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Working Party on International Nuclear Data Evaluation Cooperation (WPEC)

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The OECD Nuclear Energy Agency (NEA) organizes cooperation between the major nuclear data evaluation projects in the world. The NEA Working Party on International Nuclear Data Evaluation Cooperation (WPEC) was established to promote the exchange of information on nuclear data evaluation, measurement, nuclear model calculation, validation, and related topics, and to provide a framework for cooperative activities between the participating projects. The working party assesses nuclear data improvement needs and addresses these needs by initiating joint activities in the framework of dedicated WPEC subgroups. Studies recently completed comprise a number of works related to nuclear data covariance and associated processing issues, as well as more specific studies related to the resonance parameter representation in the unresolved resonance region, the gamma production from fission product capture reactions, the ^{235}U capture cross section, the EXFOR database, and the improvement of nuclear data for advanced reactor systems. Ongoing activities focus on the evaluation of ^{239}Pu in the resonance region, scattering angular distribution in the fast energy range, and reporting/usage of experimental data for evaluation in the resolved resonance region. New activities include two subgroups on improved fission product yield evaluation methodologies and on modern nuclear database structures. Future activities under discussion include a pilot project for a Collaborative International Evaluated Library Organization (CIELO) and methods to provide feedback from nuclear and covariance data adjustment for improvement of nuclear data. In addition to the above mentioned short-term task-oriented subgroups, WPEC also hosts a longer-term subgroup charged with reviewing and compiling the most important nuclear data requirements in a high priority request list (HPRL).

I. INTRODUCTION

In 1989, the OECD Nuclear Energy Agency (NEA) established the Working Party on International Nuclear Data Evaluation Cooperation (WPEC) to provide a forum for cooperation between the major nuclear data eval-

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uation projects. The collaboration started between the US ENDF [1], the NEA Data Bank JEF(F) [2], and the Japanese JENDL [3–5] projects, and was subsequently extended to include the Russian BROND and the Chinese CENDL [6] projects thanks to the support of the International Atomic Energy Agency (IAEA) [7]. The main objectives of the cooperation are (i) to improve the quality and completeness of the evaluated nuclear data libraries by means of international cooperation and (ii) to help coordinate the nuclear data measurements required within this framework. The WPEC members meet annually to review the status of the major nuclear data evaluation libraries, as well as the associated nuclear data measurement efforts, and to discuss nuclear data challenges and problems common to all projects. Needs for improvement of nuclear data are addressed by collaborative efforts in the framework of dedicated WPEC subgroups consisting of experts from the different evaluation projects. The outcome and recommendations of the WPEC subgroups are published in reports that can be obtained from the NEA or downloaded directly from the WPEC webpage at www.oecd-nea.org/science/wpec.

II. RECENTLY PUBLISHED STUDIES

A brief summary of studies already published as WPEC reports is given below.

A. Covariance Data in the Fast Neutron Region

Subgroup 24 reviewed methodology and developed tools for producing covariance data in the fast neutron energy region. These involve both normal least-squares procedures and recent stochastic (Monte Carlo) techniques. Since all modern approaches depend on extensive usage of nuclear reaction modelling, the subgroup evaluated to what extent nuclear modeling deficiencies contribute to the uncertainty of contemporary nuclear data evaluation. Detailed conclusions are available in Ref. [8].

B. Assessment of the Unresolved Resonance Treatment for Cross Section and Covariance

Subgroup 32 assessed the methodologies used in the unresolved resonance region (URR) for cross section and covariance data representation. It was shown that (i) the results using single-level Breit-Wigner (SLBW) average resonance parameters are appropriate for the URR, (ii) interpolation of resonance parameters is advised, as opposed to interpolation of cross sections and (iii) the entire URR cross section should be stored in ENDF File 3, whereas File 2 parameters should be used solely for the calculation of the self-shielding factors (i.e. LSSF = 1 option). Detailed conclusions are available in Ref. [9].

