Status of ENDF reviews

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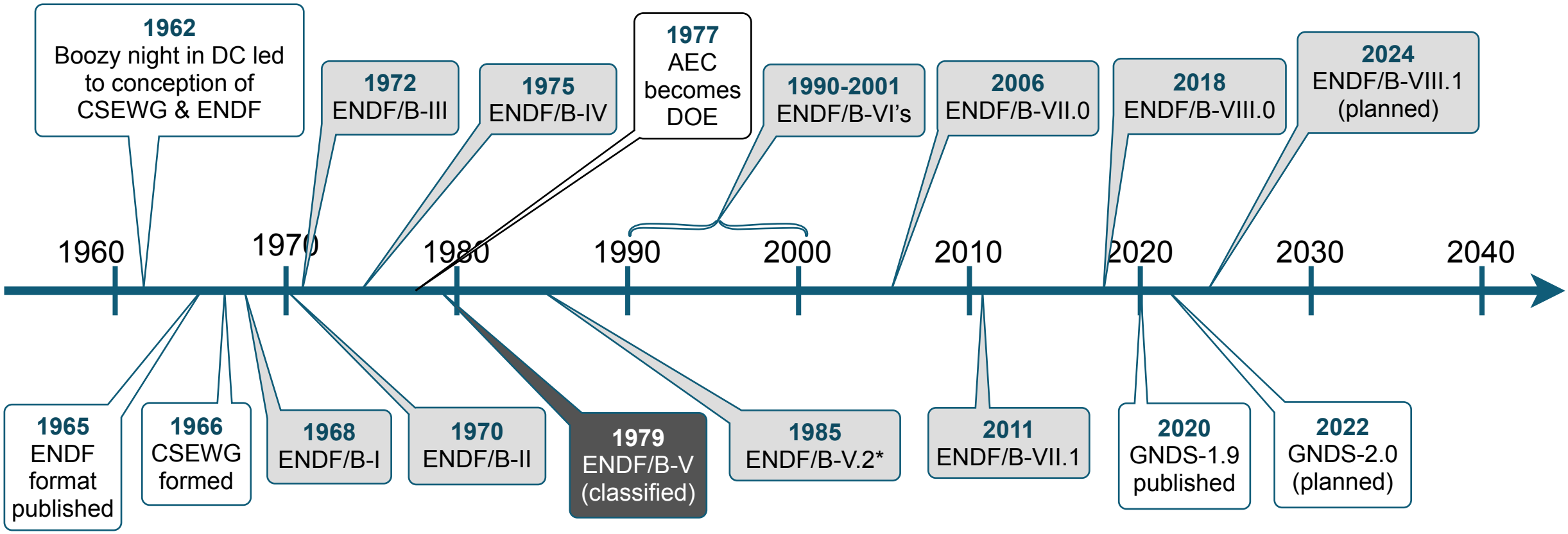
2022 CSEWG Meeting - Validation session
October 31st, 2022

Brookhaven National Laboratory
U.S. DEPARTMENT OF ENERGY
@BrookhavenLab

ENDF Timeline



* everybody's favorite release

Timeline courtesy of Dave Brown

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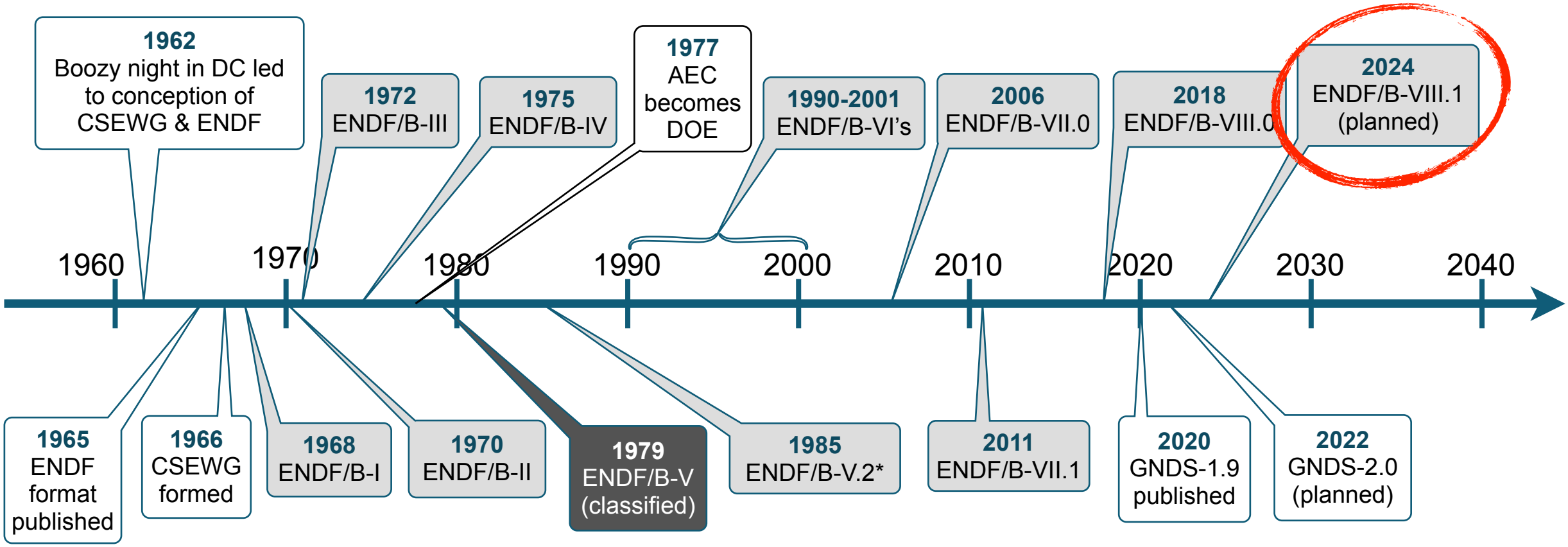

