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Overview of the Nuclear Data Activities at the Oak Ridge National Laboratory for Criticality Safety Applications

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Introduction

In response to concerns raised in the Defense Nuclear Facility Safety Board (DNSFB) Recommendation 93-2, the US Department of Energy (DOE) developed a comprehensive program to maintain and enhance its capability to predict the criticality of systems throughout the DOE complex. Elements developed to implement the response to DNFSB 93-2 included Critical Experiments, Criticality Benchmarks, Training, Analytical Methods, and Nuclear Data. The Nuclear Data Element of the Nuclear Criticality Safety Program (NCSP) consists of a variety of differential measurements at the Oak Ridge Electron Linear Accelerator (ORELA) of the Oak Ridge National Laboratory (ORNL), precise fitting of the differential data with the generalized least-squares fitting code SAMMY to represent the data in the resolved, unresolved, and high energy ranges, and the development and benchmark testing of a complete evaluation for a given nuclide for inclusion into the Evaluated Nuclear Data File (ENDF/B).

The current ENDF/B library was developed for fast and thermal fission reactors and fusion reactors but it is now being extended for more general applicability. Criticality safety practitioners recognize that many situations encountered in the DOE complex are characterized by neutron spectra in the intermediate energy region, as opposed to the high-energy region for fast reactors and fusion systems or the low energy region for thermal reactors. Consequently, the Nuclear Data Element focuses primarily on the intermediate energy region, so that upgrades to existing evaluated data will remove deficiencies in the current ENDF/B evaluations.

The thrust of the Nuclear Data Element is to utilize ORELA to obtain high-resolution data in the intermediate energy region and to apply the modern resonance formalism in SAMMY to fit the data. The SAMMY fits also provide covariance information for subsequent use in criticality predictability applications in order to properly assess uncertainties in calculated results. The measured and evaluated data are tested and submitted to the Cross Section Evaluation Working Group (CSEWG) to be considered for inclusion in the ENDF library.

Data Measurements and Evaluation at the Oak Ridge Electron Linear Accelerator (ORELA)

Data Measurements:

To fulfill the needs for better data for application to criticality safety problems, cross-section measurements are underway at the ORELA facility. Up to the present, cross section measurements for Aluminum (^{27}Al), natural Chlorine, and ^{233}U have been carried out. Transmission and capture cross section measurements for ^{27}Al were done from a few eV up to several hundred keV. Transmission measurements for natural Chlorine were also performed. The motivation for measuring ^{27}Al came from an inconsistency in the results of calculations of systems including ^{27}Al and ^{235}U mixtures.

High-resolution transmission and fission cross section data for ^{233}U from a few eV to several keV have been measured at ORELA. Criticality safety concerns with the Molten Salt Reactor Experiment (MSRE) at ORNL was the primary driving force for measuring and evaluating the ^{233}U cross sections. The characteristic neutron spectra of the fuel drain tank and the fuel flush tank of the MSRE span the range from thermal to very high energy, peaking in the intermediate energy range. Extension of the resolved energy range are needed to obtain better cross section self-shielding predictions.

Data Evaluation:

The analysis and evaluation of the measured data are performed using the computer code SAMMY, which uses the generalized least-squares method (Bayes' method) to extract resonance parameters in the resolved and unresolved energy region. In addition, SAMMY also provide covariance information for use in criticality predictability applications. Efforts are underway to extend SAMMY to the analysis of experimental data in the high energy range.

Recently, resolved resonance parameters have been obtained with SAMMY for the following isotopes: ^{28}Si , ^{29}Si , ^{30}Si , and ^{235}U . These evaluations have been accepted for inclusion in the ENDF/B library. Ongoing evaluations in the resolved energy range are: ^{16}O , ^{27}Al and ^{233}U . Evaluation of the ^{235}U cross section in the unresolved energy range is underway.

Comments

This paper will provide an overview of the nuclear data element of the DOE nuclear criticality safety program. The ongoing nuclear data activities at ORNL will be presented.