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2009.1 Revision of the Evaluated Nuclear Data Library (ENDL2009.1)

I. J. Thompson, B. Beck, M. A. Descalles, C. Mattoon, N. C. Summers

May 18, 2015

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2009.1 Revision of the Evaluated Nuclear Data Library (ENDL2009.1)

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(Dated: May 18, 2015)

LLNL's Computational Nuclear Data and Theory Group have created a 2009.1 revised release of the Evaluated Nuclear Data Library (ENDL2009.1). This library is designed to support LLNL's current and future nuclear data needs and will be employed in nuclear reactor, nuclear security and stockpile stewardship simulations with ASC codes. The ENDL2009 database was the most complete nuclear database for Monte Carlo and deterministic transport of neutrons and charged particles. It was assembled with strong support from the ASC PEM and Attribution programs, leveraged with support from Campaign 4 and the DOE/Office of Science's US Nuclear Data Program.

This document lists the revisions and fixes made in a new release called ENDL2009.1, by comparing with the existing data in the original release which is now called ENDL2009.0. These changes are made in conjunction with the revisions for ENDL2011.1, so that both the .1 releases are as free as possible of known defects.

Contents

I. INTRODUCTION

LLNL's Computational Nuclear Physics Group and Nuclear Theory and Modeling Group have collaborated to produce a next iteration of LLNL's evaluated nuclear database ENDL2009. ENDL2009 was the second in a series of major ENDL library releases designed to support LLNL's current and future nuclear data needs. This library contains many evaluations for radiochemical diagnostics (part of a Campaign 4 L2 milestone), structural materials (part of an ASC Attribution L2 milestone), and thermonuclear reactions (to support NIF diagnostics). In addition, ENDL2009 was at the leading edge of nuclear data library development by reviewing and incorporating new evaluations as they are made available to the nuclear data community. In addition, ENDL2009 supported new features such as energy dependent Q values from fission and unresolved resonances. Furthermore, this was the first ENDL library to be released in the TDF format. Finally, this release was our most highly tested release as we strengthened our already rigorous testing regime by adding tests against LANL Activation Ratio Measurements and many more new critical assemblies. That testing has now beed incorporated into our development process and is serving to guide library improvements.

This document lists the revisions and fixes made in a new release called ENDL2009.1, by comparing with the existing data in the original release which is now called ENDL2009.0. We have added tests against activation foil measurements in the FUND-IPPE-FR-MULT-RRR-001 assembly.

The new library can be found on LLNL's Open & Secure Computing facilities. In addition, the data will soon be made available in the Nuclear and Atomic Data System (NADS) data viewer at `http://nuclear.llnl.gov/NADS`.

II. MODIFICATIONS FROM ENDL2009.0

These are listed according to the ND keys used on the JIRA database at `https://lc.llnl.gov/jira/browse/ND/fixforversion/10807`.

1. ND-6: n+^{1}H elastic and capture cross section do not sum to total cross section

At low energies below 10 keV, the sum of capture and elastic n+^{1}H cross sections differed by more than 0.1% from the total cross section given in the evaluation. This problem was found to occur when using `prepro` (SIGMA1) to heat the cross sections to room temperature. When the heating was performed using FUDGE, the sum of the partial cross sections matched the total cross sections. We therefore reimported the ENDF evaluation into `GND` using FUDGE, heated the cross sections to room temperature, and used these cross sections to replaced the `prepro` generated cross sections.

The three yo=I=s=0 files for C=1, 10 and 46 have been updated.

Repository revisions 920, 921, 924, 925.

2. ND-11: t(d,n)α angular distribution has a spike at a single energy and angle

The neutron angular distribution from the t(d,n)α reaction, in file `yi03/za001003/yo01c11i001s000`, had at an incident energy of 0.85 MeV a spike at outgoing angle $\mu = \cos\theta = 0.96111$ that erroneously increased the angular probability distribution by 0.2 at that one angle. We have replaced that angle's value with mean value of points on either side of the spike.

Repository revision 899.

3. ND-15: ascii data in release does not match processed data

In the `endl_official/endl2009.0` directory containing the official relase of ENDL2009.0, it was discovered that the `ascii` data did not match the process data found in the `ndf` and `mcf` files. This was evident in the fact that we were unable to process the `ascii` data without crashing the `ndfgen` and `mcfgen` . During the build process, changes must have occured to the `ascii` data in order to process it, which were not checked into the svn repository, and did not make it into the `endl_official` release directory. Care was taken in this new ENDL2009.1 release to keep the `ascii` data in sync with what was processed and released into the `endl_official` directory.

