Status of the ENDF Project

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Pavel Oblozinsky
National Nuclear Data Center
Brookhaven National Laboratory

The present status of the United States ENDF project, including its future plans, is summarized in three relevant documents that resulted from the last meeting of the CSEWG organization. These documents are reproduced below:

- Cross Section Evaluation Working Group Highlights,
- ENDF/B-VII planning, and
- Development of the ENDF/B-VII library.

1. Cross Section Evaluation Working Group Highlights

The 51st meeting of the Cross Section Evaluation Working Group was held at Brookhaven National Laboratory, November 6-7, 2001. A total of 44 individuals participated from 13 U.S. organizations and one each from KAERI (S. Korea), NEA Data Bank (Paris) and IAEA Nuclear Data Section (Vienna). The meeting was marked by the CSEWG Symposium “A CSEWG in Retrospective”, devoted to the 35th anniversary of CSEWG and to its previous 50 meetings, and held on November 5, 2001.

Evaluations

Several ongoing evaluation activities were reported. LANL is engaged in $^{235,238}\text{U}$ evaluations, including data testing in fast critical assemblies, with work focusing on (n,f), (n,n') and (n,2n) data. Another LANL project deals with development of activation database up to 150 MeV for transmutation technologies. BNL continued in 19 fission products evaluations in the fast energy region under a collaborative effort with KAERI. Progress was achieved in $^{28,30}\text{Si}$ and $^{235}\text{U}$ evaluations primarily motivated by criticality safety (ORNL). Evaluations of neutron capture on Eu, Gd and Sm performed by LLNL are important for radiochemical analyses of archived nuclear test data.

Release 8 of ENDF/B-VI, approved at the previous meeting, was issued in October 2001. From now on the ENDF/B-VI will remain frozen until the new version of ENDF/B is released. CSEWG activities will focus on the development of a new version of the library, ENDF/B-VII.
Formats and processing

Four nuclear data processing codes are under continuous development and testing. NJOY processing system evolved from the version 99.32 to 99.63, and a new release called NJOY2001 is nearing completion (LANL). ORNL is testing its AMPX-2000, using all evaluations included in the ENDF/B-VI library. The LLNL code can now read the ENDF-6 format, convert it into the ENDL format, allowing thus use of the ENDF/B-VI data files. Progress at ANL was limited to minor format modifications.

The ENDF=102 Formats Manual is online and up-to-date. A couple of recommendations for additions were made that would clarify some points. Several format proposals and suggestions were discussed. Extension of Files 8,9,10 to provide data for elemental evaluations and means for describing all possible reaction products at high energies was approved. Inclusion of charged particles into the Reich-Moore formalism (generalized R-matrix format), and handling covariance data for resonance parameters were suggested, proposals will be submitted for the next meeting.

Future ENDF-7 format triggered hot debate, with two distinctly different approaches. An evolutionary approach favored a smooth development from ENDF-6, without any major changes. Advocates of revolutionary approach wanted employment of modern technologies to make ENDF attractive for future (young) users. An ad hoc committee ENDF-7 Formats and Beyond (Maurice Greene, chair) was appointed to look into these issues.

Data Testing

Progress and status of several data validation and testing activities were reported. Of most interest were those related to criticality safety and to $^{238}$U neutron cross section data.

The status of the NEA International Criticality Safety Benchmark Evaluation Project was given (ANL) and distribution of the related Handbook has started (NEA). ORNL presented validation results with new Si evaluation, supported by the DOE Nuclear Criticality Safety Program. $^{238}$U benchmark testing was examined by KAPL, with contribution from IAEA. The problem of $^{238}$U over-absorption has been addressed, though not yet resolved, using the NEA listserver to exchange information with the JEFF project and IAEA (C. Lubitz).

Measurements

The status of the International Standards Evaluation Project was reviewed (A. Carlson) including a new IAEA CRP to update standards cross sections for light nuclei. Timely output of this project, in particular methodology for combining light- and heavy-element evaluations, is of top importance for the development of the ENDF/B-VII library.

The future of the CSEWG Measurement and Basic Science Committee was discussed. There was substantial support for continuing the existing activities.
ENDF/B-VII

The decision to develop the ENDF/B-VII library has been reached already last year. The present meeting focused on planning activities. First, identified were goals and new features of the library, the bottom line being its evolutionary character. Second, agreement was reached on commitments and timetable. In particular, ENDF-7 format should be finalized and fixed before the next CSEWG meeting, followed by evaluations submitted in 2002 and 2003. New standards cross sections should be partially submitted in 2003 to allow adjustment of key evaluations and their validation, followed by submittal of complete set of standards in 2004. Validation should be performed during 2003 and 2004. The library should be completed in 2004 and released in 2005.

Next Meeting

The next CSEWG meeting will be held at BNL on November 5-7, 2002.

2. ENDF/B-VII Planning

The last session of the 51st CSEWG meeting was devoted to ENDF/B-VII planning. V. McLane introduced the topic by summarizing the status of the current ENDF/B-VI library. Then, R. MacFarlane discussed photonuclear data files that should represent one of several new features of the ENDF/B-VII library.

Following this, the group discussed our aim of releasing a new version, B-VII, in the 2004-5 frame. The basis for discussion was the document “Development of the ENDF/B-VII library” drafted by P. Oblozinsky (CSEWG chair), M. Chadwick, M. Greene, R. McKnight and D. Smith (CSEWG Committee chairs), and by A. Carlson (Standards). As a result of this discussion, the document was updated (see Section 3).

Two specific issues were discussed in length, update of Standards cross sections, and ENDF-7 formats.

