

**Homogeneous Critical Monte Carlo Eigenvalue
Calculations with Revised ENDF/B-VI Data Sets**

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A new national evaluated nuclear data file, ENDF/B-VI, was released for world-wide distribution in 1990 (Ref. 1). This file represented the culmination of a multi-year, multi-national effort to coalesce the latest, most accurate experimental and calculated neutron cross section data into a single database. Of particular interest for thermal reactor calculations was a new evaluation for ^{235}U . However, Monte Carlo eigenvalue calculations with ENDF/B-VI cross sections for a large number of simple, homogeneous critical assemblies containing enriched ^{235}U in an aqueous solution and spanning a wide H/U range revealed a large positive eigenvalue trend as a function of increasing epithermal fission rate (Ref. 2). This trend was believed to have been caused by too small a value for the ^{235}U capture resonance integral. The ENDF/B-VI value, near 133.5b, is smaller than either the accepted experimental value of 144 ± 6 barns, Ref. 3, or the ENDF/B-V value of 139.5b. In contrast, the fission resonance integral remained in good agreement with experiment (279.2b in ENDF/B-VI, 282.4b in ENDF/B-V and 275(5) barns in Ref. 3). The net effect is that ENDF/B-VI's epithermal alpha (the ratio of the capture resonance integral to the fission resonance integral) of 0.478 is significantly smaller than the experimental value of 0.52(2) and the marginally low ENDF/B-V value of 0.494.

Recently, Lubitz (Ref. 4) proposed a modification to the ENDF/B-VI ^{235}U data set that results in a significant increase to the low capture resonance integral (from 133.5b to 143.4b) while further lowering the fission resonance integral (from 279.2b to 277.6b), yielding an epithermal alpha of 0.517. This is accomplished by favoring the higher capture data of Perez/deSaussure, Ref. 5, over that of deSaussure, Ref. 6, while simultaneously using the lower of the fission cross section data from ORELA and NIST, References 7 and 8. These changes are applied only to data below 900 eV and are most important for the region below 110 eV. Within the evaluated data file, these changes are accomplished by altering the resolved resonance capture and fission widths. The fission width changes are very small, but the average capture width changes from about 35 mV to 38.2 mV. This revised average capture width has a reasonable value, and in fact is very close to the overall average capture width for the 3,479 individual resonances that are defined in the original ENDF/B-VI ^{235}U file.

The calculated eigenvalues are fit to a function of the form $k(\text{calc}) = A + B \cdot F_{25} + C \cdot L$, where A, B and C are fitting coefficients, F_{25} is the epithermal fission rate and L is the epithermal leakage fraction. Epithermal is defined as energy above 0.625 eV. Results of the Monte Carlo eigenvalue calculations are illustrated in the figure. Details of the critical experiments from Oak Ridge (data labeled by # or L#) and Rocky Flats (R#) are provided in References 9, 10 and 11. The data and the fitted curves are identified as "projected" in the figure. This means that the quantity $(k(\text{calc}) - C \cdot L)$ is plotted along the ordinate of the epithermal fission rate figure and that the quantity $(k(\text{calc}) - B \cdot F_{25})$ is plotted along the ordinate of the epithermal leakage fraction figure. In addition to the fitted curves, the individual projected data from the original ENDF/B-VI calculations are also illustrated. A similar spread of the individual eigenvalues about the fitted curves was seen with the modified ^{235}U cross section calculations. These results demonstrate that ENDF/B-VI's large epithermal fission rate eigenvalue trend can be substantially reduced by the proposed ^{235}U modifications.

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The already small eigenvalue trend as a function of epithermal leakage fraction changed little with these cross section modifications. These calculations provide strong evidence that the low capture resonance integral in ENDF/B-VI is primarily responsible for the large eigenvalue trend with epithermal fission rate, and that a modification of the ^{235}U evaluation along the lines presented in Ref. 4 will yield a significantly improved evaluated data set.

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