4. ND-16: EGDL fluorescence data missing

The nuclear fluorescence data from EGDL, which resides in the I=30,32 files for incident gammas, was present in ENDL2008.2 release, but was erroneously not in the ENDL2009.0 release. These data have been included in the ENDL2009.1 release.

Repository revision 817.

5. ND-17: Unresolved Resonance Region (URR) data removed

For this release the URR I=20 data were removed. Due to changes in `NJOY` formatting, these data could not be processed and was therefore removed from the release to keep the `ascii` data in sync with what was processed.

Repository revision 813.

6. ND-18: `endep` changes to gamma C55 files not in released ascii data

When ENDL2008.2 was processed, `endepC++` (the code that calculates the average energy deposition from the distribution data) did not worry about energy balance. When ENDL2009.0 was processed, `endepC++` (via the `-rescale_c5x_cs` option which is true by default) attempted to balance energy by rescaling the C55 data. That is, if there is too much (little) outgoing energy, the C55 gamma multiplicity is effectively lowered (raised). Changes to C55 data were not checked into svn repository and therefore C55 ascii data did not match processed data.

The reason the rescaled C55 data was not checked into the repo, is that the ENDLBUILDER scripts processed the data in a tmp directory, and as part of the build process it ran `endep` . The data were rescaled in the tmp directory, but not in the original ascii directory, and therefore this change was lost. We modified the ENDLBUILDER scripts to run endep manually first on the ascii data (with the rescaling option) and then process the data afterwards, giving the flag to skip the endep stage as it is already done. This way the rescaling happens in the ascii directory and the changes can be saved.

Repository revision 822.

7. ND-19: separate ^{241}Am(n,γ) cross section to ground and isomer state in ^{242}Am

In translating n+^{241}Am evaluation from ENDF/B-VII.0, the (n,γ) C=46 cross section was given as the sum of the cross sections to the ground and isomer states in ^{242}Am. In ENDF the branching ratios to the ground and isomer states were given elsewhere (MT8), but they are not translated by fete.

ENDL format has support for cross sections to final isomer states, so a fix was applied by hand to put in two levels in C=46 file, corresponding to ground and isomer final states of ^{242}Am respectively. The sum of these two cross sections from ENDL2009.0 was divided according to the branching ratios from ENDF/B-VII.0. The spectra and multiplicities, also from ENDF/B-VII.0, were assumed to be the same for both levels.

Repository revisions 859, 967.

8. ND-20: separate ^{45}Sc(n,γ) cross section to ground and isomer state in ^{46}Sc

In translating n+^{45}Sc evaluation from ENDF/B-VII.0, the (n,γ) C=46 cross section was given as the sum of the cross sections to the ground and isomer states in ^{46}Sc. In ENDF the branching ratios to the ground and isomer states were given elsewhere (MT8), but they are not translated by fete.

ENDL format has support for cross sections to final isomer states, so a fix was applied by hand to put in two levels in C=46 file, corresponding to ground and isomer final states of ^{46}Sc respectively. The sum of these two cross sections from ENDL2009.0 was divided according to the branching ratios from JEFF 3.1. The spectra and multiplicities, also from JEFF 3.1, were assumed the same for both levels.

Repository revisions 824, 860, 967.

9. ND-21: move all C=21 files to C=20 when C=20 does not exist

ENDL has both C=20 and C=21, to describe the (n,np) and (n,pn) channels respectively, but ENDF only has the sum of both of these channels. Most Hauser-Feshbach codes only calculate the sum. When we have the sum of both channels, sometimes this has been put in C=20 and sometimes in C=21. We now decide to put the sum in C=20 for uniformity across our databases.

Repository revision 827.

10. ND-25: Maxwellian averaged cross section I=80,81,84,89,90,91,92 for charged particle libraries

These files have been removed from the library as they are redundant.

