BNL evaluation report

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Tuesday, November 3, 2009

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Brookhaven Science Associates

59 neutron files in ENDF/A 37 files since CSEWG-2008

- 1. 0-01_H_001-fix0.lanl
- 2. 0-21_Sc_045-fix0.lanl
- 3. 0-39_Y_089-fix0.lanl
- 4. 0-40_Zr_096-fix0.lanl
- 5. 0-42_Mo_097-fix0.lanl
- 6. 0-95_Am_242-fix0.lanl
- 7. 0-95_Am_242m-fix0.lanl
- 8. n-04_Be_009-new-091029.lanl
- 9. n-17_CI_035_081111.ornl
- 10. n-22_Ti_048-fix-0902xx.lanl
- 11. n-22_Ti_46-newMF32.ornl-lanl
- 12. n-22_Ti_47-newMF32.ornl-lanl
- 13. n-22_Ti_49-newMF32.ornl-lanl
- 14. n-22_Ti_50-newMF32.ornl-lanl
- 15. n-24_Cr_52-new.ornl
- 16. n-24_Cr_53-new_res.ornl
- 17. n-28_Ni_58-new_res.ornl
- 18. n-28_Ni_60-new_res.ornl

- 19. n-29_Cu_063.CENDL31b7
- 20. n-29_Cu_065.CENDL31b6
- 21. n-72_Hf_174_jeff31-mod1.RQWright
- 22. n-72_Hf_176_jeff31-mod1.RQWright
- 23. n-72_Hf_177_jendl33-mod2.RQWright
- 24. n-72_Hf_178_jeff31-mod1.RQWright
- 25. n-72_Hf_179_jendl33-mod1.RQWright
- 26. n-72_Hf_180_jeff31-mod3.RQWright
- 27. n-74_W_180-new.iaea
- 28. n-74_W_182-new.iaea
- 29. n-74_W_183-new.iaea
- 30. n-74_W_184-new.iaea
- 31. n-74_W_186-new.iaea
- 32. n-91_Pa_232-mod-res.RQWright
- 33. n-92_U_236-090903.lanl_fix
- 34. n-92_U_237-090903.lanl
- 35. n-94_Pu_240-new.lanl
- 36. n-95_Am_240-new-0709.llnl
- 37. n-95_Am_241-090903.lanl-fix

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List of NNDC actions

- ¹⁹F merge ORNL / LLNL files?
- ²³Na new evaluation with covariances
- ⁵⁵Mn merged information from ORNL/LLNL/BNL
- ¹⁵⁷Gd any change from Mughabghab assessment? RPI data 10% lower at thermal
- Cd new Mughabghab thermal value adopted (in ENDF/A)
- ⁹⁰Zr adopt VII.0beta4 BNL ⁹⁰Zr evaluation?
- W adopt IAEA evaluation (still being refined)
- Major NNDC effort focused on covariances (Pavel's talk)





¹⁹F evaluation

Action on BNL: merge LLNL and ORNL evaluations

LLNL evaluation

- based on ENDF/B-VIIb1, October 17, 2005
- prompt gamma-ray spectrum for thermal radiative capture has been updated with new experimental data (EGAF) (MF/MT=3/102 and 12/102 ?)

ORNL evaluation

- based on ENDF/B-VII.0, December 2006
- first RR evaluation using LRF=7

Recommendation: Return to LLNL for merging



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²³Na evaluation (M. Pigni, S.F. Mughabghab)

Three-track effort

- GNEP (AFCI) covariances related to ENDF/B-VII.0
- Assimilation new cross sections fully determined by model calculations; model parameters constrained by integral experiments
- ENDF/B-VII.1 in principle the same as 'Assimilation' but constrains of the latter might be too restrictive



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²³Na evaluation methodology

- Atlas of Neutron Resonances => Resonance Region
- EMPIRE => Fast Neutron Region
 - spherical optical model (new CC potential ready)
 - EMPIRE-specific level densities
 - MLO1 gamma-ray strength functions
 - exciton model with cluster emission
 - cross section fluctuations accounted for through energy dependent tuning of total and absorption



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²³Na(n,tot) Atlas RR up to ~1 MeV; fluctuations in fast region



²³Na(n,tot) Extension of the Resonance Region



²³Na(n,*)



²³Na(n,2n)

ENDF/B-VII.0 follows higher data; we tend to prefer the lower ones



²³Na evaluation - further development

- Decouple ENDF/B-VII.1 effort from Assimilation and AFCI
- Improve region between 0.5 and 1 MeV
- Use Coupled-Channels for modeling incident (possibly also outgoing) channels
- Refocus (n,2n) on lower group of experimental data





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⁵⁵Mn evaluation ORNL-BNL-IAEA-Ljubljana collaboration

- New resonance region evaluation from ORNL available in ENDF/A (covariances under revision)
- Excellent CC potential by R. Capote
- Zolotariev evaluation guides (n,2n)
- First calculated results compare favorably with microscopic data
- Preliminary validation results indicate need for improvement
- Work continues...



