Methods for Sensitivity and Uncertainty Analysis in the SCALE 6.2 Code System

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Abstract: Sensitivity and uncertainty analysis methods have been used extensively in criticality safety and reactor physics applications for purposes such as quantifying the impact of uncertainty in nuclear data, selecting relevant benchmark experiments, quantifying computational biases, and guiding the adjustment of nuclear data.

Until recently, sensitivity methods have been limited to eigenvalue sensitivity analysis and criticality safety applications. This presentation will discuss newly developed Generalized Perturbation Theory (GPT) sensitivity methods, which calculate sensitivity coefficients for ratios of reaction rates rather than critical eigenvalues, enabling the extension of sensitivity and uncertainty analysis to a more diverse set of nuclear engineering applications.

This presentation will discuss the continuous-energy, adjoint-weighted sensitivity analysis methods developed in the TSUNAMI code within the SCALE 6.2 Code System, and will describe several sample applications of these methods, including a recently completed project to optimize Cf-252 production in Oak Ridge National Laboratory's High Flux Isotope Reactor.

Bio: Dr. Christopher Perfetti is an R&D scientist in the Radiation Transport Group within the Reactor and Nuclear Systems Division at Oak Ridge National Laboratory. He joined ORNL as a postmaster's research associate in 2011, became a postdoctoral research associate in 2012, and was converted to a staff member in 2014.

Chris received B.S. and M.S. degrees in nuclear and radiological engineering from the University of Florida in 2007 and 2008, respectively, and received his Ph.D. in nuclear engineering from the University of Michigan in 2012 under the mentorship of Professor Bill Martin. His dissertation work developed algorithms for adjoint-weighted sensitivity analysis using continuous-energy Monte Carlo methods with improved computational efficiency and reduced memory requirements.

Chris' research interests include sensitivity and uncertainty analysis methods, Monte Carlo methods for improved reactor physics modeling and simulation, advanced reactor core design, radioisotope production, reactor safety, and radiation shielding.