11. ND-48: gamma multiplicity (I=9) file is very different from ENDF file

The ENDL files for gamma multiplicities (I=9 files) are very different from the ENDF files that fete translated them from. (This is an appearance of the bug ND-33 seen in ENDL2011.0). The ENDL files were generated using fete revision 2393 (from documentation.txt) When we rerun the translation using revision 2310, the ENDL data match the ENDF data, so we do not trust any revision of fete beyond this number. There are in fact 21 different fete revisions used in the translation of ENDL2009.1 (out of 460 translations), and 125 out of the 460 translations are from fete revisions > 2310.

For ENDL2009.1, we re-translated ENDF files using fete r2310, to replace all yo=7 I=4,9 s=0 files with these re-translated files. This affected za027057, za027058, za033075, za068164, za068168, za075189. There may be others, but these were causing crashes with mcfgen processing.

12. ND-51: missing particle angular distributions in ^{19}F

The evaluation for the ^{19}F target from ENDF/B-VII had (n,d) and (n,t) reactions which do not have I=4 exit energy distributions. The I=4 data from ENDL99 was used for these data.

Repository revision 1009.

13. ND-52: n+^{67}Ni evaluation ends short of 20 MeV

The nuclide ^{67}Ni has evaluations which end at 12.8 MeV: short of 20 MeV. The c01 and c10 were extended to 20 MeV with TENDL2009 data.

Repository revision 999.

14. ND-54: States presumed to be isomers with no decay γ angular distributions

The 27 nuclides listed in this section have reactions which produce together a combined total of 50 discrete excited states (s=1) at the given energies (in MeV) which do not have double-differential distributions from their γ decays.

The following reactions are to isomeric final states *confirmed* from NNDC:
^{99}Tc(n$\rightarrow$n$'$ at 0.142683, τ at 0.74335),
^{103}Rh(n$\rightarrow$n$'$ at 0.039756),
^{169}Tm(n$\rightarrow$t at 0.2078, α at 0.0059),
^{171}Tm(n$\rightarrow\alpha$ at 0.059),
^{169}Yb(n$\rightarrow$n$'$ at 0.024199, τ at 0.2078),
^{170}Yb(n$\rightarrow\alpha$ at 0.2078),
^{176}Yb(n$\rightarrow$n$'$ at 1.05),
^{110}Pd(n$\rightarrow\alpha$ at 0.56145 and 0.6982),
^{184}Os(n$\rightarrow$p at 0.18801),
^{186}Os(n$\rightarrow$p at 0.149, t at 0.18801, α at 0.3095),
^{188}Os(n$\rightarrow$p at 0.17207, t at 0.149, α at 0.19743),
^{189}Os(n$\rightarrow$n$'$ at 0.030812),
^{190}Os(n$\rightarrow$p at 0.21),
^{191}Os(n$\rightarrow$n$'$ at 0.074382, d at 0.21),
^{192}Os(n$\rightarrow$t at 0.21),
^{190}Pt(n$\rightarrow$p at 0.0261),
^{192}Pt(n$\rightarrow$p at 0.05672, d at 0.17124, t at 0.0261, α at 0.03081),
^{194}Pt(n$\rightarrow$d at 0.08024, α at 0.07438),
^{195}Pt(n$\rightarrow$n$'$ at 0.2593, p at 0.1, t at 0.08024),
^{196}Pt(n$\rightarrow$p at 0.41, d at 0.1),
^{198}Pt(n$\rightarrow$d at 0.115, t at 0.41),
^{199}Hg(n$\rightarrow$n$'$ at 0.5325),
^{209}Bi(n$\rightarrow\tau$ at 1.3481),
^{236}Np(n$\rightarrow$n$'$ at 0.06),
^{248}Bk(n$\rightarrow$n$'$ at 0.05).

The following reaction is to a state not confirmed as an isomer: ^{187}Os(n$\rightarrow$d)^{186}Re at 0.17393 MeV.
This is above the known isomer state at 0.149 MeV.
In this list, d=^{2}H, t=^{3}H, τ=^{3}He and α=^{4}He.

No repository changes yet (see Appendix A.2) for any of these reactions.

15. ND-56: Too much energy deposition in the d+t reaction to the ^{5}He excited state

The reaction d + t $\rightarrow \gamma$ + ^{5}He* $\rightarrow \gamma$ + n + ^{4}He was seen to give excessive energy deposition in an `endep` calculation. This was remedied by changing the excitation energy X1 from 0 to 19.815 MeV in the C=20 s=1 inelastic files.

