



ENDF/B-VII.1 Status

(NDWG, Port Jefferson, June 24-25, 2010)

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ENDF/B-VII.0 → ENDF/B-VII.1



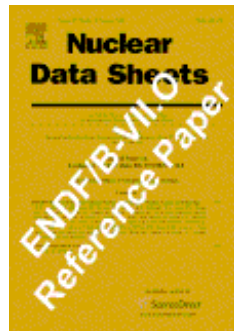
Released December 2006
(16 years after ENDF/B-VI)



CSEWG 2006

Major contributors

- LANL (actinides, light nuclei, thermal neutron scattering)
- BNL (fission products resonances & fast, decay data)
- ORNL (resonances)



226 citations
(SCOPUS)

Release December 2011
5 years after ENDF/B-VII.0

Major improvements:

- structural materials
- minor actinides
- covariances (110 materials for AFCI)
- eliminating some deficiencies
- fixing errors

Roadmap:

- beta0 version December 2010
- beta1 version June 2011
- beta2 version September 2011?
- release & paper December 2011



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Improvements

Achieved and...

still needed :)

Improvements reported to CSEWG

- Mosteller
 - 233U, HEU, and plutonium cases with fast neutron spectra
 - much better consistency between bare spheres and the corresponding Flattop cases
 - dramatically better results for BIG TEN
 - better results for the water-reflected spheres of HEU and plutonium.
- Cullen
 - Godiva (U235), Jezebel (Pu239) and Jezebel23 (U233) reproduced to within the accuracy of the models, 1.0 +/- 0.001.
- MacFarlane and Kahler
 - performs better in ICS- BEP U-233 solution criticals, and a few of the U-233 lattice criticals
- Kolbe et al
 - VII.0 should be used for criticality safety evaluation of wet storage pools.

McKington's list of deficiencies

- Large discrepancies in **239Pu** in thermal (e.g., solutions) and intermediate spectra systems
- Improvements needed in resolved and unresolved resonance range of **Cr** and **Mn** as evidenced in Pu/C/SST assembly
- Very poor performance for clean assemblies with **W**
- Puzzling results with **233U** data testing
- Some issues remain with **Zr** isotopes
- Although largely improved, some large discrepancies remain with **9Be**
- Some discrepancies with **238U** capture
- Results for many polyethylene moderated and reflected critical assemblies are very high
- Some **Pb** biases remain in thermal systems

Needs for Improvement

More deficiencies...

- sodium (**Na**) void worths under-predicted
- Mosteller: fast cross sections for **Be** and **Th** should be reviewed
- Descalle: deficiencies in **⁹Be** and in the isotopes of **Ni** and **W**
- Mosteller: 18 evaluations require review, including portions of **²H**, **⁹Be**, **^{63,65}Cu**, **¹¹³Cd**, **²³²Th**, **^{233,235}U**, **²³⁷Np** and **²³⁹Pu**.
Improvements needed in the elastic scattering angular distributions for the **Ti** and **V**.
- Kozier: continuing deficiencies in **²H** cross sections; Mosteller: low energy elastic scattering cross section should be reduced by 0.15%.

Progress toward ENDF/B-VII.1

Materials under evaluation

- **H3:** LANL corrected (n,2n) cross sections
- **Li6 & O16:** New evaluations to be completed by LANL.
- **Be9:** New LANL evaluation includes RPI experimental data
- **Na23:** New evaluation with covariances has been prepared by BNL
- **Cr isotopes:** ORNL working on SAMMY analysis of RRR in Cr50 and Cr53
- **Mn55:** New evaluation underway by the BNL/IAEA collaboration, new RRR by ORNL
- **Fe56:** Modification to α -production cross sections by LANL
- **Ni58, 60:** New RRR (extended to 812 keV) with covariances by ORNL. New LANL calculations at higher energies reproduce α -production data of LANSCE.
- **Zn62-73:** New LLNL evaluations still under improvement
- **Y89:** Capture recalculated at LANL. RRR needs to be cut short to avoid missing resonances
- **Zr:** New Zr90 evaluation by BNL successfully tested by KAPL, but other tests are mixed. New BNL evaluations for Zr91,93,95



Progress toward ENDF/B-VII.1

Materials under evaluation (continuation)

- **Gd157**: thermal cross section measured by RPI 9% lower than ENDF/B-VII.0. Decision needed.
- **Cd113**: Thermal capture modified by Mughabghab. RRR, however, might be replaced by the new Geel evaluation (July 2010)
- **W**: IAEA makes refinements to improve benchmarking. LLNL evaluated unstable isotopes.
- **Pu239**: New RRR were evaluated by ORNL but problems in Pu solution benchmarks persist. CEA modified RRR in JEFF-3.1.1 to technically solve the issue. ORNL works on a similar fix.
- **Minor Actinides**: JENDL Actinoid file reviewed and submitted by LLNL. Some materials might be replaced. In particular, work on **Np** isotopes is underway at LANL. New EMPIRE based evaluations for **Cm** isotopes, including covariances, being performed at KAERI. Alternative evaluations for **Np237** and **Pu242** produced by BNL.
- **Fission spectra**: LANL is preparing prompt fission spectra on finer energy grid.
- **Fission product yields** important update by LANL.



