Cumulative notes from CSEWG-2015 and mini-CSEWG-2016

Green= FY16 done Orange=FY16 to do Red=FY17 to do Black = comments from mini-CSEWG meeting, April 2016, Los Alamos

235U

Talou-Rising PFNS (and IAEA thermal PFNS) included in the ENDF evaluation. Validated against prelim 235U chi-nu data, and against Lestone 235U Nuex PFNS. Merge new IAEA low energy resonance and nu-bar evaluation into ENDF. Check whether this evaluation matches new DANCE 235U(n,g) reductions near 1 keV – Marco/Skip?

Large scale criticality testing of the file.

Validation testing with IAEA-ORNL team to support improved performance, especially for LEU systems. 7.8-11 eV standard region fixed? As above – for the new March-2016-IAEA file for testing at mini-CSEWG April 2016 at 14 MeV.

Encouraging integral criticality performance by the latest ORNL-IAEA resonance file "23c". LCT 8 (B&W) now look much better, important for the commercial reactor industry. Because these inter-comparisons use the thermal PFNS with the lower 2.000 MeV average energy (which increases reactivity) the file has other features that balance this – higher thermal capture and new resonance parameters up to 20 eV, lower nu-bar, and used with Hale's oxygen that also has lower reactivity owing to increased (n,a) absorption.

Neutron standard fit based on microscopic data resulted in U-235 thermal nubar of 2.426 (0.007) that corresponds to K1=721. The adopted thermal nu-bar was derived by increasing the fitted value by 0.00566 to match the recommended K1 value of 722.7. Note that the increased nu-bar value is within the quoted uncertainty of the fitted standard value. Resonance nu-bar was fitted to available experimental data renormalized to the adopted thermal nu-bar (as described in the comments of the file).

(Talou's plots of the nu-bar at low energies should be discussed, if the 23c nu-bar is accepted – nu-bar has fluctuations (which is OK) but looks low compared to most data in the 10s of eV range, presumably so as to improve integral performance. If this is the case, it should be explicitly discussed in our documentation).

We need to check this file indeed matches the new DANCE and RPI capture data near 1 keV. The file agrees with standards recommended resonance fission integrals in the 7.8-11 eV region. New 1-100 eV data from CERN may become available.

The 23c fast criticality is slightly higher, seemingly from a nu-bar increase in the fast region above 100 keV, and even though this leads to a small over-prediction of Godiva the general modeling of bare fast HEU assemblies looks pretty good.

Pulsed sphere testing of 235U. Japanese void reactivity testing – does change in the capture solve this problem? (still needs to be done.)

Prompt fission gamma spectrum (PFGS) update –
a) numerical - separate fission gammas from other gammas, to avoid double counting error in event mode. Test file to assure no change in results in normal usage
b) upgrade data to take advantage of recent LANSCE/DANCE and Geel thermal PFGS data and Talou model calculations
c) P(nu) & Chi(nu) representations for first time, for correlation work.

Highest priority is to update the recommended total PFGS spectrum (with best recommended multiplicity and average energy), informed by code calculations and by DANCE data, remembering that the DANCE data cannot be used alone because of detector cut-off issues at low gamma-ray energies. Any neutron incident-energy dependence that is deemed appropriate should be used. Additional refinements such as nu-bar-gam(nu-gam) and chi-gam(nu-gam) are "nice to have" but lower priority.

TKE - upgrade to Tovesson LANSCE/TKE data. Morgan said: a new ENDF format proposal should be submitted well before CSEWG.

FPY - upgrade to include any changes implied by TUNL measurement - especially at 14 MeV and fast & LANSCE FPY measurements. Fission theory and model advance validation against FPY data – Lestone model predictions.

Inelastic - review recent fast region evaluation by IAEA and consider whether to adopt any for B-VIII. Assess any proposed changes based in Kawano theory work. (Unlikely – because of insufficient time. Waiting for RPI-type semi-integral data).

Capture - review other recent DANCE data in > keV region to assess whether any ENDF changes warranted – especially 10's of keV (unlikely – because of insufficient time). Asses impacts of modified capture cross section on late-time diagnostics.

More extensive criticality validation testing needed. Mission-relevant testing. Update uncertainty covariance evaluations. Completion of above tasks as needed.

R. Capote: Alternate 235U fast region >2.25 keV has been evaluated at IAEA. This took fission from the B-VII.1 (like 2006 standards); capture is also from VII.1 (but could be modified later). PFNS was Rising-Talou from the CRP for all energies (except the thermal point). Their modeling used a triple-humped barrier formulation (for the first time), agreeing with the standards to 3%, giving additional confidence in the use of the optical potential for elastic and inelastic scattering.

