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STANDARD PROBLEM EXERCISE TO VALIDATE CRITICALITY CODES FOR SPENT LWR FUEL TRANSPORT CONTAINER CALCULATIONS

DISCLAIMER

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PAPER SUMMARY

During the past two years, a Working Group established by the Organization for Economic Co-operation and Development's Nuclear Energy Agency (OECD-NEA) has been developing a set of criticality benchmark problems which could be used to help establish the validity of criticality safety computer programs and their associated nuclear data for calculation of k_{eff} for spent light water reactor (LWR) fuel transport containers. The basic goal of this effort was to identify a set of actual critical experiments which would contain the various material and geometric properties present in spent LWR transport containers. These data, when used by the various computational methods, are intended to demonstrate the ability of each method to accurately reproduce the experimentally measured k_{eff} for the parameters under consideration.

The logic used in choosing the experimental data was to be able to establish, in a stepwise fashion, the validity of the method by introducing a new parameter with each new problem. In this way, the effect of the new parameter on the validity of the method can be observed. This procedure will prevent the masking of errors by a combination of negative and positive bias in the results caused by the simultaneous introduction of various parameters, thereby leading to unwarranted confidence in the results.

Nine critical experiments were chosen which covered the area of application desired for this study. They covered such salient parameters as ^{235}U enrichment variation, the effect of Boral as a poison, and the effect of various reflector materials.

The satisfactory computation of k_{eff} for the nine problems would be expected to establish the validity of a method for problems with parameters similar to those present in the experiments.

To test this theory, four additional problems were defined which represented hypothetical cask designs. As these problems had no known answer, they, in effect, represented a "blind" test which could be used to judge the uniformity of results produced by methods which had been validated against the experimental data.

Fourteen organizations representing eleven NEA countries participated in this exercise by using the computer method commonly used by each organization. While a few participants used identical computer programs and nuclear data, most participants' results were unique in that either the computer program and/or the nuclear data were not the same as those used by other participants. This variety of methods provided an excellent opportunity to evaluate the hypothesis.

The computed values of k_{eff} for the experimentally critical systems ranged from 0.98 to 1.02 and the k_{eff}'s for this hypothetical casks agreed within ± 0.03. The results for almost all methods showed consistent behavior between the experimental systems and the hypothetical casks. That is, if there was a positive (or negative) bias shown for the critical experiment systems, a similar positive (or negative) bias was shown for the casks.

This successful effort in developing a benchmark procedure for validating criticality calculations for spent LWR transport packages along with the successful intercomparison of a number of methods should provide increased confidence by licensing authorities in the use of these methods for this area of application.