ENDF/B-VII.1 Status

as of June 23, 2010

New evaluations: 9Be, 19F, 35Cl, 37Cl, 39K, 41K, 46Ti, 47Ti, 49Ti, 50Ti, 52Cr, 53Cr, 55Mn, 58Ni, 60Ni, 78Kr, 90Zr, 123Xe, 124Xe, 180W, 182W, 183W, 184W, 186W, 185Re, 187Re, 237U, 239U, 240Pu, 240Am

IAEA

New covariances: 235U, 238U, 239Pu

Corrected for ACE library: 1H, 45Sc, 89Y, 96Zr, 97Mo, 242Am, 242m1Am

Simple fixes: 3H, 22Na, 87Rb, 113Cd, 233U, 236U, 241Am

Taken from other libraries: 63Cu, 65Cu, 174Hf, 176 Hf, 177Hf, 178Hf, 179Hf, 180Hf

JENDL Actinoid files: 225Ac, 226Ac, 227Ac, 227Th, 228Th, 229Th, 230Th, 231Th, 233Th, 234Th, 229Pa, 230Pa, 231Pa, 232Pa, 230U, 231U, 232U, 234Np, 235Np, 236Np, 238Np, 239 Np, 236Pu, 237Pu, 238Pu, 241Pu, 242Pu, 244Pu, 246Pu, 240Cm, 241Cm, 242Cm, 243Cm, 244Cm, 245Cm, 246Cm, 247Cm, 248Cm, 249Cm, 250Cm, 245Bk, 246Bk, 247Bk, 248Bk, 249Bk, 250Bk, 246Cf, 248Cf, 249Cf, 250Cf, 251Cf, 252Cf, 253Cf, 254Cf, 251Es, 252Es, 253Es, 254Es, 254m1Es, 255Es, 255Fm



Covariances for ENDF/B-VII.1

Recent and ongoing projects/activities

- **AFCI** (ex **GNEP**) project (BNL, LANL) - see next viewgraph
- **Evaluation of MF32** (ORNL), **MF33** (LANL) covariances for the individual materials supported by criticality safety or defense.
- Work continues on improvement of covariance evaluation methodology
 - role of systematic uncertainties in the RRR
 - role of the scattering radius uncertainty
 - role of correlations
 - neutron widths among resonances
 - neutron width and scattering radius
 - among fast neutron experiments
 - role of model defects in fast neutron region
- Validation of the **processing codes PUFF and NJOY** - good progress

Advanced Fuel Cycle Initiative (AFCI)

Major covariance effort by BNL and LANL

List of nuclei in AFCI (priority materials in **bold**)

¹ H	²⁸ Si	⁹² Mo	¹⁰⁹ Ag	¹⁴⁹ Sm	²³² Th
² H	²⁹ Si	⁹⁴ Mo	¹²⁷ I	¹⁵¹ Sm	²³³ U
⁴ He	³⁰ Si	⁹⁵ Mo	¹²⁹ I	¹⁵² Sm	²³⁴ U
⁶ Li	⁵⁰ Cr	⁹⁶ Mo	¹³¹ Xe	¹⁵³ Eu	²³⁵ U
⁷ Li	⁵² Cr	⁹⁷ Mo	¹³² Xe	¹⁵⁵ Eu	²³⁶ U
⁹ Be	⁵³ Cr	⁹⁸ Mo	¹³⁴ Xe	¹⁵⁵ Gd	²³⁸ U
¹⁰ B	⁵⁵ Mn	¹⁰⁰ Mo	¹³³ Cs	¹⁵⁶ Gd	²³⁷ Np
¹¹ B	⁵⁴ Fe	⁹⁹ Tc	¹³⁵ Cs	¹⁵⁷ Gd	²³⁸ Pu
¹² C	⁵⁶ Fe	¹⁰¹ Ru	¹³⁹ La	¹⁵⁸ Gd	²³⁹ Pu
¹⁵ N	⁵⁷ Fe	¹⁰² Ru	¹⁴¹ Ce	¹⁶⁰ Gd	²⁴⁰ Pu
¹⁶ O	⁵⁸ Ni	¹⁰³ Ru	¹⁴¹ Pr	¹⁶⁶ Er	²⁴¹ Pu
¹⁹ F	⁶⁰ Ni	¹⁰⁴ Ru	¹⁴³ Nd	¹⁶⁷ Er	²⁴² Pu
²³ Na	⁹⁰ Zr	¹⁰⁶ Ru	¹⁴⁵ Nd	¹⁶⁸ Er	²⁴¹ Am
²⁴ Mg	⁹¹ Zr	¹⁰³ Rh	¹⁴⁶ Nd	¹⁷⁰ Er	^{242m} Am
²⁵ Mg	⁹² Zr	¹⁰⁵ Pd	¹⁴⁸ Nd	²⁰⁴ Pb	²⁴³ Am
²⁶ Mg	⁹³ Zr	¹⁰⁶ Pd	¹⁴⁷ Pm	²⁰⁶ Pb	²⁴² Cm
²⁷ Al	⁹⁴ Zr	¹⁰⁷ Pd		²⁰⁷ Pb	²⁴³ Cm
	⁹⁵ Zr	¹⁰⁸ Pd		²⁰⁸ Pb	²⁴⁴ Cm
	⁹⁶ Zr			²⁰⁹ Bi	²⁴⁵ Cm
	⁹⁵ Nb				²⁴⁶ Cm