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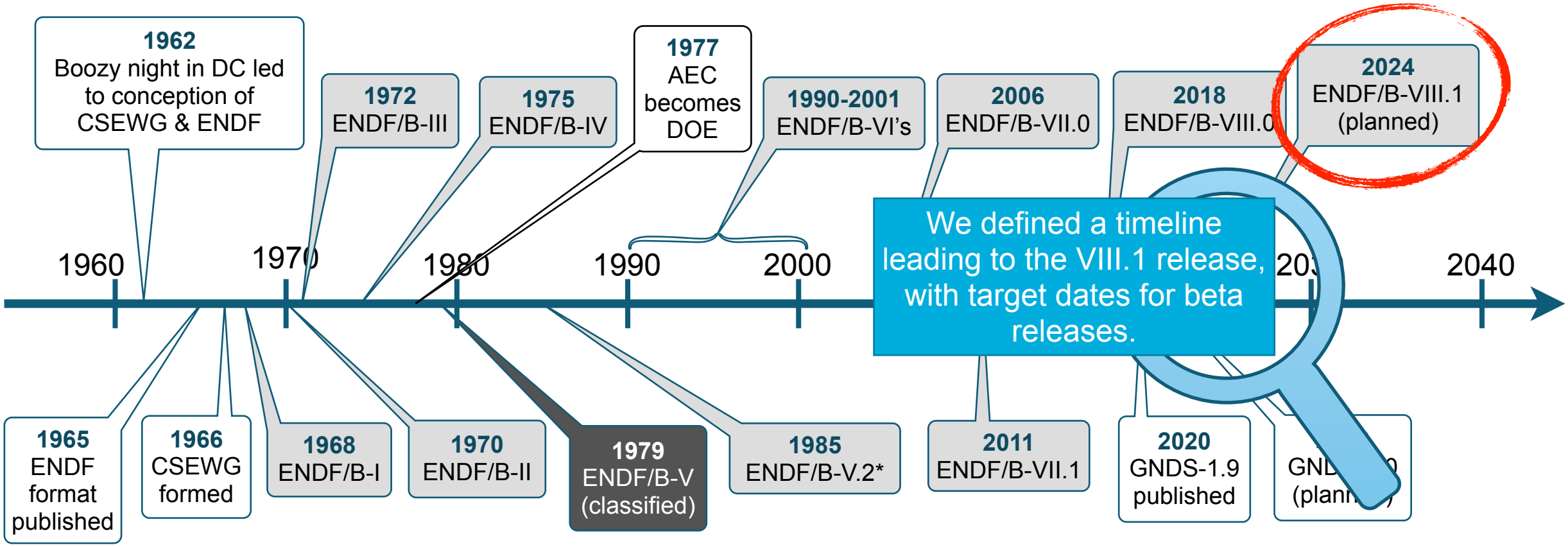

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Release timeline

ENDF/B VIII.1

Jan - Mar 2023
- Collect feedback from the community on the beta version
- Wrap up "lesser impactful" files

Oct 31 - Nov 4 2022
CSEWG
- Validation results of ^{239}Pu and INDEN
- Status of reviews (what's lagging?)

Sep 2022
- Distribute "β_0" (VIII.0+INDEN) for testing

June 2023
- Release second beta
- First complete draft of Big Paper

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- FPY files w/ covariances tested

2022 2023 2024

Aug-Oct 2022
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Still need to squeeze in a mini-CSEWG and another Hackathon…

ENDF/B-VIII.1 Beta0 released (Plural!)

ENDF/B VIII.1

- Needed a Beta version for preliminary validation ahead of 2022 CSEWG
- No time yet for full review: Focused on neutron sub library and materials from INDEN collaboration (some degree of internal review)
- Indicate what should be the general trend of the VIII.1 release
- 3 “sub-releases”: Different ^{239}Pu candidates
- Planned Beta1: December 2022
  - Single Pu file
  - Fully reviewed files
  - All sub libraries
  - Substantial testing
    - CSEWG
    - Internal validation
- Beta2: tested against crits, LPS, by LANL and LLNL users, to ensure performance is as expected.