Repository revision 980, 983.

16. ND-59: too much energy in breakup distributions for d $\rightarrow$ n+p breakup on protons and α-particles

The I=4 files describing the d $\rightarrow$ n+p breakup were giving too much energy deposition, for both proton and α-particle targets. This error resulted from an erroneous translation of the previous data in ECPL for the inverse reactions of protons and α-particles on deuterons: the incident energies were scaled as if the breakup distributions depended only on the incident energy in the c.m. frame. However, the I=4 files describe data in the laboratory frame, so they should *not* have been changed.

Note that all the described double-differential cross sections are purely the simplest phase-space distributions, and await an actual model calculation of breakup.

Repository revisions 985, 987.

III. OUTLOOK

This new library can be found on LLNL's Open and Secure Computing facilities in file directory `/collab/usr/gapps/data/nuclear/endl_-official/endl2009.1`. In addition, the data may soon be viewed in the Nuclear and Atomic Data System data viewer at `http://nuclear.llnl.gov/NADS`.

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Appendix A: Known Issues

1. ND-47: the ^{7}Be evaluation ends at 8.1 MeV

Our evaluation is from ENDF/B-VII (December 2006). Issue of a low energy limit is being addressed at CSEWG by LANL. See `https://ndclx4.bnl.gov/gf/project/endf/tracker/?action=TrackerItemEdit&tracker_item_id=196&start=0`. We will update our evaluation with LANL's fixes when they become available.

2. ND-54: `endep` should not generate files for decays of isomer states

The isomer states in 27 nuclides listed in section 14 above for ND-54 should *not* have extra files generated by `endep` for their decay. Those stubs presently give fudge-check warnings of missing I=1 and I=9 files.

3. ND-64: `endep` incorrectly processes discrete gamma decays from n+^{11}B

For many of the discrete states produced in n+^{11}B reactions, there are no yo07 files for gamma distributions, but instead the gamma lines are included in a c=55 s=3 file.

Therefore endep should stop producing stubs of yo07 files for these decays. Those stubs presently give fudge-check warnings of missing I=1 and I=9 files.

This requires endep to be fixed to implement properly the input control `make_inelastic_endep_if_gamma_-data_missing`.

4. ND-66 Erroneous cross section for ^{7}Li(t,n)^{9}Be(gs) reaction

For the reaction ^{7}Li(t,n)^{9}Be, the data on ENDL says it comes from the paper Brune et al PRC 43 (1991)875. The cross section should be taken from Fig. 7 in the paper, however, it appears that the cross section in ENDL is from Fig. 9 or similar source, and is too large. Most of the extra cross sections should probably be moved to the ^{7}Li(t,n)[$^{9}\mathrm{Be}^{*} \rightarrow \mathrm{n}, 2\alpha$] channel.

This error dates back at least to ENDL94.

Appendix B: Detailed Test Results

1. Criticality tests

Criticality tests by deterministic (AMTRAN) and Monte Carlo (MERCURY) codes were performed. The new revision ENDL2009.1 was compared with both the previous ENDL2009.0.1 evaluation, and with measurements from critical assemblies.

Table I compares the measured values of k_{eff} criticality coefficients with those calculated from ENDL2009.1 by Monte Carlo calculations, and in the last column gives the ratios of ENDL2009.1 to ENDL2009.0.1 values. Table II compares the measured values of k_{eff} criticality coefficients with those calculated from ENDL2009.1 by deterministic calculations, and in the last column gives the ratios of ENDL2009.1 to ENDL2009.0.1 values.

Figures 1 and 2 plot the ratio of ENDL2009.1 to ENDL2009.0.1 coefficients from deterministic and Monte Carlo modeling respectively. Figures 3 and 4 plot the C/E ratios of ENDL2009.1 to experiment, from deterministic and Monte Carlo modeling respectively.

The deviations between the predictions from the two different ENDL2009 releases are seen to be acceptably small compared to their common differences to the measured values.

2. Further Testing

This revision was accepted by both the deterministic and Monte Carlo transport teams at LLNL.

TABLE I: Summary of k_{eff} ratios of Monte Carlo tests with `Mercury`.