We need to see Capote's new elastic compared to VII.1, but his work compared to data looks good (he thought back-scattering was low in ENDF).

Total inelastic scattering looks similar, by 5-7% or so.

(n,2n) rather similar, slightly higher near threshold – and similar at 14 MeV. He should add Younes GEANIE data here too.

DDXS data 1-2.2 MeV look good compared to Kornilov DDXS data. 30 and 150 look OK. We need to compare against ENDF data (14 MeV, angle integrated and many angles ...).

M. Chadwick – regarding 14 MeV and pseudo-levels and preequilibrium: analogous to what we did for VII, Capote used his own pseudo-level treatment, by adapting info from 238U scattering. We have compared against ENDF data (14 MeV, angle integrated and many angles ..., Kammerdiener data, etc). 23c version does not match the Kammerdiener 14 MeV spectra as well as VII.1 – IAEA will fix in the next release, possibly by using our VII.1 pseudo-levels.

Nu-bar – he changed VII.1 a bit higher from 100 keV – 2 MeV. He will check why (unresolved in 2.25-25 keV range or so was kept). The 23c file overcalculates Godiva slightly, but represents a good match of the ensemble of fast HEU bare crits.

239Pu

WPEC-SG34 resonances adopted; SG34/JEFF3.2 nu-bar adopted below 650 eV & total nu-bar updated.

No changes to fast PFNS yet below 5 MeV- when chi-nu data are available, compare against our current VII.1 PFNS evaluation. Compare against Pu of Lestone, Nuex and Chatillon and other data. Adopt LANL/Neudecker evaluation of PFNS above 5 MeV. Test Neudecker data against LLNL pulsed sphere experiment.

Make "Romano tweak" to thermal PFNS for criticality performance.

P(nu) & Chi(nu) representations for first time, for correlation work. This was discussed by Talou, and it looks like something that can be done for ENDF/B-VIII.

Adopt Talou's untweaked nu-bar from covariance analysis. Review nu-bar over whole energy range including WPEC-SG34 recommendation (which appears low....). Capote has raised the suggestion of increasing the fast nu-bar (say back to VII.1) to increase fast Pu assembly criticality slightly (~50 pcm); this will be considered in the coming months.

PFGS as for 235U - highest priority is to update the recommended total PFGS spectrum (with best recommended multiplicity and average energy), informed by code calculations and by DANCE data, remembering that the DANCE data cannot be used alone because of detector cut-off issues at low gamma-ray energies, and using any neutron incident-energy dependence that is deemed appropriate. Additional refinements such as nu-bargam(nu-gam) and chi-gam(nu-gam) are nice to have but lower priority.

TKE, FPY as for 235U.

Capture - obtain Mosby DANCE data and consider changes to ENDF above 1 keV. Validation testing needed to check implications of the changes. We ought to be able to include this upgrade soon. Kawano has made a trial evaluation informed by the preliminary data and Kahler has assessed the performance. The Jezebel criticality is reduced a few hundred pcm owing to the higher capture in TK's evaluation at the highest energies. This needs to be studied more once the Mosby DANCE data are finalized, in case a change for B-VIII is made. We would like Kawano's recommendation on what options we have to change the fast region and the URR to include these new data. See if TK can make another version similar to his present trial, but following the highest-energy (lower) Mosby data – does this reduce the Jezebel under-prediction?

Review TPC 239Pu/235U fission cross section ratio and use international standards committee and CSEWG to assess implications and path forward. Likely not enough time to impact VIII.0 but assess impacts on mission relevant simulations.

Inelastic - consider any changes needed for ENDF/B-VIII based on Kawano theory. Probably insufficient time, and maybe best to wait till new RPI type data become available.

Consider any lower energy resolved resonance changes beyond WPEC-SG34 upgrades. Assess status of IAEA. ORNL and Leal proposed changes. Have DANCE folk interact with SAMMY folk on any changes proposed - including up to 4 keV. Assess whether Tovesson first fission resonance data should impact the new ENDF evaluation. (Much of this will likely not be possible before VIII).

If any changes warranted, much work will be needed on the database and on validation testing.

More criticality testing. More criticality testing. Mission relevant testing.

Update uncertainty covariance evaluations.

Completion of above tasks as needed.