Changes* in VIII.1 Beta0 from VIII.0:

- ^{28,29,30}Si
- ^{50,52,53,54}Cr
- ^{54,56,57}Fe
- ^{63,65}Cu
- ^{233,235,238}U
- ^{239}Pu
  - Beta0a: INDEN
  - Beta0b: LANL
  - Beta0c: LLNL

Small fixes in Beta0.1:

- Release readme and change log
- ^{239}Pu MF1/MT458
  - Beta0a.1: INDEN
  - Beta0b.1: LANL

Changes* in VIII.1 Beta0.2 from VIII.0:

= Changed from Beta0.1

- ^{19}F
- ^{28,29,30}Si
- ^{50,52,53,54}Cr
- ^{54,56,57}Fe
- ^{63,65}Cu
- ^{233,235,238}U
- ^{239}Pu
  - Beta0a.2: INDEN
  - Beta0b.2: LANL (10/17)
  - Beta0c.2: LLNL

**There were additional changes done shortly after the VIII.0 release, but before the whole evaluated file repository was migrated to GitLab, which are now part of ENDF/B-VIII.1Beta0:*

- ^{10}B: ENDF/B-VIII.0 errata
- ^{156,158,160,161,162,163,164}Dy: Set of ORNL evaluations
- ^{192}Pt: Tweaked energy of first resonance
- ^{240}Pu: Fix of unitarity issue by LANL

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Review status - neutron sub library

Actinides

- ^{239}Pu
  - On-going collaborative process
  - Multiple evaluations are converging
  - Multiple helpful and enlightened discussions have been occurring
  - CSEWG Executive Committee should decide the best course of action towards Beta1
  - Recommended evaluation in Beta1 should be better than when process started
  - Evaluators are encouraged to keep on working on their files even after release
- $^{235,238}U$: waiting for reviewer assignment
- ^{233}U: new INDEN file is expected soon

Main updates for VIII.1 - neutron sub library

INDEN

- ^{235}U
- ^{239}Pu
- ^{238}U
- ^{233}U
- $^{54,56,57}Fe$
- $^{28,29,30}Si$
- ^{55}Mn
- $^{50,52,53,54}Cr$
- $^{63,65}Cu$
- $^{16,18}O$ - not ready for submission
- $^{10,11}B$ - not ready for submission
- ^{139}La

■ = Submitted
■ = Under review
■ = Not submitted yet
■ = Approved

Non-INDEN

- $^{140,142}Ce$ (ORNL)
- ^{103}Rh (RPI/IRSN)
- ^{86}Kr (BNL)
- ^{6}Li (LANL)
- $^{106,108,110,111,112,114,116}Cd$ (LANL)
- ^{6}Li, ^{234}U (LANL)
- ^{181}Ta (RPI/ORNL/ LANL)
- Fission products (RQW+BNL): ^{78}Se, ^{84}Kr, ^{85}Rb, ^{97}Mo, ^{99}Tc, ^{102}Pd, ^{109}Ag, $^{113,115}In$, $^{115,119}Sn$, ^{127}I, $^{122,124}Te$, $^{133,134}Cs$, $^{130,134,137}Ba$, ^{138}La, ^{143}Pr, ^{147}Pm, $^{148,150}Nd$, ^{153}Sm, ^{155}Eu, ^{160}Gd, ^{159}Tb, $^{166,168,170}Er$, $^{175,176}Lu$, $^{168,176}Yb$, $^{174,176,177,178,179,180}Hf$
- Other small fixes

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Main updates for VIII.1 - TSL sublibrary

- tsl_20pGraphite, tsl-AlinAl2O3, tsl-Be-metal, tsl-Be-metal+Sd, tsl-BeinFLiBe.endf, tsl-CainCaH2.endf, tsl-CinSiC, tsl-CinUC, tsl-FinFLiBe, tsl-graphiteSd, tsl-H1inCaH2, tsl-H2inCaH2, tsl-HinCH2, tsl-HinHF, tsl-LiinFLiBe, tsl-OinAl2O3, tsl-SiinSiC, tsl-UinUC (NCSU)
- tsl-7Liin7LiD-mixed, tsl-BeinBe2C, tsl-CinBe2C, tsl-Din7LiD-mixed, tsl-Hin7LiH-mixed, tsl-HinZrH2, tsl-HinZrHx, tsl-ZrinZrH2, tsl-ZrinZrHx (NNL)
- tsl-CainCaH2, tsl-HinCaH2 (from JEFF, conflict with NCSU), tsl-HinIceIh (JEFF, conflict with RPI), tsl-HinMesitylene-PhaseII, tsl-HinToluene, tsl-Mg, tsl-Si (JEFF non-conflictive)
- tsl-CinC5O2H8, tsl-CinCH2, tsl-HinC5O2H8, tsl-HinCH2, tsl-HinIceIh, tsl-OinC5O2H8, tsl-OinIceIh (RPI)
- tsl-CinCH2, tsl-HinCH2, tsl-HinH2O (ESS)
- tsl-HinUH3, tsl-NinUN, tsl-UinUN (ANL)

