

A new post-irradiation experiment (PIE) for high burn-up BWR fuel assemblies has been recently performed in Japan. The C/E values with JENDL-4.0 show significant improvements to evaluate the atomic number densities of ^{238}Pu, ^{134}Cs and ^{154}Eu, compared with those of JENDL-3.3. These results are coincident with those previously reported for the PIE analysis for a PWR, Takahama-3 (Ref.: *J. Nucl. Sci. Technol*. **48[2]**, 172-187 (2011)).

3) Criticality for fast systems:

The ENDF/B-VII.1 (ENDF-7.1, hereafter) released in Dec. 2011 was applied to the criticality analyses of typical fast reactor cores, and the results were compared with those of JENDL-4.0. **Figure 1** shows the C/E values by ENDF-7.1 and JENDL-4.0. Both libraries seem to possess sufficient capability to predict the various sizes of fast reactor cores, but there are two different points in detail. One is the reflector effect for the ultra-small uranium cores, Godiva (bare) and Flattop-235 with natural uranium reflector. The C/E values by JENDL-4.0 are almost constant for these two cores, but ENDF-7.1 increases $\boldsymbol{k}_{\mathrm{eff}}$ of FLATTOP-235 with the reflector by +300 pcm. From the sensitivity analysis, the cancellation among inelastic, capture cross sections (positive) and mu-bar, elastic cross sections of ^{235}U (negative) seems to make the reflector effect by ENDF-7.1 worse than JENDL-4.0. The other is also the reflector effect where the natural uranium blanket (FCA X-1 core) was replaced with the stainless steel reflector

(FCA X-2 core). Since the core fuel is identical for these two cores, the constant C/E values seem favorable from the reflector effect viewpoint. From **Fig.1**, the replacement reactivity from ^{238}U blanket to SS reflector seems better evaluated by JENDL-4.0 than by ENDF-7.1. This difference is found to be caused by the negative reactivity from mu-bar of ^{52}Cr and Na, and elastic cross section of ^{57}Fe, ^{60}Ni, Al by the sensitivity analysis shown in **Fig.2**.

New Evaluations

Thermal neutron cross sections for ^{2}H, ^{59}Co, ^{58,62}Ni and ^{93}Nb have been reevaluated for the purposes of the down-stream of fuel cycle and replacements of power reactors.

The data which are not updated in JENDL-4.0 are continuously considered to be revised, especially for FP region nuclides. The evaluation for Ga, Ru, Rh, Sb, Te, I, La, Ce, Pr and Er was planned. Among them, full evaluation for ^{69,71}Ga, ^{99}Tc*, ^{156}Er, ^{175,176}Lu and Ho isotopes has been done. New evaluation for Ru is in progress. Simultaneous evaluation of neutron and photon induced reactions for Pd isotopes have been performed.

Some new data for the medical RI production, the reactions of ^{64,66,67,68,70}Zn up to 40 MeV were evaluated.

* : N. Iwamoto, "Evaluation of neutron nuclear data for Technetium-99," *J. Nucl. Sci. Technol.* **49**, 244-252 (2012).

Covariances

The covariance data were updated for ^{52,53}Cr. Those for resolved resonance parameters of ^{233,235,238}U and ^{239}Pu were also investigated and stored in MF=33, not in MF=32. Covariance data for Sm isotopes are under evaluation. The updated and newly evaluated 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)**. 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. The JENDL Decay Data File is planned to be prepared for 1689 nuclides (A=3-260).

**: 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

2011 Symposium on Nuclear Data

The symposium was held on 16 and 17, November, 2011 at the RICOTTI, Tokai-mura, Ibaraki. There were 97 participants. The symposium was hosted by nuclear data division, Atomic Energy Society of Japan. The topics related to accident analysis codes, next nuclear development, radiation protection, decay heat, activation cross section, nuclear data measurements and nuclear theories were presented. Totally 37 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 accelerator driven system (ADS), that is, the difference of $\boldsymbol{k}_{\mathrm{eff}}$ 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.

