ORNL Methodology for Covariance Generation for Sensitivity/Uncertainty Analyses

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Recently an evaluation of the neutron resonance parameters of ^{238}U from thermal to 20 keV was obtained from a SAMMY analysis of high-resolution neutron transmission and capture measurements; this evaluation is available in the U.S. Evaluated Nuclear Data File, ENDF/B-VII. In this paper, we describe the generation and testing of the covariance matrix associated with those resonance parameters.

For reactor applications, resonance parameters from the evaluated data files are used to generate pointwise cross sections, which in turn are weighted with an appropriate neutron flux spectrum and integrated over energy to produce multigroup cross sections. These multigroup cross sections are then used in calculations of design parameters for nuclear applications. In order to correctly assess the uncertainties in those design parameters, the nuclear data uncertainty information from the evaluated data libraries is propagated through each step of this process.

The computer code SAMMY is used for evaluation of experimental data in the resolved and unresolved resonance energy regions. This code uses R-matrix theory plus corrections for experimental conditions in conjunction with generalized least-squares fitting procedures to find those resonance parameter values which give the best fit of theoretical calculation to experimental cross section. Statistical uncertainties on the experimental data are properly incorporated into the fitting procedure, as are systematic uncertainties on measurement-related quantities such as normalizations, backgrounds, time-of-flight, sample thickness, and others. The result of the evaluation is a set of resonance parameters and the corresponding resonance parameter covariance matrix (RPCM) that provide both a best fit of theory to experiment and an accurate representation of the inherent uncertainties in those experiments.

The RPCM associated with the ENDF/B-VII ^{238}U evaluation has been tested for consistency with experimental integral data. The RPCM was processed by the ERRORJ and PUFF-IV codes into multigroup form for criticality safety applications. The TSUNAMI code was then used to calculate the uncertainty in the multiplication factor due to uncertainty in the resonance parameters. Based on those tests, resonance parameter uncertainties were scaled slightly to conform with results of integral experiments. The final ^{238}U RPCM will be submitted for inclusion in ENDF/B-VII.