August 28, 2007

MEMORANDUM TO: Luis A. Reyes
Executive Director
for Operations

FROM: Michael F. Weber, Director
Office of Nuclear Material Safety **/RA/**
and Safeguards

SUBJECT: CLOSURE OF GENERIC ISSUE NMSS-0007, "CRITICALITY BENCHMARKS GREATER THAN 5% ENRICHMENT"

In accordance with Management Directive 6.4, "Generic Issues Program," the purpose of this memorandum is to inform you that the Office of Nuclear Material Safety and Safeguards (NMSS) is closing Generic Issue NMSS-0007, "Criticality Benchmarks Greater than 5% Enrichment." The purpose of the original generic issue was to address potential regulatory challenges associated with the adequacy of methods, analytical tools, and guidance for criticality safety software used in licensing nuclear facilities.

Issue

Computer codes used for criticality calculations must be benchmarked against critical experiments that represent the specific fissile materials, configurations, moderation, and neutron-poisoning conditions that represent the facility being licensed. However, it is well recognized that existing critical benchmark experiments will never precisely match these conditions. In addition, there are fewer benchmark experiments that are available at higher enrichment ranges [e.g., between 5 to 20 percent and lower-moderation (i.e., H/X, where H is hydrogen and X is fissile media)] ranges, that could be of future interest to potential applicants. Methods are needed to extend the range of applicability of current benchmark experiments via sensitivity/uncertainty (S/U) analysis techniques.

Background

NMSS has performed extensive work with Oak Ridge National Laboratory (ORNL) to further develop criticality safety computer codes [e.g., Standardized Computer Analyses for Licensing Evaluation (SCALE)] to address these challenges. The final reports for the S/U methods were published in November 1999 as Volumes I and 2 of NUREG/CR-6655. The reports covered the following subjects: (1) methodology for defining range of applicability, including extensions of enrichments from 5 to 11 percent; (2) test applications and results of the method; (3) test application for higher enrichments using foreign experiments; and (4) feasibility study for extending the method to multidimensional analyses, such as transport casks and reactor fuel.

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Results of the test applications of the ORNL methods showed that, for simple geometries with neutron spectra that are well-moderated (high H/X), benchmark experiments at 5 percent enrichment are applicable to calculations up to 11 percent enrichment. On the other hand, these test applications also show that benchmark experiments at intermediate and higher H/X values are not applicable to calculations at very low H/X. There are relatively few benchmarks at these very low H/X values for many compositions of interest to low-enriched uranium licensees.

Although licensees must apply the ORNL method to each individual process, to determine an acceptable subcritical margin, the results indicated that there may be situations where there are no applicable benchmarks. In these cases, the method provides sensitivity and uncertainty information, to help designers allow adequately large margins to cover the lack of benchmark validation. The computer codes [(i.e., Tools for Sensitivity and Uncertainty Analysis Methodology Implementation (TSUNAMI)] for S/U methods were incorporated into the release of SCALE 5.0 in 2004.

Discussion

In June 2006, staff issued Fuel Cycle Safety and Safeguards (FCSS) Interim Staff Guidance (ISG) -10, “Justification of Minimum Margin of Subcriticality for Safety” (ML061650370). The ISG clarified guidance to the NRC staff when reviewing criticality safety analyses in integrated safety analysis, license applications, or amendment requests or other related licensing activities for fuel cycle facilities, under 10 CFR Part 70. The ISG communicates the acceptability of the TSUNAMI computer code in SCALE 5.0, as one method for determining minimum margins of subcriticality with limited benchmark experiments. For applications where few benchmarks exists, TSUNAMI can be used to apply larger margins to ensure validity of the SCALE criticality codes. Further benchmark experiments may be needed if future applicants request lower margins.

Conclusion

NMSS will continue to address future regulatory challenges associated with benchmarking criticality codes, as needed, through additional research, code development, and/or guidance development. The issuance of FCSS ISG-10 was the final milestone required to close out Generic Issue NMSS-0007. Therefore, NMSS-0007 is closed as a formal generic issue.

cc: B. Sheron, RES
C. Miller, FSME
J. Dyer, NRR
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