

Proposal for OECD/NEA/NSC/WPNCS Expert Group on Uncertainty Analysis for Criticality Safety Assessment

INTRODUCTION

The Expert Group on Uncertainty Analysis for Criticality Safety Assessment (UACSA) was established to address issues related to Sensitivity/Uncertainty (S/U) studies for criticality safety calculations. In the first years of the group activity two principal directions have been formed: estimation of the bias and its uncertainty for validation of criticality safety calculations and the assessment of manufacturing/operational (including depletion when applicable) uncertainties.

At the first stage, the work of the EG was focused on approaches for validation of criticality safety calculations. Methodologies that establish uncertainties related to operations and manufacturing parameters for application system are subject for further work.

Lessons learnt at the first stage are documented in the state-of-the-art report and bring up issues for further activities of the EG. The study shows that k_{eff} sensitivities to neutron cross sections are commonly used in similarity assessments and/or as part of the validation algorithm. Monte Carlo codes with explicit 3-Dimensional geometry have become commonly used to compute the sensitivities along with one- or two-dimensional deterministic tools. Testing the sensitivity calculation methods and tools is therefore a useful step towards improvement of S/U capabilities for CSA. A Benchmark test has been proposed to compare computation of k_{eff} sensitivities to nuclear data.

The report also concludes that it is important to ensure that the k_{eff} uncertainties for the benchmark experiments are well evaluated and that correlations between the benchmark uncertainties are established. It is essential that these types of correlation are considered at the planning stage of experimental work. Correlation matrices for some configurations from the *International Handbook of Evaluated Criticality Safety Benchmark Experiments* (ICSBEP Handbook) are provided in the DICE database of the ICSBEP. The method used to establish those correlations will be described by the ICSBEP/DICE Subgroup. It is expected that other methods will be proposed by the EG. The EG will review the description, discuss the methods, and draft recommendations to the ICSBEP on the method or methods to identify, quantify and document correlations between benchmark parameters and to estimate and document the correlations between benchmark- k_{eff} uncertainties.

It is anticipated that there will be synergy between the EG UACSA and (1) the ICSBEP in the above activity on correlations and on the techniques evaluating error related to manufacturing parameters; and (2) the WPNCS EG on Advanced Monte Carlo Techniques in the area of Monte Carlo perturbation theory for sensitivity computation and use of Bayesian Hierarchical Monte Carlo methods. The Benchmark test on sensitivity computation may also be of interest to the EG on Uncertainty Analysis for Modeling (UAM).

SCOPE

Under the guidance of the Working Party on Nuclear Criticality Safety (WPNCS) the Expert Group will perform specific tasks associated with study of uncertainty analysis methods and their use by criticality safety practitioners. The following focus areas will guide the EG work:

- k_{eff} uncertainty due to technological or manufacturing parameters;
- k_{eff} sensitivities to nuclear data;
- Parameter correlations between benchmarks and k_{eff} sensitivities to parameters. Related to repeatability and reproducibility;
- Correlations in k_{eff} biases and uncertainties of benchmark experiments and their origins in benchmark parameter biases and uncertainties.

OBJECTIVES

- Survey of the techniques for establishment of best-estimate results (as opposed to nominal or design-basis results) together with biases and uncertainties due to technological parameters.
- Survey of the techniques and software tools for computation of k_{eff} sensitivities to nuclear data and draft recommendations to practitioners for using those techniques.
- Draft recommendations to the ICSBEP on methods to identify, estimate and document parameter correlations between different experiments and to identify, estimate and document k_{eff} correlations between benchmark experiments due to those parameters.

DELIVERABLES

2010, December: State-of-the art report: Overview of Approaches Used to Determine Computational Bias in Criticality Safety Assessment and their Comparison as Applied to Phase I of the UACSA Benchmark Exercise

2011, September: Draft of 2nd report: Synthesis and analysis of the results for Benchmark test Phase II: reactivity impact of manufacturing tolerances of parameters characterizing a fuel assembly configuration.

2011, September: Draft of 3rd report: Synthesis and analysis of the results for Benchmark test Phase III: computation of k_{eff} sensitivity to nuclear data.

2012, September: Draft of note: Recommendations to the ICSBEP on the method or methods to identify, estimate and document both parameter correlations between different benchmarks (covering both experiments and simplifications) and the k_{eff} correlations between benchmarks due to those parameters.

MEETING FREQUENCY

The Expert Group will meet at least once a year, usually in conjunction with the WPNCS meetings.