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Benchmark Tests of the Multigroup Cross Section Libraries for Fast Reactors

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1. Introduction

In Korea, a design study for a fast breeder reactor named KALIMER (Korea Advanced LIquid MEtal Reactor) has been carried out. The simulations of the KALIMER core have been performed with the JEF-2.2-based 80-group neutron library KAFAX-F22 or the ENDF/B-VI.6-based 150-group neutron library KAFAX-E66. [1] Recently, newly evaluated nuclear data files such as ENDF/B-VII (beta 0 and 1), JEFF-3.1, and JENDL-3.3 have been released. And thus there is a need to update the libraries for the KALIMER by using the new data files.

In this study, the fast cross section sets with 150 groups were prepared based on ENDF/B-VII beta 0, JEFF-3.1, and JENDL-3.3. The validations of the libraries have been carried out for 14 Cross Section Evaluation Working Group (CSEWG) fast benchmark problems [2] through the 1-D and 2-D DANTSYS [3] calculations. The effective multiplication factors (k_{eff}'s) and central spectral indices have been compared with the experimental values and the results by the MCNPX [4] calculations.

2. Data Processing

The MATXS-format 150-group neutron libraries using ENDF/B-VII beta 0, JEFF-3.1, and JENDL-3.3 have been produced. The neutron group structure uses one-eighth lethargy widths in almost all the energy range, except between 1 and 10 keV in which one-sixteenth lethargy widths are used. The patched version of NJOY99.90 [5] was utilized for a nuclear data processing. In the NJOY processing, an equilibrium core flux of the KALIMER was used as a weighting function. Background cross sections for a self-shielding were also selected from those of the calculations. The libraries for MCNP4C have also been generated based on the same data files.

3. Benchmark Calculations and Results

The MATXS-format neutron libraries have been validated through the 1-D and 2-D DANTSYS code calculations for 14 CSEWG fast benchmark problems. Figures 1 and 2 show the comparisons of the k_{eff}'s and C/E values of F28/F25 (the fission reaction rate ratio of U-238 to U-235) obtained by the 2-D DANTSYS calculations for the CSEWG problems among the three libraries. The k_{eff} values agree well with the experiments except for some large size benchmark problems loaded with Pu-dominant MOX fuels and the VERA-11A core. The JENDL-3.3 results are underestimated when compared with the ENDF/B-VII beta 0 and JEFF-3.1. The F28/F25 values agree well with the experiments to within ~10% when considering the uncertainties of the experiments.

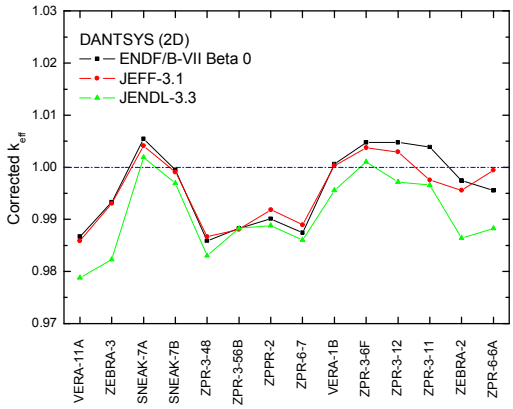

Figure 1. Effective multiplication factors by the 2-D DANTSYS calculation.

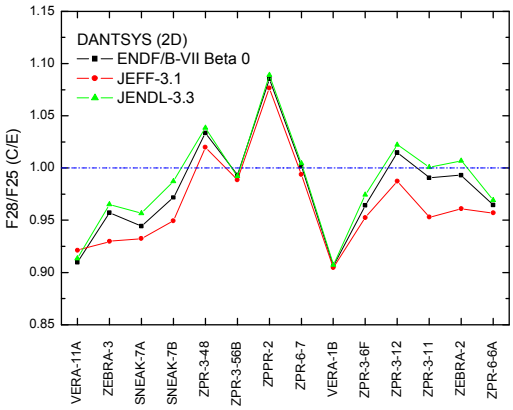

Figure 2. C/E values of the fission reaction ratio of U-238 to U-235 by the 2-D DANTSYS calculation.

Figures 3 and 4 show the comparisons of the k_{eff}'s and C/E values of F28/F25 among the results calculated by the MCNPX, 1-D and 2-D DANTSYS codes with the JEFF-3.1-based library. For the large size cores such as ZPR-3-48, ZPR-3-56B, ZPPR-2, and ZPR-6-7, the k_{eff} results by the 2-D DANTSYS are underestimated compared with the experiments and MCNPX results. The 1-D and 2-D results by the DANTSYS show good agreements except for ZPR-3-56B and ZPPR-2. The F28/F25 values by the MCNPX, 1-D and 2-D DANTSYS generally agree well except for ZPPR-2 core. More detailed descriptions of the other results will be given in the presentation.

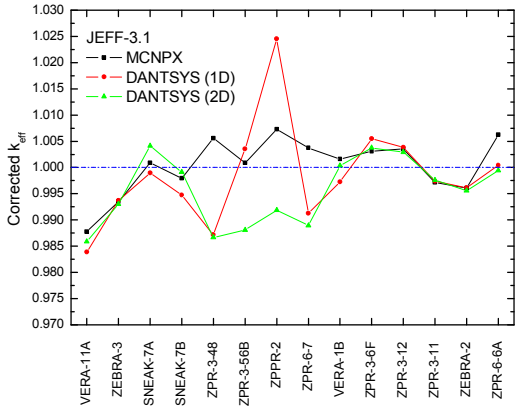

Figure 3. Effective multiplication factors calculated by the MCNPX, 1-D and 2-D DANTSYS.

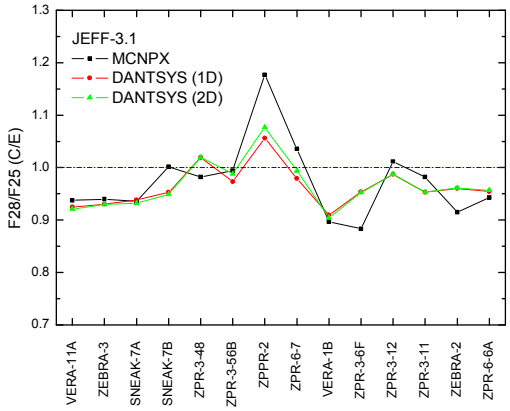

Figure 4. C/E values of the fission reaction ratio of U-238 to U-235 calculated by the MCNPX, 1-D and 2-D DANTSYS.

ACKNOWLEDGEMENT

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