

WPEC Subgroup Proposal

P. Oblozinsky
National Nuclear Data Center, BNL

Title

Creation of International Library of Neutron Cross-Section Evaluations for the Bulk of Fission Products

Short Justification for a Subgroup

Proposed Subgroup should deal with follow-up activities to the Subgroup 21 that was charged to assess neutron cross-section evaluations for the bulk of fission products. SG21 reviewed a complete set of 218 materials (211 old and 7 new) in the fission products range ($Z = 31 - 68$), and provided recommendations for the best evaluations currently available [1,2]. To make use of these recommendations, actual files should be assembled and tested.

The purpose of the proposed Subgroup is to create ENDF-6 formatted files, including basic testing for all FP materials, and data validation for selected materials. It is assumed that the bulk of these files will be adopted by all major nuclear data projects. In this way, neutron cross-section evaluations for the bulk of fission products will *de facto* acquire a status of internationally recognized library.

Subgroup Monitor

JEFF R. Jacqmin (CEA Cadarache)?

Subgroup Chairman

ENDF P. Oblozinsky (BNL)

List of Subgroup Participants

ENDF P. Oblozinsky (BNL), M. Herman (BNL), S. Mughabghab (BNL),
R. MacFarlane (LANL)?
JEFF R. Jacqmin (CEA Cadarache)?, A. Trkov (IAEA)?
JENDL T. Nakagawa (JAERI), K. Shibata (JAERI)
BROND V. Pronyaev (IAEA and Obninsk), A.V. Ignatyuk (Obninsk)
CENDL Ge Zhigang (CNDC)

Definition of the Project

The project will create ENDF-6 formatted files of neutron cross-section evaluations for all fission products currently available in major data projects in accordance with the recommendations of SG21 [2]. Use will be made of extensive new BNL-325 evaluations in thermal, resolved and unresolved resonance region that are currently under completion by S. Mughabghab, BNL.

For 25 materials as specified by SG21 the project will perform relatively simple evaluations in the fast neutron region using the code EMPIRE. This will allow replacing obviously obsolete or incomplete existing evaluations with results deemed to be much better due to up-to-date physics and parameterization.

ENDF-6 formatted files will be created for 218 materials (211 old plus 7 new). It is understood that for 84 materials complete ENDF-6 formatted files are readily available. For the remaining 134 materials merging of MF=2 region and fast neutron region must be performed, including a handful of materials where merging involves data from 3 different sources.

Data files for all materials will be subject to basic testing (data verification). Afterwards, isotopic files will be summed up to get evaluations for natural elements, and these will be compared with experimental data as a part of data validation process. As a final step, limited to a few selected materials, full-scale data validation will be performed.

Justification of the Project

The project represents a logical step after successful completion of the work conducted under SG21 that provided recommendations only. Hence, there is a clear need to create actual ENDF-6 formatted files.

Due to extremely limited resources, it would be very difficult to modernize existing fission products evaluations in important libraries currently under development, such as ENDF/B-VII, JEFF-3.1 and BROND-3.

The project will produce International Library of Neutron Cross-Section Evaluations for the Bulk of Fission Products that will be available for each national nuclear data project, allowing thus considerable improvement of evaluations for many materials in each of the national libraries.

It is assumed that each national project would assign its own preferences for priority fission products and related evaluations, and use the present library for remaining bulk of fission products evaluations.

Relevance to Evaluated Data Files

The project will produce ENDF-6 formatted files with evaluations of cross-sections for 218 materials in the fission products range deemed to be best evaluations available. It is assumed that the bulk of these files will be adopted by ongoing and future evaluation projects and included into respective libraries. This would represent a bold step towards creation of internationally adopted fission product library.

Deliverables

- ENDF-6 formatted files for 218 fission product materials.
- Results of data testing for all files.
- Results of data validation for selected fission product materials.

Time-Schedule and Milestones

- 1st year: Creation of files according to SG21 recommendations.
- 2nd year: Basic testing of files completed, validation of priority materials started.
- 3rd year: Validation of priority materials completed. Final report.

References

1. Conclusions of SG21 Workshop, BNL, April 19 – 23, 2004, attached, see also SG21 Webpage, www.nndc.nl.gov/sg21/.
2. SG21 Summary Recommendations for Fission Products Evaluations, see SG21 Webpage, www.nndc.bnl.gov/sg21/.