238U

IAEA and Geel have a new evaluation proposed for ENDF/B-VIII. Test it out. (n,2n) was informed by our TUNL data. Check comparison. Validation tests of 238U(n,2n) in crits reaction rates to ensure continued good performance. As above, using new March 2016 update. Check capture consistent with standards.

R. Capote: Fast region has had little changes. Capture has not been changed – we should ask Roberto to provide a figure to check this, since the VII.1 file for capture in the keV region was a little different from the B-VII standards (so as to better match Bigten). In future beta-releases, the adoption of the latest "standards" 238U(n,g) will be

In future beta-releases, the adoption of the latest "standards" 238U(n,g) will be considered. Inelastic has modest changes compared to VII.1. Likewise for (n,2n). He has thermal 235U neutron spectra averaged values that support his value.

In the resonance region, some bound state parameters were changed to better model capture in the 10s-100e eV range. Capote said(?) that the resonance parameters from B-VII.1 were not actually changed. Schillebeeckx led this work. Below 20 keV in the RR region there are some differences between VII.1==new file, and Geel new data (we have not received new Geel resonance data yet). A few percent changes (e.g., 5 % lower at 80 keV) have been made to capture in 20 keV-150 keV URR. There are no changes above 150 keV.

They adopted Talou-Rising PFNS (up to 5 MeV + ENDF above that?) We need comparisons against data, including Baba, 14 MeV pseudo-levels, etc etc.

Y. Danon: sub-threshold fission cross section needs checking. Check whether the file agrees with data, not just a model calculation, for this very small cross section.

Validation tests against new RPI semi integral data – by IAEA Reflected crits performance slightly worse. Can this be solved – by IAEA? Much validation testing for crits, and mission testing. The latest 238U file seems to better match the reflected flattop crits, nicely bringing down the over-prediction.

PFNS unchanged from VII.1? Assessment of some of the strange recent PFNS shape at lower emission energies, measured at RPI and France. P(nu) & Chi(nu) representations for first time, for correlation work.

FPY & TKE – as for 235U. More crit testing and mission testing. Completion of above tasks as needed.

160

Hale's new R matrix analysis finalized and compared against various measured data, with data testing - including merging with higher energy old data above 8 MeV. Compare against the various (n,a) existing measurements - as being summarized by Georginis. Georginis recommends B&H*0.95 and Har05*1.42 as the appropriate normalizations, and Hale concurs. Ask Georginis why he doesn't publish his own corrected Geel data in te 3-6 MeV region, which we gather he says agrees well with these other data and his recommended normalizations (ask him to publish as a CIELO paper). Ask Kunieda to provide his own independent assessment – last time we saw, he was in agreement with Hale.

Compare total elastic low energy cross section against Plompen recommendation, 3.765b. Articulate reasons for differences – role of Schneider data? Hale has done this. Compare total against recent RPI data. Consider any evaluation upgrades based on RPI work. (last comparison was C/E =1.01 using Hale 1 – Hale 2 was more like 1.008 versus 0.988 for VII.1). The Cierjacks'80 data is off by 3.2 percent compared to RPI, as agreed by most of the community now (Gerry has 3.78% or so). It can still be fit, owing to its good resolution, but with a renormalization. Validation testing of the new file is needed, especially for the related impacts of this and the new 235U evaluation in reactor and solution criticality safety applications.

Performance is encouraging, when used with the latest IAEA 235U file. Documentation of the work should include comparison of new versus VII.1 plutonium evaluations for key cross sections, showing the merging at 9 MeV and the use of corrected Geel data for (n,a) in the 6.3-9 MeV region.

Test leakage and transport and Kerma as well as criticality.

View on the integral (poor?) performance on neutron transmission test problems?

Compare against LENS preliminary (n,a) data as confirmation validation test of the >30% change to (n,a) in the 3-6 MeV region. Backup plan if LENS data contradict this change?! (Though unlikely to be finalized in time for B-VIII)

Adopt VII.1 capture, but consider any updates in keV region as needed (Wick Haxton discussion).

Uncertainty covariance upgrades.

12C, 13C to replace ^{nat}C in ENDF

Advance 12C and 13C evaluations and perform initial data testing.

Finalize Hale R matrix evaluations. Criticality validation testing, as well as transport, kerma *etc*.

Merging with high energy ENDF data to 150 MeV. Just for 12C? What for 13C? Just to 20 MeV.

Standards: Compare averaged isotopic scattering with natural carbon scattering standard - adopt if acceptably close.

Uncertainty covariance updates. Completion of above tasks as needed.