C. ^{235}U Capture Cross Section in the keV to MeV Energy Region

Subgroup 29 investigated calculated-over-experiment ratio (C/E) discrepancies in fast uranium-core integral parameters observed with all major evaluated libraries. The work included a review of the capture cross section of ^{235}U and sensitivity analyses performed to better understand the influence of other nuclear data on these discrepant integral parameters. A probable overestimation of the ^{235}U capture cross-section in the 0.1-2.5 keV energy range was shown. Detailed conclusions are available in Ref. [10].

D. Quality Improvement of the EXFOR Database

Subgroup 30 contributed to establishing EXFOR, the international experimental nuclear reaction database, as a more easily accessible and error-free database. The subgroup produced an EXFOR master database from which many data and format errors have been removed. Detailed conclusions and recommendations are available in Ref. [11]. Activities to further improve the quality of the EXFOR database are still ongoing at the IAEA-NDS, the NEA Data Bank, and NRG [12].

III. RECENTLY COMPLETED STUDIES

A number of WPEC subgroups have completed their work and are about to publish the results. This section provides a brief description of each of these activities.

A. Prompt Photon Production from Fission Products

Subgroup 27 was established to study gaps and inconsistencies in gamma production data for heating predictions in reactors. The work focused on gamma rays produced by radiative capture on the most important fission products. The gamma emission data from TALYS/TENDL were added to the JEFF-3.1.1 evaluation of the 89 most important fission products for thermal reactor applications. These files are available in JEFF-3.1.2 [13]. The work of Subgroup 27 will be published in Ref. [14].

B. Processing of Covariance in the Resonance Region

Subgroup 28 was established following international efforts to include covariance data in evaluated libraries and the development of sensitivity and uncertainty analysis tools for use with these data [8, 15, 16]. The main objective of Subgroup 28 was to produce resonance parameter

evaluations with covariance data for important nuclides, such as ^{235}U, ^{238}U, and ^{239}Pu, and to implement methods to process and test these data. Participants investigated the results of different processing methods implemented in the ERRORR and PUFF codes and improved the agreement between these codes. The final conclusions of Subgroup 28 will be published in Ref. [17].

C. Meeting Nuclear Data Needs for Advanced Reactor Systems

Subgroup 31 was established to investigate the possibilities of meeting nuclear data needs for advanced reactor systems. The Subgroup reviewed the nuclear data needs identified by Subgroup 26 on *"Uncertainty and Target Accuracy Assessment for Innovative Systems Using Recent Covariance Data Evaluations"*, and considered the practicality of meeting these data needs. The subgroup concluded that some target accuracies are extremely tight, but could nevertheless be reached in the framework of an ambitious experimental program, where successful double-check experiments would play an important role. Detailed conclusions are available in Ref. [18].

D. Methods for the Combined Use of Integral Experiments and Covariance Data

Subgroup 33 was established to investigate whether the assimilation of accurate integral experiment information in nuclear data libraries would provide core designers with nuclear data that meet design target accuracies for a wide range of innovative reactor and fuel cycle systems. The findings of the subgroup pointed out that the statistical adjustment methodologies used worldwide are well understood and essentially equivalent [19]. The results of the benchmark adjustments indicate common trends for important data, even when starting from different basic nuclear data and different covariance matrices. In this respect, these methodologies can provide a powerful tool for the improvement of nuclear data (and associated uncertainties) if used in an appropriate manner. Final conclusions and recommendations are available in Refs. [20, 21].

IV. ONGOING ACTIVITIES

A. High Priority Request List for Nuclear Data

Subgroup C was established as a long-term subgroup charged with the task of maintaining a high priority request list for nuclear data. The purpose of this list is to provide a guide for those planning measurement, nuclear theory, and evaluation programs. There are 36 requests in the list, divided into two main categories: high priority requests (26) and general requests (10). In order to be considered as high priority, a request needs to be justified by quantitative sensitivity studies (or the equivalent) and sufficiently documented. The high priority request list for nuclear data can be consulted at www.oecd-nea.org/dbdata/hprl.