Main updates for VIII.1 - TSL sublibrary

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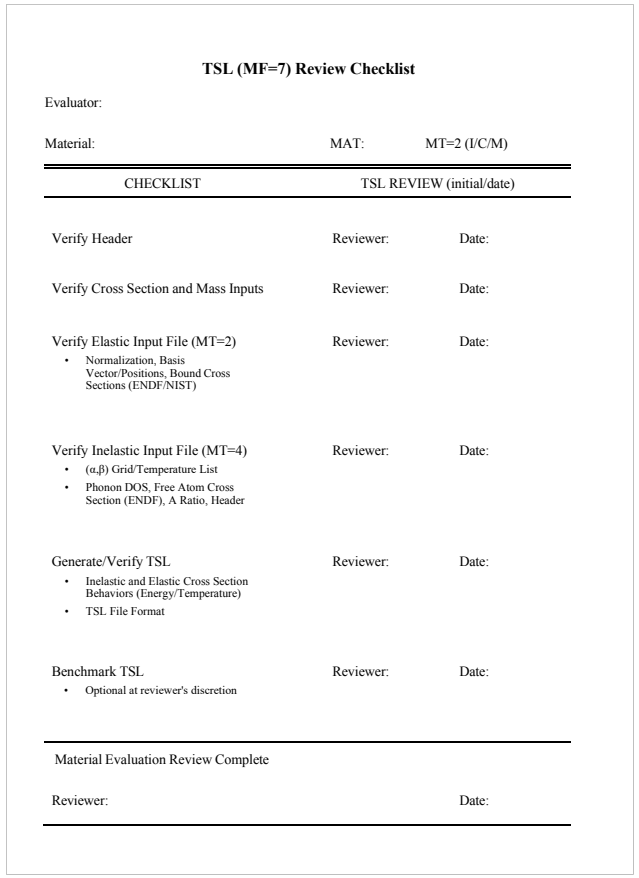
- tsl-7Liin7LiD-mixed, tsl-Bein CinBe2C, tsl-Din7LiD-mixed, tsl-Hin7LiH-mixed, tsl-HinZrH2, tsl-HinZrHx, tsl-ZrinZrH2, tsl-ZrinZrHx (NNL)

- On track to double the TSL evaluations in ENDF/B!
- Implemented format changes to accommodate the increased number of materials.
- Review process being set-up, coordinated by TSL eval. chair

- tsl-CainCaH2, tsl-HinCaH2 (from JEFF, conflict with NCSU), tsl-HinIceIh (JEFF, tsl-HinMesitylene-PhaseII, Mg, tsl-Si (JEFF non-
- -CinCH2, tsl-HinC5O2H8, IceIh, tsl-OinC5O2H8, tsl-
- tsl-CinCH2, tsl-HinCH2, tsl-HinH2O (ESS)
- tsl-HinUH3, tsl-NinUN, tsl-UinUN (ANL)

Leveraging the experience with NCSU internal review approach

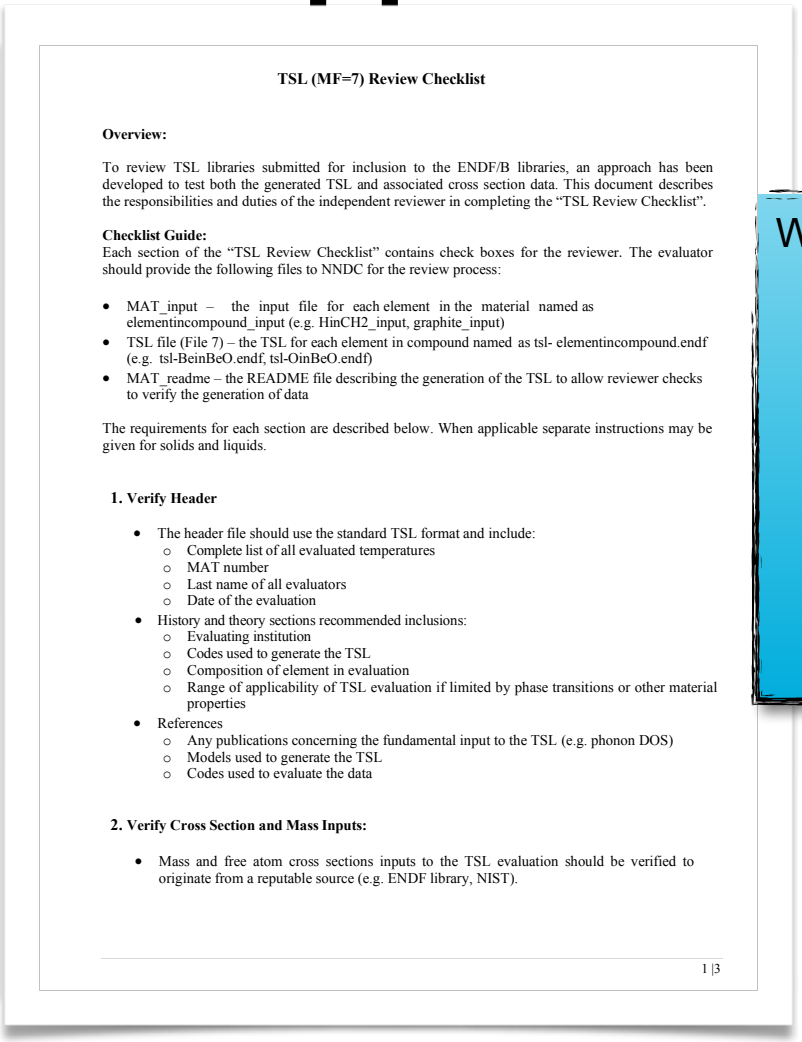


TSL (MF=7) Review Checklist

Evaluator:

Material: MAT: MT=2 (I/C/M)

CHECKLIST	TSL REVIEW (initial/date)	
Verify Header	Reviewer:	Date:
Verify Cross Section and Mass Inputs	Reviewer:	Date:
Verify Elastic Input File (MT=2) • Normalization, Basis Vector/Positions, Bound Cross Sections (ENDF/NIST)	Reviewer:	Date:
Verify Inelastic Input File (MT=4) • (α,β) Grid/Temperature List • Phonon DOS, Free Atom Cross Section (ENDF), A Ratio, Header	Reviewer:	Date:
Generate/Verify TSL • Inelastic and Elastic Cross Section Behaviors (Energy/Temperature) • TSL File Format	Reviewer:	Date:
Benchmark TSL • Optional at reviewer's discretion	Reviewer:	Date:
Material Evaluation Review Complete		
Reviewer:		Date:



TSL (MF=7) Review Checklist

Overview:

To review TSL libraries submitted for inclusion to the ENDF/B libraries, an approach has been developed to test both the generated TSL and associated cross section data. This document describes the responsibilities and duties of the independent reviewer in completing the "TSL Review Checklist".