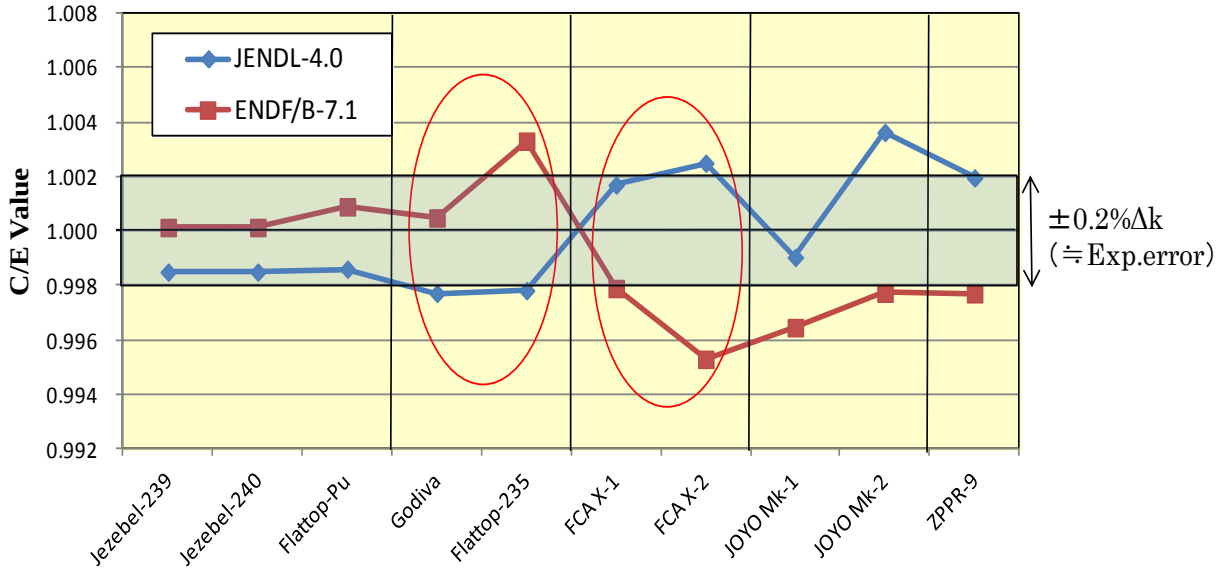

Fig. 1 C/E values of criticality for fast systems by Monte Carlo calculation

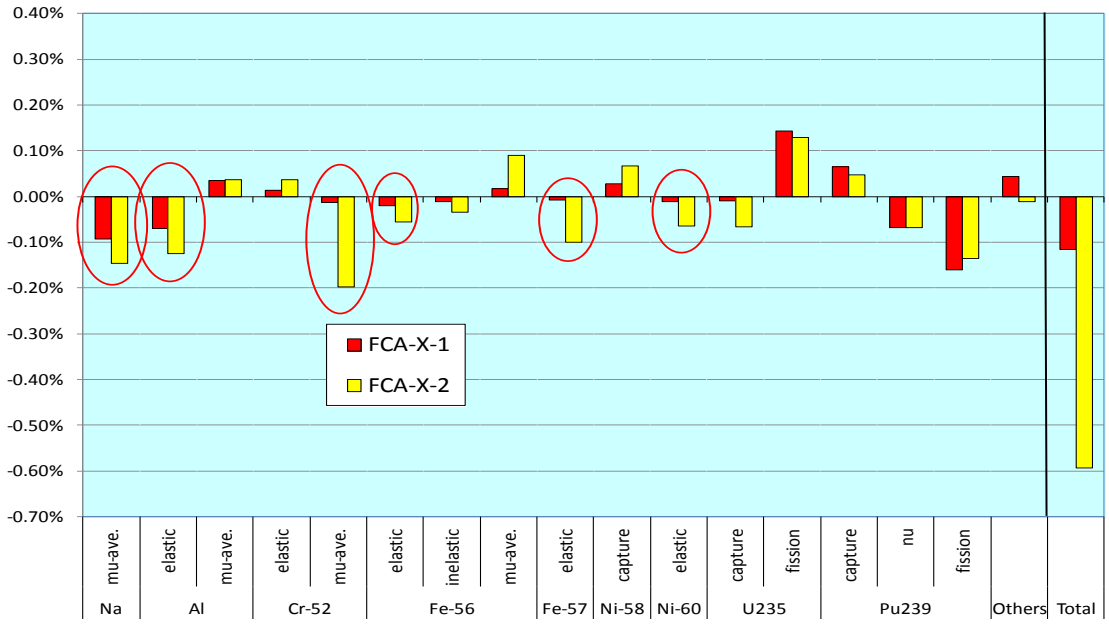

Fig. 2 Isotope- and reaction-wise contribution to the C/E difference of criticality between ENDF-7.1 and JENDL-4.0