

March 19, 2002
Rev. April 9, 2002

WPEC sub-group proposal

Title:

Recommended Nuclear Data Modifications for Improved LEU-LWR Reactivity Predictions

Short Justification for a Subgroup:

Over the past two years, it has been demonstrated that the use of the most recent U235 and U238 cross-section evaluations has improved many reactor physics and neutronic calculations : U-236 build-up calculations, reactivity prediction for highly-enriched U235 systems, etc. Nevertheless, despite these improvements, the calculated eigenvalue of Low Enriched Uranium (LEU) fuelled thermal Light Water Reactors (LWR) is underestimated by about 0.3 to 0.4% $\Delta k/k$. It has been pointed out that part of this underestimation could be linked to an overestimation of the U238 resonant capture integral, but other nuclear data are also suspected (U238 high energy data, O16(n, α), H1, or ν_{U235}).

A NEA website <http://www.nea.fr/lists/ueval.html> was created in 2001 to collect feedback and viewpoints on this issue but up to now, no satisfactory explanation has been found. The purpose of this subgroup is to address this issue in a more structured way with the objective to solve the LEU-LWR reactivity under-prediction problem.

Subgroup Monitor:

ENDF

Subgroup Coordinator:

JEFF Arnaud Courcelle (CEA)

List of Subgroup Participants:

ENDF C. Lubitz, ...
JEFF
JENDL
BROND

Definition of the Project:

The project will investigate the trends derived from the integral experiments as well as the sensitivity to the U238 capture cross section and to the other nuclear data important for thermal LEU-LWR calculations.

A selection of relevant integral experiments will allow the sub-group to :

- derive clear trends on U238 capture cross sections,
- assess the sensitivity of the thermal LEU-LWR eigenvalue to the different nuclear data,
- validate the different modifications on cross-sections that will be proposed by the sub-group.

The project will encourage the use of continuous-energy Monte-Carlo methods to obtain the most accurate results. In this scope, the Hellstrand U238 experiments will give important information related to the effective resonance integral.

The sub-group will focus on the U238 capture cross section and will study specific topics concerning the improvement of the current evaluation such as :

- the assessment of the 2200 m/s capture,
- the influence of solid state effects on the first three large U238 resonances,
- the inclusion of integral information (effective resonance integral) in the fit,
- the assessment of uncertainty on resonance parameters.

The project will be able to suggest improvements to the U238 evaluation either *via* a rigorous fit of the differential measurements in a limited part of the resonance range or *via* an adjustment methodology. A complete U238 re-evaluation in the resolved resonance range is not expected in the framework of this sub-group.

An important additional task of the subgroup will be to test the other nuclear data impacting LEU-LWR reactivity, in particular : U238 high energy data, O16 (n, α), H2O scattering cross-section or H1 (n, γ).

Justification of the Project:

Over the past 15 years, a great effort of re-evaluation has been done to provide the most accurate cross-section evaluations for reactor calculations. This work has led to a re-evaluation of U238 in 1994 (Moxon et al.) and U235 in 1997 (Leal et al.). An extensive validation work has demonstrated that the new U235 evaluation significantly improves many aspects of the reactor calculations such as the U236 build-up calculation or the highly-enriched uranium systems reactivity prediction. However, it has been demonstrated that the reactivity prediction for LEU-LWR reactors is significantly underestimated with this new set of nuclear data. Several integral validation studies have shown a discrepancy between the differential and integral information concerning the U238 resonant capture which seems to be still overestimated.

The purpose of the sub-group is to address this problem. It will closely associate the nuclear data evaluators and the reactor physicists. A major task will concern the U238 evaluation and the still pending issues such as the thermal capture value, the influence of the solid state effects on the resonance parameters assessment and the consistency between the differential and integral information (especially the effective capture

resonance integral). In addition, an investigation of the other nuclear data important for reactor calculations (U235, O16, H2O) is also needed. Furthermore, an extensive integral benchmarking will be associated to the re-evaluation work.

The final objective of the project is to recommend improvements of the U238 evaluation and find a set of cross sections that

- eliminates the current under-prediction of LEU-LWR thermal reactor eigenvalues while preserving the quality of reactivity calculation for fast benchmarks;
- ensures the consistency between the integral and differential information (U238 effective capture resonance integral).

Relevance to Evaluated Data Files:

The problems described here and the expected recommendations are of potential interest to all evaluated file projects.

Deliverables:

- Trends on cross sections derived from integral experiments
- Recommendations for the U238 evaluation and the other nuclei important for LEU-LWR

Time-Schedule and Milestones:

- mid-2002 Definition of the work plan
- mid-2003 Trends
- mid-2004 Recommendations
- Dec. 2004 Report