Checklist Guide:
Each section of the "TSL Review Checklist" contains check boxes for the reviewer. The evaluator should provide the following files to NNDC for the review process:

- MAT_input – the input file for each element in the material named as elementincompound_input (e.g. HinCH2_input, graphite_input)
- TSL file (File 7) – the TSL for each element in compound named as tsl- elementincompound.endf (e.g. tsl-BeinBeO.endf, tsl-OinBeO.endf)
- MAT_readme – the README file describing the generation of the TSL to allow reviewer checks to verify the generation of data

The requirements for each section are described below. When applicable separate instructions may be given for solids and liquids.

1. Verify Header

- The header file should use the standard TSL format and include:
  - Complete list of all evaluated temperatures
  - MAT number
  - Last name of all evaluators
  - Date of the evaluation
- History and theory sections recommended inclusions:
  - Evaluating institution
  - Codes used to generate the TSL
  - Composition of element in evaluation
  - Range of applicability of TSL evaluation if limited by phase transitions or other material properties
- References
  - Any publications concerning the fundamental input to the TSL (e.g. phonon DOS)
  - Models used to generate the TSL
  - Codes used to evaluate the data

2. Verify Cross Section and Mass Inputs:

- Mass and free atom cross sections inputs to the TSL evaluation should be verified to originate from a reputable source (e.g. ENDF library, NIST).

1 |3

When contacted about the review panel, Ayman Hawari stated:

"Yes we're discussing a TSL review panel but haven't finalized membership yet. However, the panel will aim to avoid any COI situations and will be inclusive.

If you have suggestions or questions please feel free to let me know."

Main updates for VIII.1 - Alphas, deuterons & Decay

Alpha sub library

- ^{9}Be, ^{17}O, ^{18}O
- Files existed before but many reactions are being described for the first time

Deuteron sub library

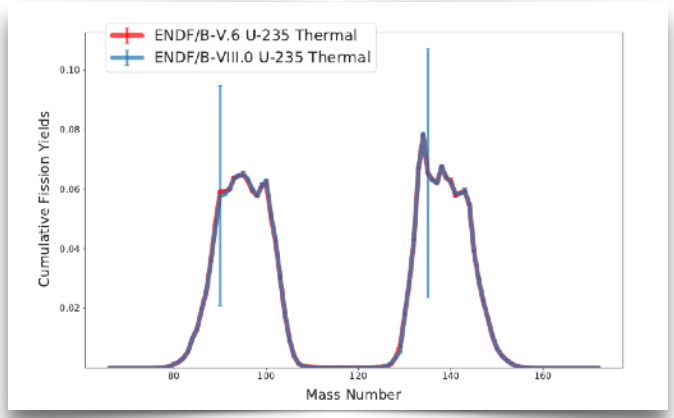
- ^{3}He, ^{6}Li
- Files have just been submitted last week by M. Paris

Decay sub library

- 520 submissions: updated half-lives and neutrino spectra
- 30 reviewed and approved already and 22 more are underway
- Andrea Mattera and Paul Romano have reviewed and found many typos and issues in documentation
- Decay files are in the process of being updated, so review has stalled while this is completed.

Fission Yields and Photo-nuclear sub libraries

A. Mattera & A. Sonzogni noticed some cumulative yields had **huge** unphysical uncertainty (coming from wrong error propagation) and recalculated them and updated the values: **BNL-220804-2021-INRE**



Spontaneous Fission Yields

- sfy-092_U_238.endf
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- sfy-096_Cm_246.endf
- sfy-096_Cm_248.endf
- sfy-098_Cf_250.endf
- sfy-098_Cf_252.endf
- sfy-099_Es_253.endf
- sfy-100_Fm_254.endf
- sfy-100_Fm_256.endf

n-induced Fission Yields

- nfy-090_Th_227.endf
- nfy-090_Th_229.endf
- nfy-090_Th_232.endf
- nfy-091_Pa_231.endf
- nfy-092_U_232.endf
- nfy-092_U_233.endf
- nfy-092_U_234.endf
- nfy-092_U_235.endf
- nfy-092_U_236.endf
- nfy-092_U_237.endf
- nfy-092_U_238.endf
- nfy-093_Np_237.endf
- nfy-093_Np_238.endf
- nfy-094_Pu_238.endf
- nfy-094_Pu_239.endf
- nfy-094_Pu_240.endf
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- nfy-095_Am_241.endf
- nfy-095_Am_242m1.endf
- nfy-095_Am_243.endf
- nfy-096_Cm_242.endf
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- nfy-098_Cf_251.endf
- nfy-099_Es_254.endf
- nfy-100_Fm_255.endf

Photo-nuclear

Taken from IAEA CRP

Nuclear Data Sheets 163 (2020) 109-162

Available online at www.sciencedirect.com
ScienceDirect
Nuclear Data Sheets
ELSEVIER
Nuclear Data Sheets 163 (2020) 109–162
www.elsevier.com/locate/nds