⁵⁵Mn(n,tot) New omp closely follows Abfalterer 2001



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⁵⁵Mn(n,tot) New omp closely follows Abfalterer 2001



¹⁵⁷Gd thermal cross section controversy (S.F. Mughabghab)

- In ENDF/B-VII.0 and in Atlas $\sigma_{Y^0} = 254000 \pm 815$ b is based on several precise direct measurements on ¹⁵⁷Gd and ^{nat}Gd.
- RPI reported value about 9% lower, resulting from their derived resonance parameters (0.0314 eV).
- RPI result is supported by measurements of radial distribution of ²³⁸U capture to total fission reaction rate in BWR assemblies with Gd pins.
- Hints from the reactor community 'Gd burns too fast' confirm RPI result.
- If RPI measurement is adopted then at least 6 precise measurements must be discarded.





¹¹³Cd thermal capture cross section (S.F. Mughabghab)

New value proposed by Said and present in ENDF/A already adopted



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⁹⁰Zr evaluation

- ENDF/B-VII.0 uses β3 BNL evaluation tested by KAPL
- ENDF/A contains slightly improved β4 BNL evaluation also positively tested by KAPL
- Trkov's validation of Zr's in ENDF/B-VII.0 in TRIGA reactor calculations indicates that ENDF/B-VI.8 ^{nat}Zr performed better
- Need to test $\beta 4^{90}$ Zr from ENDF/A
- To improve one might need to evaluate the whole Zr chain unlikely because of lack of manpower





180,182,183,184,186W evaluations

- Three evaluation efforts going on
 - IAEA-ORNL-Ljubljana (in ENDF/A)
 - KAERI (South Korea)
 - FZK (Karlsruhe, UE)
 - in addition: ENDF/B-VII.0 evaluations with EGAF thermal neutron capture spectra inserted by LLNL
- IAEA evaluations shown to perform better in benchmark tests and have already been adopted by CSEWG
- Further refinements are still under way
- Merging EGAF data into IAEA evaluations is a problem (double counting of primary γ's)



ENDF/B-VII.0 deficiencies

www.nndc.bnl.gov/exfor/4web/VII.0-deficiencies.html

		Deficiencies in ENDF/B-VII.0 library
Material	Deficiency	Detailed description
Neutron sublibrar	У	
AI-27	MT=32, 33, and 45 to be removed?	The MT = 32, 33 and 45 cross-section files from 27AI in ENDF/B-VII.0 are very strange looking. In all three cases, there is only one non-zero point in the cross-section table and that non-zero point is very small (5.2e-4 for MT=32, 4.3e-7 for MT=33 and 4.7e-12 for MT=45) and always at 20 MeV. In all three cases, the threshold for the reaction is very close to 20 MeV, and there is a point just after the 20 MeV point with zero cross-section. I recommend removing all of the MT = 32, 33 and 45 files from 27AI
Am-242	Angular distributions (MF4/MT18) missing	242Am (mat 9546) does not have angular distribution data (mf=4, mt=18) for the prompt fission neutrons, as required by Section 4.4.3 of the ENDF manual.
B-7	Line numbers	All MT sections in B7 start at line number 0 instead of 1.
Be-7	Energy range too short	
		The entire 7Be evaluation ends at 8.1 MeV.
Be-7	No MT=1	
		I found that the Be7 evaluation does not have MT=1
Ca-46	Unphysical shape of elastic	Ca-46 has an natural abundance of 0.004% so it is unlikely to be important when modeling Ca in concrete, tuff, and other materials. We noticed the problem because the evaluation violated some of the ENDF-6 rules we check in our processing codes. I would be satisfied with repairing the evaluation, but would prefer the elastic scattering cross section to have a shape that makes physical sense in this energy range. The JENDL-3.3 Ca- 46 evaluation has a sig_es(2200)=2.93252b and would appear to be a reasonable evaluation to compare the repaired Ca-46 evaluation against for reasonableness.
Cd-106, Cd-108	Missing resonances	In a number of evaluations groups of resonances are missing - ZA=48106 - all resonances between about 600 eV and 2.6 keV are missing. ZA=48108 - all resonances between 350 eV and 2.6 keV are missing.

- We need to address these deficiencies!
- Proposed action: each Lab reviews deficiency list for proper files and provides fixes or comments before next (mini-)CSEWG meeting.



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