Attachment

Working Party on International Nuclear Data Evaluation Cooperation, Subgroup 21
Assessment of Neutron Cross-Section Evaluations for the Bulk of Fission Products

Conclusions of the Workshop on Assessment of Fission Products Evaluations

April 19 – 23, 2004
NNDC, BNL, Upton, NY 11973

Summarized by Pavel Oblozinsky
National Nuclear Data Center, BNL
April 28, 2004

Recommended evaluations

1. Workshop discussed reviews prepared by SG21 reviewers for a complete set of 211 materials in the fission products range ($Z = 31 - 68$). Workshop made recommendation for best evaluation for each material, considering separately thermal and resonance region, and fast neutron region.
2. 7 new materials were added in view of availability of new BNL-325 evaluations. Thus, the final list of SG21 materials includes 218 materials.
3. New BNL-325 evaluations (thermal, resolved resonance region, unresolved resonance region), currently under preparation by S. Mughabghab, provided extremely valuable input into final recommendations. In total, new BNL-325 was recommended for 109 materials. In addition, new BNL-325 evaluations have already been included into complete evaluations of 27 materials submitted to ENDF/B-VII.

Note: Reference to new BNL-325 - S. Mughabghab "Neutron Cross Sections: Neutron Resonance Parameters and Thermal Cross Sections", under preparation (assumed to be submitted to Academic Press by the end of 2004).

4. For 25 materials (including 7 new materials) new evaluation in fast energy region was recommended using nuclear reaction model code Empire. In general, these are materials where little or no data are available. Empire is equipped with up-to-date reaction physics and input parameter libraries, and thus deemed well suited to predict unknown cross sections.
5. It was found that JENDL-3.3 provides best evaluations for a large number of materials. This is followed by the forthcoming ENDF/B-VII, CENDL-3 and ENDF/B-VI library. Other libraries, JEF-2.2 (JEFF-3.0) and BROND-2, were recommended only exceptionally.

6. It was noted that in rare earth region (highly deformed nuclei), paramagnetic elastic scattering plays an important role. This is due to non-nuclear interaction that can reach up to about 20 barns at thermal energy. These cross sections are included in some evaluations, though, due to their non-nuclear nature, they should be omitted. Workshop recommendations strictly avoided evaluations that include paramagnetic elastic cross sections.

Note: This point should be discussed at next CSEWG meeting.

7. Proposal for a follow-up WPEC Subgroup was approved. New SG should be charged to create data files based on SG21 recommendations, and to perform their basic testing and partial validation.

Follow-up work (new SG)

1. For 84 materials complete files are already available, meaning that merging of files with MF=2 data and fast neutron data is not needed. In remaining cases, for 134 materials, merging must be done.
2. It is assumed that BNL will merge (assemble) all files, in particular files for 134 materials where different evaluations were recommended for slow and fast neutron regions. It is expected that majority of files will be merged without particular problems. Remaining cases that would need more elaborated approach, will be merged by T. Nakagawa (up to ~20 materials) and by V. Pronayev (also up to ~20 materials).
3. A possibility was discussed to assure that unresolved resonance parameters are used for self-shielding calculations (proper flag in file is needed). This would reduce practical consequences of possible inconsistencies on the boundary of URR and fast region.
4. All 218 files will be subject to basic testing (file verification), including a simple run by NJOY. This will be done by BNL.
5. Afterwards, isotopic files will be summed up to get evaluations for natural elements, and these will be compared with data as a part of data validation process.
6. No conclusion was reached on full-scale data validation, except of understanding that this should be limited to a small set of priority materials.

To do list

1. S. Mughabghab, BNL will complete new BNL-325 evaluations considering priorities and recommendations of the Workshop. This includes unresolved resonance parameters for several materials that should be derived from systematic.
2. V. Pronyaev, IAEA will look into problems with energy balance reported by PSYCHE for some of ENDF/B-VII files that were assembled by KAERI. In general, these problems are not considered critical, but it would be useful to understand the reasons behind them and rectify the problems.
3. M. Herman, BNL will look into evaluations in fast neutron region using Empire for 25 materials identified by the Workshop.
4. T. Nakagawa, JAERI will look into elemental evaluations created from isotopic evaluations and their comparison with data measured on elemental targets.
5. P. Oblozinsky, BNL will finalize proposal for new WPEC Subgroup, to be discussed at WPEC annual meeting, Aix en Provence, France, May 25-28, 2004.