IAEA Photonuclear Data Library 2019

T. Kawano,[1,*] Y. S. Cho,[2] P. Dimitriou,[3] D. Filipescu,[4] N. Iwamoto,[5] V. Plujko,[6] X. Tao,[7] H. Utsunomiya,[8] V. Varlamov,[9] R. Xu,[7] R. Capote,[3] I. Gheorghe,[4] O. Gorbachenko,[6] Y.L. Jin,[7] T. Renstrøm,[10] M. Sin,[11] K. Stopani,[9] Y. Tian,[7] G.M. Tveten,[10] J.M. Wang,[7] T. Belgya,[12] R. Firestone,[13] S. Goriely,[14] J. Kopecky,[15] M. Krtička,[16] R. Schwengner,[17] S. Siem,[10] and M. Wiedeking[18]

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[6] *Nuclear Physics Department, Taras Shevchenko National University, Kyiv, Ukraine*
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[8] *Department of Physics, Konan University, Okamoto 8-9-1, Higashinada, Kobe 658-8501, Japan*
[9] *Lomonosov Moscow State University, Skobeltsyn Institute of Nuclear Physics, Moscow 119991, Russia*
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[11] *Faculty of Physics, University of Bucharest, Bucharest-Magurele, Romania*
[12] *Centre for Energy Research, Hungarian Academy of Sciences, Konkoly Thege Miklos 29-33, 1525 Budapest, Hungary*
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[15] *JUKO Research, Kalmanstraat 4, Alkmaar 1817, The Netherlands*
[16] *Charles University, V Holešovičkách 2, 18000 Prague, Czech Republic*
[17] *Helmholtz Zentrum Dresden-Rossendorf, Bautzner Landstrasse 400, 01328 Dresden, Germany*
[18] *iThemba LABS, P.O. Box 722, Somerset West, 7129, South Africa*
(Received 16 July 2019; revised received 15 October 2019; accepted 31 October 2019)

We report our coordinated efforts to address these data needs and present the results of the new up-to-date evaluations included in the new updated IAEA Photonuclear Data Library consisting of 219 nuclides. The new library includes 188 new evaluations produced by the CRP evaluators, and one evaluation taken from the JENDL/PD-2016 library, while 20 evaluations were retained from the previous 1999 IAEA Photonuclear Data Library. In most of the cases, the photon energy goes up to 200 MeV. A total of 55 nuclides are new in this library reflecting the progress in measurements but also the developing data needs. In this paper we discuss the new assessment method and make recommendations to the user community in cases where the experimental data are discrepant

Fission Yields and Photo-nuclear sub libraries

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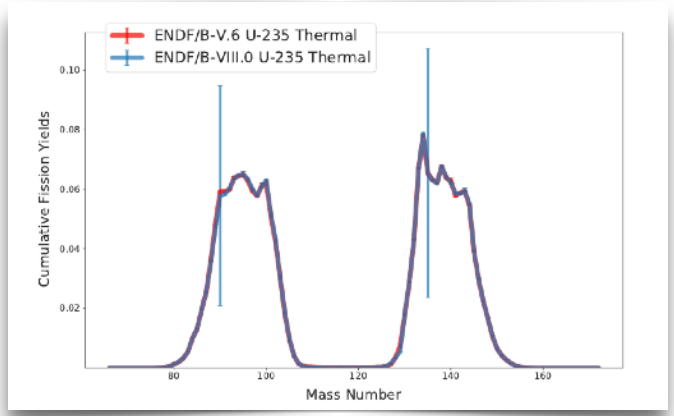

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Photo-nuclear

Taken from IAEA CRP

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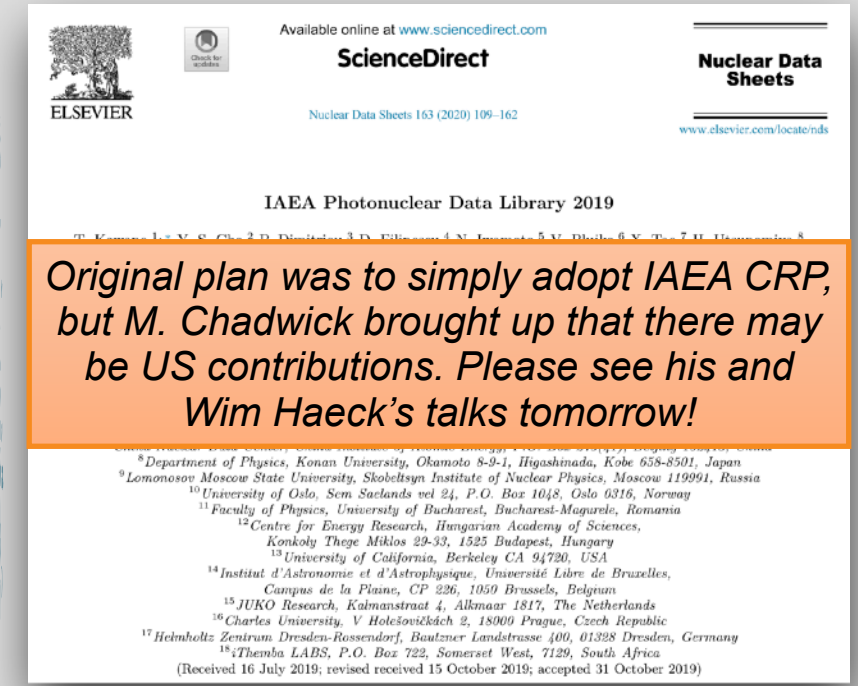
Available online at www.sciencedirect.com
ScienceDirect
Nuclear Data Sheets
Nuclear Data Sheets 163 (2020) 109–162
www.elsevier.com/locate/nds
ELSEVIER

IAEA Photonuclear Data Library 2019

Original plan was to simply adopt IAEA CRP, but M. Chadwick brought up that there may be US contributions. Please see his and Wim Haeck's talks tomorrow!

