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Performance of the New Continuous Energy Capability in KENO V.a

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INTRODUCTION

Oak Ridge National Laboratory (ORNL) has incorporated continuous energy capability in the KENO V.a and KENO VI codes that are maintained as part of the Standardized Computer Analyses for Licensing Evaluation (SCALE) code system.[1] Both codes can perform neutron transport calculations in either multigroup or continuous energy mode. The energy treatment mode is automatically selected based on the cross-section library name if the problem is initiated by one of the corresponding control modules. For KENO V.a the control module is CSAS5; for KENO-VI the control module is CSAS6. Discussion in this paper is limited to calculation in the continuous energy mode.

ORNL has developed a continuous energy cross-section format and the continuous energy cross-section processing software needed to prepare data libraries for KENO. The processing software has been added to the AMPX [2] code system that is used to prepare nuclear data libraries for SCALE. Production-level continuous energy libraries based on ENDF/B-VI Release 8 and ENDF/B-VII Release 0 evaluations have been prepared using the AMPX code system. Both sets of cross sections have been generated at multiple temperatures: 300, 600, 900, 1200, and 2400 K. In addition, the cross sections for the nuclides with thermal scattering data have been generated at the temperatures that are provided in the corresponding ENDF/B evaluation files. Although temperature interpolation of the cross sections is not yet available in the continuous energy mode of KENO, having multiple temperature cross sections available allows more accurate (albeit approximate) analysis of high-temperature systems. As part of the benchmarking effort, critical benchmark experiments that include a wide variety of fissile systems in various moderator and reflector configurations have been selected.

This paper provides the results of initial validation efforts for KENO V.a and the corresponding continuous energy cross-section data that are based on the ENDF/B-VII Release 0 evaluations for more than 500 benchmark problems. Previous studies [3,4] have only reported on the performance of the code and continuous energy cross sections based on ENDF/B-VI Release 8 and ENDF/B-VII Release 0 for a limited number of benchmarks. These benchmark problems provide a comprehensive validation suite.

BENCHMARK PROBLEMS

Benchmark problems that have been used in this study have been selected to provide a validation suite from a wide range of fissile systems. The benchmark problems have been divided into six groups that represent the type of fuel and enrichment: High enriched uranium systems (HEU), intermediate enriched uranium systems (IEU), low enriched uranium systems (LEU), mixed oxide systems (MOX), plutonium systems (Pu), and ^{233}U systems (U-233). The benchmark problems are from the *International Handbook of Evaluated Criticality Safety Benchmark Experiments* (*IHECSBE*) (2007).[5]

CALCULATIONS

More than 500 benchmark problems have been modeled and analyzed for the six groups described above. All KENO calculations used continuous energy cross sections based on ENDF/B-VII Release 0 evaluations and have been run with a sufficient total number of histories to achieve a standard deviation of k_{eff} of 0.0005 or less.

RESULTS

The average percent difference between the calculated and benchmark k_{eff} values for the HEU group is 0.0. While there is poor agreement for some of the benchmark cases in this group, calculations reported by the evaluators of these benchmarks using other code and data sets show similar poor agreement.

The average percent difference between the calculated and benchmark k_{eff} values for the IEU group is 0.04.

The average percent difference between the calculated and benchmark k_{eff} values for the LEU group is –0.13.

The average percent difference between the calculated and benchmark k_{eff} values for the MOX group is –0.5. The reason for this large average value is set I of the mct012 series benchmarks. Calculations using other code and data sets reported by the

evaluators of these benchmarks show similar poor agreement.

The average percent difference between the calculated and benchmark k_{eff} values for the Pu group is 0.2. Although there are some benchmark cases in this group for which KENO calculations show poor agreement, calculations using other code and data sets reported by the evaluators of these benchmarks show similar poor agreement.

Finally, the average percent difference between the calculated and benchmark k_{eff} values for the U-233 group is 0.0.

REFERENCES

1. *SCALE: A Modular Code System for Performing Standardized Computer Analyses for Licensing Evaluation*, ORNL/TM-2005/39, Version 5.1, Vols. I–III, November 2006. Available from Radiation Safety Information Computational Center at Oak Ridge National Laboratory as CCC-732.
2. M. E. Dunn and N. M. Greene, "AMPX-2000: A Cross-Section Processing System for Generating Nuclear Data for Criticality Safety Applications," *Trans. Am. Nucl. Soc*. **86**, 118–119 (2002).
3. S. Goluoglu, M.E. Dunn, N.M. Greene, L.M. Petrie, and D.F. Hollenbach, "Generation and Testing of the ENDF/B-VI Continuous-Energy Cross-Section Library for Use with Continuous-Energy Versions of KENO," *Proc. of ICNC 2007*, St. Petersburg, Russia (2007).
4. S. Goluoglu, S.M. Bowman, and M.E. Dunn, "KENO Monte Carlo Code Capabilities," *Trans. Am. Nucl. Soc*. **97**, 592–593 (2007).
5. *International Handbook of Evaluated Criticality Safety Benchmark Experiments*, NEA/NSC/DOC(95)03, OECD-NEA (September 2006).