## SPEAKER / PRESENTATION INFORMATION

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| **Biography** | • MSc in Physics.<br>• Worked in PSA/PRA of nuclear fuel processing and reprocessing facilities, propagation of pollutants with off-gas, waist air and water, criticality safety analysis and control.<br>• Has worked for Siemens/AREVA since 1989.<br>• Group leader criticality safety analysis since 1990.<br>• Chair of the Criticality Safety Committee of the German Society of Standardization (DIN).<br>• Member of KTA working groups dealing with criticality safety.<br>• Member of WPNCS and most of their expert groups since 1998.<br>• Member of the IAEA burn-up credit consultancy group. | | |
| **Title** | ***Hierarchical Bayesian Methods for Criticality Safety Assessment*** | | |
| **Abstract** | Criticality Safety Analysis uncertainty evaluation requires accountability for all uncertainties and correlations in the parameters describing the nuclear fuel system (NFS) to be analyzed, the parameters characterizing the benchmarks selected to estimate the bias of the applied calculation procedure, and the nuclear data (ND) involved in the NFS to be analyzed and the selected benchmarks. This is conveniently accomplished by using hierarchical Bayesian methods for the bias estimation procedure.<br><br>Step 1 of the procedure consists of drawing joint Monte Carlo (MC) samples on all the parameters characterizing all the benchmarks and on the ND involved in all the benchmarks by using probability density functions (PDFs) derived from the empirical data while taking the possible incompleteness of these data into account.<br><br>Step 2: Calculation of $k_{eff}$-values for each of the MC samples, thus obtaining a n×m matrix K of estimated bias values (n = number of MC samples, m = number of benchmarks).<br><br>Step 3: Calculation of sample means and sample covariance matrix from matrix K.<br><br>Step 4: Verification of a normal PDF model from which sample means and sample covariance matrix are observed.<br><br>Step 5: Drawing of an MC sample on the unknown covariance and then on the unknown benchmark means of the normal PDF model by making use of the distribution properties following from the PDF model for the sample covariance matrix and the sample means.<br><br>Step 6: Regression analysis of the sampled benchmark means using a linear model including a certain set of explanatory variables for the benchmarks (such as the TSUNAMI $c_k$ values, fuel enrichment, moderation ratios, etc.).<br><br>Step 7: Drawing of an MC sample on the bias at those values of the explanatory variables | | |

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| | which characterize the NFS to be analyzed. This step makes use of the distribution properties of the residual sum of squares and the estimates of the coefficients of the linear regression model.<br><br>It is necessary to repeat Steps 5 and 6 until a sufficient number of samples on the bias related to the NFS to be analyzed have been drawn. The distribution of the sampled bias values is then used to estimate an upper confidence limit of the bias related to some pre-given probability content (e.g., 95%).<br><br>The steps to evaluate the NFS are as follows:<br><br>Step 1: Same as Step 1 above in the case of the bias evaluation (MC samples on ND only required if not drawn for the benchmarks).<br><br>Step 2: Calculation of $k_{eff}$ for each of the MC samples.<br><br>Step 3: Evaluation of the distribution of the sampled $k_{eff}$-values (estimation of an upper confidence limit).<br><br>These hierarchical procedures take into account not only all the uncertainties due to the NFS, the benchmarks, and the ND, but also all the uncertainties due to the empirical data required for choosing PDFs, the finite number and the possible incompleteness of these data, and the fundamental variability due to the selection of PDFs required for evaluating the empirical data. |