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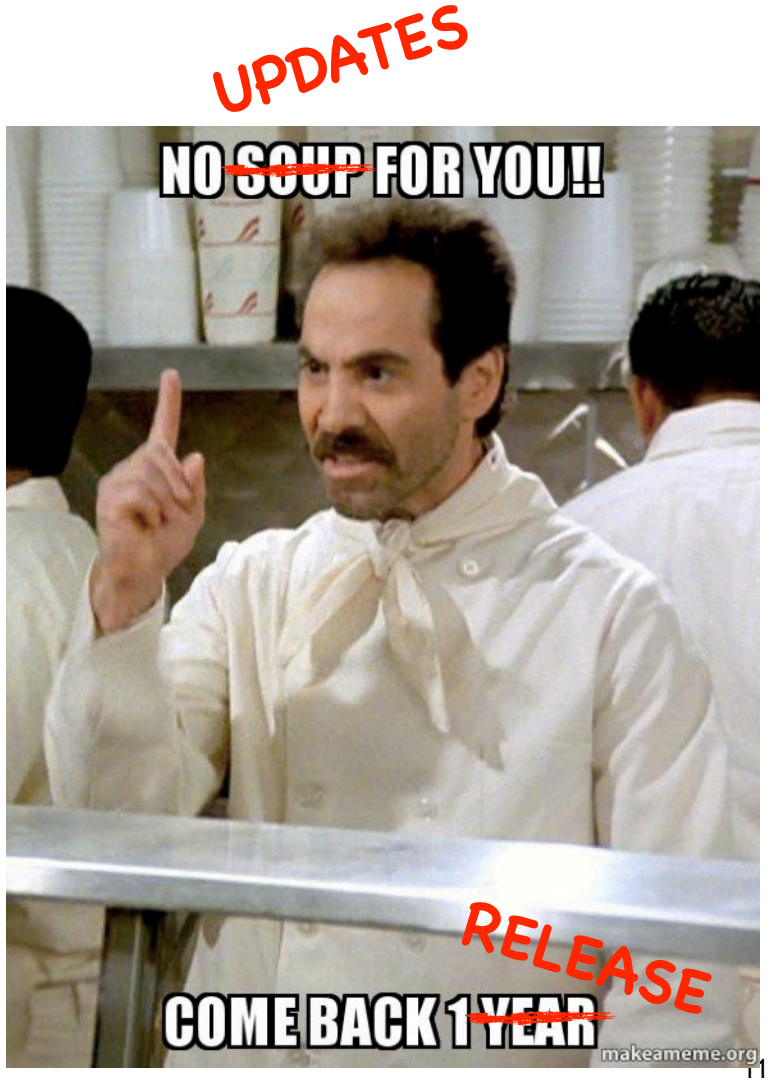
We report our coordinated efforts to address these data needs and present the results of the new up-to-date evaluations included in the new updated IAEA Photonuclear Data Library consisting of 219 nuclides. The new library includes 188 new evaluations produced by the CRP evaluators, and one evaluation taken from the JENDL/PD-2016 library, while 20 evaluations were retained from the previous 1999 IAEA Photonuclear Data Library. In most of the cases, the photon energy goes up to 200 MeV. A total of 55 nuclides are new in this library reflecting the progress in measurements but also the developing data needs. In this paper we discuss the new assessment method and make recommendations to the user community in cases where the experimental data are discrepant

No significant updates expected from…

- Atomic relaxation
- Electrons
- Gammas
- Helium-3
- Photo-atomic
- Protons
- Tritons
- Standards



Pardon my recruiting…

- We need volunteer reviewers!
- Specially for the decay, fission, and **neutron**
- The number of reviewers has been the main bottleneck
- To have a major portion of submitted evaluations included in Beta1, we have to move fast

… to be a volunteer reviewer!

Backup

Change logs

Change log

ENDF/B-VIII.1 Beta Release Change Log

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ENDF/B-VIII.1-Beta0.2 (October 26, 2022)

There are important updates in the ENDF/B-VIII.1-Beta0.2 release, namely:

- 19F: adopted INDEN evaluation, labeled as f19j4HE_zc - Inelastic replaced by Morgan data below 1.4 MeV, F-19(n,2n) from IRDFF-II, rest from JENDL/HE
- 56Fe: Updated INDEN evaluation to version fe56e80X29r61 - CIELO RR evaluation, including Perey RRR angular distributions below 850keV, was restored for Fe-56. ENDF/B-VIII.0 1/v background reduced more than 50% to reproduce hmi006 (ZPR-9/34) - the iron benchmark. Kinney fit changed to tune11. The added (smaller) background is in excellent agreement with the direct capture cross section estimated by Japanese colleagues and included into the JENDL-5 evaluation.
- 239Pu:
    - Beta0a.2: Remains unchanged relative to Beta0a.1.
    - Beta0b.2: Update of LANL 239Pu file corresponding to LANL "10/17" sent by M. Mumpower on October 24, 2022. This aims to address issues raised in the Summer review and include preliminary covariances.
    - Beta0c.2: Updated LLNL 239Pu file labeled "yi01za094239.endl2022-ex5+0.17pc.endf", submitted by Ian Thompson on October 17, 2022. His description is "We sent from LLNL a final version of our submission, called ‘ex5’, [...]. This replaces MT=875 (MF=3 and 6) with MF=16 name. "