Standards

A difficult issue was how to take advantage of the ongoing Standards work improvements. The Standards project, as coordinated by Carlson, may not be completed until about 2004-5, and this may be too late to impact the B-VII release. Yet, many of the standards improvements (especially for H and for the actinide fission cross sections) need to be incorporated into B-VII. Carlson agreed to spend some time this year investigating whether an interim standards file could be produced in a shorter frame of about 1 year. This may mean to drop for a while co-variances and to focus first on completion of the cross section values.

ENDF-7 Formats and Beyond

An ad hoc committee ENDF-7 Formats and Beyond has been appointed. Its charge is to define new
ENDF-7 format and to look into possible future revolutionary format development. Results should be reported to the next CSEWG meeting. Members:

N.M. Greene (ORNL) chair  
M.C. White (LANL) co-chair  
R.E. MacFarlane (LANL)  
V. McLane (BNL)  
D.P. McNabb (LLNL)  
A. Trkov (IAEA/WPEC)  
C.A. Wemple (INEL)

3. Development of the ENDF/B-VII library

The ENDF/B-VI library was released in January 1990, followed by updates released every 1-2 years, with release 8 issued in October 2001. The 49th CSEWG meeting held at BNL, November 8-10, 2000 reached a consensus that a new version of the library, ENDF/B-VII, should be created. A completion date of 2004 was proposed.

The 51st CSEWG meeting held at BNL, November 6-7, 2001 identified goals, new features, and agreed on commitments and the timetable for the development of the ENDF/B-VII library as follows:

Goals

1. Develop a new version of the library in an evolutionary manner
2. Consolidate numerous modifications of the original ENDF/B-VI library
3. Update standard cross sections
4. Review current evaluations, improve them by replacement or re-evaluation as needed and realistically feasible
5. Perform thorough validation before release

New features

1. New version of standard cross sections
2. Energies up to 150 MeV for selected materials
3. Photonuclear data
4. Improved evaluations for major actinides
5. Improved evaluations for fission products
6. New and improved charged particle evaluations relevant to astrophysics
7. Evaluations relevant to RIA, ADS and next generation reactors

Commitments

1. Evaluations
   BNL:
• Evaluate 19 fission products in the fast neutron energy region (BNL-KAERI collaboration), submittal in 2002.
• Review the bulk of fission product evaluations (WPEC Subgroup 21 collaboration), recommendations in 2003.
• Coordinate efforts to remove known bugs and deficiencies in ENDF/B-VI, completion in 2003.

LANL:
• Photonuclear data library: selection of 163 materials (collaboration with IAEA), verification and validation against Barber-George data, completion by November 2003.
• Additional LA150 evaluations (both n and p), including actinides:
  o Neutron data for $^1$, $^2$, $^3$H, $^3$, $^4$He, $^6$Li, $^7$Be, $^{10}$B, $^{16}$O, $^{208}$Pb, Hg isotopes, proton data for $^7$Li, all up to 150 MeV, completion in 2002 and 2003.
  o Upgrades to actinides: $^{232}$-$^{240}$U, $^{239}$Pu, $^{237}$Np, all up to 150 MeV, completion in 2002 and 2003.
• Activation file up to 150 MeV: based on EAF library, completion in 2003
• Delayed neutrons: $^{239}$Pu, $^{235}$,$^{238}$U, completion in 2003
• Light nucleus thermonuclear reactions: 40 thermonuclear reactions with p, d, t and α-particles, completion in 2002 and in 2003
• Gamma-rays in neutron capture
• Improved prompt fission neutrons (WPEC Subgroup 9 collaboration)

LLNL:
• Neutron dosimetry evaluations:
  o A number of partial evaluations
  o Also considered should be update of the IRDF file (IAEA nuclear data project).

ORNL:
• Improved evaluations at low energies for criticality safety including resonance evaluations with SAMMY:
  o $^{19}$F, $^{27}$Al, $^{28}$,$^{29}$,$^{30}$Si, $^{35}$,$^{37}$Cl, $^{233}$,$^{235}$U resolved resonance region as well as unresolved resonance region, completion in 2002.
  o $^{16}$O, $^{39}$,$^{41}$K, $^{55}$Mn, $^{238}$U, RR and UR regions, completion in 2003.

2. Standards
NIST and LANL:
• Improve a full set of neutron cross-section standards (mutual cooperation of 3 groups: CSEWG, WPEC and IAEA CRP), submittal in 2004.
• Improve a partial set of neutron cross-section standards to allow adjustment of key evaluations and their validation. Submittal of these standards in 2003 is considered to be critical, actual timetable depends on the outcome of the IAEA CRP meeting in 2002 (currently scheduled for September 2002 in Vienna).
3. Formats and processing
   Ad hoc committee ENDF-7 Formats and Beyond:
   • Consolidate numerous modifications of ENDF-6 format into ENDF-7 format: completion by November 2002.

   LANL:
   • Review format updates and modifications and ensure their compatibility with processing codes.

   ORNL:
   • Keep track of new requirements for format updates and modifications.
   • Address formats for covariance data from practical point of view.

4. Validation
   ANL:
   • Coordinate thorough validation of ENDF/B-VII before release, completion in 2004.
     Focus on:
     o Key materials for applications
     o High energy data
     o Covariance data for standards

   LANL:
   • Validate photonuclear data library, completion in 2003.
   • Actinide evaluations

   ORNL:
   • To be specified

Timetable

   ENDF-7 formats defined: 2002
   Standards submitted: 2003 – 2004
   Validation performed: 2003 – 2004
   Library completed: 2004
   ENDF/B-VII released: 2005