AFCI/GNEP project will provide 110 covariances, which will serve as a reference for constructing ENDF-6 formatted covariance files for ENDF/B-VII.1.

LANL - light nuclei, actinides, fission spectra.

BNL - structural materials, Na, minor actinides, and all the rest including RR.

- AFCI-1.2 library, August 2009
- AFCI-1.3 library, April 2010
- AFCI-2.0 library, August 2010 (to be used by SG33)



Covariance methodology at BNL

Strength in diversity

- Thermal and Resonance Region (source: Atlas of Neutron Resonances)
 - MF32 with scattering radius and thermal point uncertainties reproduced through correlations (if possible)
 - MF33 through the recently developed 'kernel approximation'
 - MF32 with systematic uncertainties in MF33
 - 'low-fidelity' (Mark Williams) solution
 - Assimilation
- Fast neutron range (MF33)
 - EMPIRE/KALMAN with/without experimental data
 - Dispersion analysis - differences between evaluations
 - Reconsider previous work
 - Assimilation
- Challenges
 - (i) correlations, (ii) correlations, (iii) correlations, ...
 - Tendency of the rigorous methods to provide unbelievable uncertainties
 - Producing uncertainties for the existing files
- Goal for VII.1: provide consistent and **reasonable** set of covariances for nuclei relevant to AFCI (extensive checking)



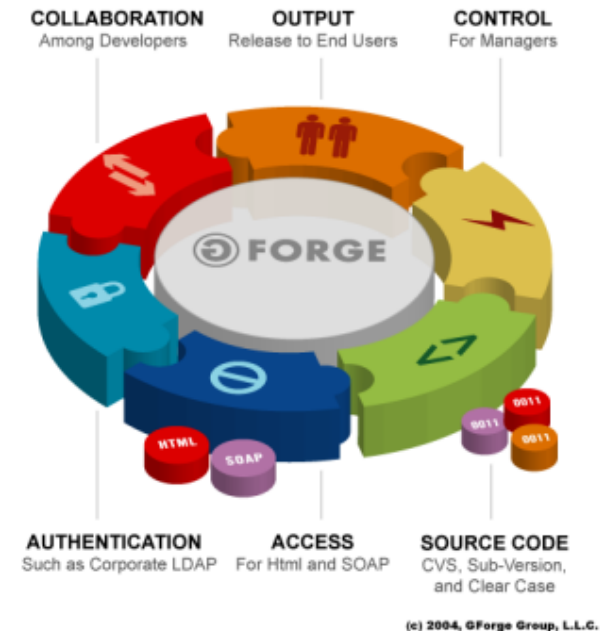
NNDC GForge site

(<https://ndclx4.bnl.gov/gf/>)

Collaborative environment for nuclear data development.

Features:

- Apache web server
- File uploading/downloading
- Subversion (SVN) versioning system
- Management of releases
- Document management
- News announcements
- Surveys for users and admins
- Issue (bug) tracking
- Task management
- Mailing lists



Current projects:

- ENDF/B-VII
- ENDF-6 manual
- EMPIRE code

Conclusions

- CSEWG is going to release ENDF/B-VII.1 in Dec. 2011, preceded by 2 or 3 beta versions (first one in Dec. 2010)
- Focus on structural materials and minor actinides.
- Covariances for 110+ materials (AFCI driven)
- Management of ENDF/B moved to GForge system
- Support from the DOE Office of Science, ARRA, criticality safety, AFCI, defense.
- We are still working on improving covariance methodology, e.g., 'kernel approach', assimilation, ...