Change log

ENDF/B-VIII.1-Beta0.1 (October 14, 2022)

Beta0.1 brings only small corrections to its three "sub-releases" Beta0a.1, Beta0b.1, Beta0c.1:

- Updated release readme files in Beta0a.1, Beta0b.1, and Beta0c.1 to account for the fact that in Beta0 there were more files changed from VIII.0 that had been previously acknowleged in the readme files, namely 10B, 156,158,160,161,162,163,164Dy, 192Pt, 240Pu. Those changes to the library were done quite some time ago, shortly after the VIII.0 release, but before the whole evaluated file repository was migrated to GitLab, hence the delay in acknowledging such changes in the Beta0 readme files. An *addendum* was added below in the description of Beta0, listing such changes in more detail.

- Minor updates to 239Pu for Beta0a.1 (INDEN) and Beta0b.1 (LANL) in the MF1/MT458 section.

    - Beta0a.1: As observed by Nathan Gibson (LANL), the INDEN file (Beta0a) was missing MF1/MT458. Roberto Capote (IAEA, INDEN) confirmed that is was an accident as the intention was to have VIII.0's MF1/MT458. R. Capote accepted N. Gibson's fix. N. Gibson states: "The included section is E8.0 with an extra point at 30 MeV, held constant from the 20 MeV point. This fix was actually done by Mark Cornock from AWE during the last round of reviews, but it agrees with some separate work we were doing locally. And it processes through HEATR in NJOY successfully!"
    - Beta0b.1: Added an extra dummy point at 30 MeV for MF1/MT458. The LANL file (Beta0b) retained the ENDF/B-VIII.0 MF1/MT458 section. However, because the rest of the file was extended to 30 MeV but this section had been left at 20 MeV, Beta0_b was crashing in HEATR. This correction, by Nathan Gibson (LANL), fixes this issue.
    - Beta0c.1: 239Pu remains unchanged from Beta0c.

Change log

ENDF/B-VIII.1-Beta0 (October 5, 2022)

For the ENDF/B-VIII.1-Beta0 release, three versions were prepared, namely Beta0_a, Beta0_b, and Beta0_c, each with a different 239Pu file. The intent of this multiple "Beta0" release for ENDF/B-VIII.1, containing only files for the neutron sub library, is to allow for preliminary testing ahead of the 2022 CSEWG Meeting.

Links to Beta0 tags:

- Beta0_a: https://git.nndc.bnl.gov/endf/library/neutrons/-/tags/version.VIII.1-Beta_0_a
- Beta0_b: https://git.nndc.bnl.gov/endf/library/neutrons/-/tags/version.VIII.1-Beta_0_b
- Beta0_c: https://git.nndc.bnl.gov/endf/library/neutrons/-/tags/version.VIII.1-Beta_0_c

The different versions of 239Pu are as follows:

- Beta0_a: 239Pu taken from INDEN - pu239p57
- Beta0_b: 239Pu taken from LANL - lanl_05l25l2022_n_94-Pu-239.endf
- Beta0_c: 239Pu taken from LLNL - yi01za094239.endl2022-ex4+0.17pc

Change log

Additional changes from VIII.0 are:

- 28,29,30Si taken from INDEN: ORNL/LTR-2018/1044 (M. Pigni et al., 2018)
- 50,53,54Cr taken from INDEN: v2.3.2, NDS 173, 1-41 (2021)
- 52Cr taken from INDEN: v2.3.4 (cr52v234c), NDS 173, 1-41 (2021) + RRR changes
- 54Fe taken from INDEN: fe54e80p
- 56Fe taken from INDEN: fe56e80X29r50
- 57Fe taken from INDEN: fe57e80o
- 63Cu taken from INDEN: cu63ane6k09aRR
- 65Cu taken from INDEN: cu65ane5k05
- 233U taken from INDEN: u233ornl_2b_nu12
- 235U taken from INDEN: u235ib46o28t6DNcnu5ef0ST25d
- 238U taken from INDEN (with Q-value fix): u238e80u8V02b + GitLab commit `ff23a85b`

Change log

Addendum:

The following files in VIII.1-Beta0 are also changed from ENDF/B-VIII.0. Those changes to the library were done quite some time ago, shortly after the VIII.0 release, but before the whole evaluated file repository was migrated to GitLab, hence the delay in acknowledging such changes in the Beta0 readme files.

- 10B: Errata submitted after VIII.0 release fixing issues with double-counting.
- 156,158,160,161,162,163,164Dy: Set of ORNL evaluations by M. Pigni et al., submitted on Oct. 2018. Report detailing changes is in preparation.
- 192Pt: Tweaked energy of first resonance from 34.80291 keV to 34.79356 keV.
- 240Pu: Fix by T. Kawano (LANL) on May 2018 reconstructing total cross section to address the issue that MF/MT=3/1 was smaller than the elastic scattering in the URR.