B. Evaluation of ^{239}Pu in the Resonance Region

Subgroup 34 was established to solve a general discrepancy when calculating criticality benchmarks with plutonium (Pu-SOL-THERM and Pu-INTER) using the most recent evaluated data libraries. The main objective of this subgroup is to produce an improved ^{239}Pu resonance parameter and associated covariance data evaluation that will be consistent with all differential information and lead to improvements in calculations of integral data. More information is available in [22] and detailed conclusions will be published in Ref. [23].

C. Scattering Angular Distribution in the Fast Energy Range

Subgroup 35 was established to improve evaluation methods for neutron scattering angular distributions for different materials (e.g. Na, Fe, U) to identify integral benchmarks sensitive to scattering data, to provide better evaluations, and to recommend new scattering measurements if necessary. Detailed conclusions and recommendations will be published in Ref. [24].

D. Evaluation of Experimental Data in the Resolved Resonance Region

Subgroup 36 was established (i) to identify and quantify the experimental details and related uncertainty components, (ii) to review the best methods for evaluating uncertainties and avoiding pitfalls, (iii) to define and analyse case studies, and (iv) to provide recommendations for reporting and usage of experimental information required to produce accurate cross sections with reliable covariance data in the resolved resonance region. Detailed conclusions and recommendations will be published in Ref. [25].

E. Improved Fission Yield Evaluation Methodologies

Subgroup 37 was established to improve fission product yield evaluation methodology. The goal is for the experts in this field to develop improved methodologies for future evaluations that are consistent with the new theoretical knowledge and experimental measurements, and include common covariance methods and data formats that will allow calculations with both improved accuracy and the

generation of uncertainties on calculated engineering parameters. The first subgroup meeting was held in May 2013.

F. A Modern Nuclear Database Structure Beyond the ENDF Format

Subgroup 38 was established to define a new and improved standard structure for storing nuclear reaction data. The main objective of this subgroup is to define a common data model/organization, to agree on best practices for evaluations, and how to implement them in the new structure and in QA tools, and to define a process for publishing and updating the standard structure. The subgroup organized three workshops in 2012 and 2013 to exchange views on the vision and goals of the new nuclear data structure and to draft a requirements document.

V. FUTURE ACTIVITIES

Two new subgroups were established in 2013. Subgroup activities should start in 2013, pending WPEC approval.

A. Methods and Approaches to Providing Feedback from Nuclear and Covariance Data Adjustment

As an extension of Subgroup 33 activities, this new subgroup will provide criteria and practical approaches for effective use of the results of sensitivity analyses and cross section adjustments as feedback to evaluators and differential measurement experimentalists in order to improve knowledge of neutron cross sections, uncertainties, and correlations to be used in a wide range of applications.

B. Pilot Project of a Collaborative International Evaluated Library Organization (CIELO)

This subgroup aims to demonstrate that a stronger and wider international collaboration can foster evaluated nuclear data advances and help establish the highest fidelity nuclear data evaluations for all nuclear data users. The creation of future improved joint general purpose nuclear reaction data evaluated files would be the opportunity to solve some of the discrepancies between the existing main evaluated files thanks to advances in our understanding of the underlying cross sections and covariance data, as well as integral parameters. The pilot project will focus on six important isotopes: ^{1}H, ^{16}O, ^{56}Fe, ^{235}U, ^{238}U, and ^{239}Pu [26].

VI. OUTLOOK

In line with the NEA mission, the WPEC promotes the exchange of information on all nuclear data related topics (i.e. evaluation, measurement, theory and validation) and provides an international framework and associated services for cooperative activities. The WPEC helps to build common understanding and expert consensus on key issues, and provides recommendations with the ultimate objective of meeting the needs of nuclear science applications by improving the evaluated libraries used in simulation codes. The WPEC also welcomes new contributions and innovative initiatives capable of further improving the methods and practices of evaluated data file production.

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