1H

Finalize 1H evaluation. Test new changes above 20 MeV up to 150 MeV.

If any cross section changes are proposed below 20 MeV, much testing and discussion is needed.

Update covariance uncertainties - especially in the few MeV region (related to a future

TPC 1H ratio measurement). Make sure a previous uncertainty "error" was fixed.

Completion of above tasks as needed.

9Be

Assess accuracy of existing evaluation. No work is planned. Is that Ok? Completion of above tasks as needed

56Fe

Initial testing of new files, and support BNL as they decide on the RR region, upper limit, angular distributions, and so on. Criticality and leakage validation testing of new BNL eval. Completion of above tasks as needed

G. Nobre & D. Brown – New evaluations were performed for three minor isotopes of iron (54,57,58Fe) including resonance region. 54Fe cross sections were obtained from EMPIRE model calculations. There are IRDFF (n,p), (n,a) and (n,2n) cross section that should be used in a file. More work and comparisons needed for (n,xn) too. **MBC** – not clear whether we should put such a file in as a starter file yet into a beta release.

M. Herman – Rev. 88 discussed in Nov 2015 – used JEFF-3.2 total from 846keV to 4 MeV. 56Fe is now at Rev.219, which now uses total from JEFF-3.2 from 846 keV up to 6 MeV and RR from JENDL-4.0 up to 850 keV. Leal's resonances are not being used in the new file, while more work is needed before Leal RR can be adopted.

The new file is largely a pure-experimental file up to 4 MeV. A large change in capture near 10 keV was motivated by Trkov's study of crits.

Elastic angular distributions from JEFF-2.2, JEFF-3.2 come from Kenney data. (But some OM calculations fit other data better.) In general, there is a big spread in experimental data. Danon results generally wanted a higher back-angle scattering component, apparently this is what is needed to improve the Fe-reflected crits, which are now under-calculated. We need to compare Kawano's paper on P1 with the lastest BNL evaluated data.

We need to check against the KAPL Trumble Fe leakage simulations of measurements (ORNL broomstick)

We reiterated the need to use data where we can to define excitation functions – not model calculations. This is especially true where we have IRDF dosimetry cross sections.

Danon - RPI data are useful for testing the neutron scattering angular distributions. In Rev.219 at back angles, C/E needs to be higher for En <2 MeV. Inelastic data near 1 MeV from Leal appears to fit the RPI data well – should be discussed more before it is rejected for B-VIII.

Capture in VII.1 has an artificial background. RPI capture data show Rev.219 looks pretty good.

(181Ta - Capture upgrade needed, e.g., below 100 keV, where ENDF looks too high. URR parameters Yaron sees look like Mughabghab – ENDF needs to be upgraded).

56Fe and other iron data testing issues

M. Herman - Generally the fast performance got worse in the latest Fe files, in particular, under-prediction of HEU and Pu reflected assemblies. HMI1 (a ZPR) gets significantly worse, partially due to a 57Fe evaluation (a capture background happens to help in this case). Mike noted that perhaps better angular distributions are needed.

Mike claims that the new 235U for VIII from the IAEA does not work well with the old VII.1 Fe, i.e. VII.1 needs updating for VIII.

Mike raised questions about the next round of CIELO nuclides to focus on.

POST-MINI-CSEWG Work:

We concluded that the 56Fe file presented at mini-CSEWG was not yet ready to go into a beta-release, since overall the integral performance compared to B-VII.1 was worse. Since min-CSEWG, BNL have made advances that resolve this concern.

It was also agreed that, for cases where IAEA dosimetry evaluations exist, these activation cross section channel evaluations should be adopted (unless there is a compelling reason why another evaluation is preferred).

FPY

Upgrades for B-VIII. Consider changing some 14 MeV values based upon the TUNL measurements, now published.

Sonzogni has identified some deficiencies in thermal and fast 235U FPYs, e.g., 86,7,8Ge and 96Y. Can these be fixed for VIII?

Is there a way to do this, while conserving the integral to 2 and ensuring consistency between individual and cumulative yields, that uses Kawano's Bayesian update approach, as was done in our last 0.5-2 MeV and 14 MeV Pu FPY update for VII.1?

Completion of above tasks as needed

Decay data library

Update for more than 20 nuclides is coming from Sonzogni. Kawano – bug for Ge fixed? The decay heat validation test looks good but JEFF FPYs were used instead of ENDF. Talou noted a long-term proposal to reinvigorate FPY and decay heat evaluations. Completion of above tasks as needed