Assembly Name	Reflector	Experiment	Calculated	C/E	σ	C ratio to 9.0.1
U MET FAST 001	bare	1.0000 ± 0.0010	1.0003 ± 0.0001	1.0003	0.3	0.9998
HEU MET FAST 002	tuballoy(topsy8)	1.0000 ± 0.0030	1.0029 ± 0.0001	1.0029	1.0	1.0001
HEU MET FAST 003	Ni	1.0000 ± 0.0030	1.0085 ± 0.0001	1.0085	2.8	1.0003
HEU MET FAST 009	Be	0.9992 ± 0.0015	0.9221 ± 0.0003	0.9229	50.5	1
HEU MET FAST 010 1	B and Be	0.9992 ± 0.0010	0.9885 ± 0.0001	0.9893	10.7	1
HEU MET FAST 010 2	B and Be	0.9992 ± 0.0010	1.0000 ± 0.0001	1.0008	0.7	1
HEU MET FAST 012	Al	0.9992 ± 0.0018	0.9852 ± 0.0001	0.9860	7.7	1
HEU MET FAST 017	Be	0.9993 ± 0.0014	0.9953 ± 0.0001	0.9960	2.9	1.0001
HEU MET FAST 019	graphite	1.0000 ± 0.0030	1.0123 ± 0.0001	1.0123	4.1	0.9998
HEU MET FAST 020	polyethylene	1.0000 ± 0.0030	1.0019 ± 0.0001	1.0019	0.6	0.9998
HEU MET FAST 028	U(99%U238)	1.0000 ± 0.0030	1.0041 ± 0.0001	1.0041	1.4	1
HEU MET FAST 038	U(99%U238)/Be Refl.	0.9999 ± 0.0007	1.0019 ± 0.0001	1.0020	2.8	1
HEU MET FAST 055	DU(ZPR3-23)	0.9955 ± 0.0028	0.9977 ± 0.0001	1.0022	0.8	1
HEU MET FAST 060	Al	0.9955 ± 0.0024	1.0016 ± 0.0001	1.0061	2.6	1
HEU MET FAST 064	Pb	0.9996 ± 0.0008	1.0167 ± 0.0001	1.0171	21.2	1
HEU MET FAST 073	Cu	1.0082 ± 0.0003	1.0120 ± 0.0001	1.0038	11.7	1
HEU MET FAST 079 1	Ti	0.9996 ± 0.0015	0.9995 ± 0.0001	0.9999	0.1	1
HEU MET FAST 079 2	Ti	0.9996 ± 0.0014	1.0004 ± 0.0001	1.0008	0.6	1
HEU MET FAST 079 3	Ti	0.9996 ± 0.0015	0.9988 ± 0.0001	0.9992	0.5	1
HEU MET FAST 079 4	Ti	0.9996 ± 0.0014	1.0027 ± 0.0001	1.0031	2.2	1
HEU MET FAST 079 5	Ti	0.9996 ± 0.0015	1.0019 ± 0.0001	1.0023	1.6	1
HEU MET FAST 084 1	Al	0.9994 ± 0.0019	0.9993 ± 0.0001	0.9999	0.0	1
HEU MET FAST 084 10	Ni	0.9993 ± 0.0022	1.0012 ± 0.0001	1.0019	0.8	1
HEU MET FAST 084 11	polythene(isotopic,not-m)	0.9995 ± 0.0019	1.0038 ± 0.0001	1.0043	2.3	0.9995
HEU MET FAST 084 12	Ti	0.9994 ± 0.0020	0.9998 ± 0.0001	1.0004	0.2	1
HEU MET FAST 084 13	Unat	0.9994 ± 0.0022	1.0002 ± 0.0001	1.0008	0.4	1.0001
HEU MET FAST 084 14	W	0.9994 ± 0.0019	1.1071 ± 0.0001	1.1078	56.6	1
HEU MET FAST 084 15	Al2O3	0.9995 ± 0.0021	0.9985 ± 0.0001	0.9990	0.5	1
HEU MET FAST 084 16	Be	0.9994 ± 0.0020	0.9975 ± 0.0001	0.9981	1.0	1
HEU MET FAST 084 17	Co	0.9995 ± 0.0019	1.0278 ± 0.0001	1.0283	14.9	1.0002
HEU MET FAST 084 18	Cu	0.9995 ± 0.0022	0.9978 ± 0.0001	0.9983	0.8	0.9998
HEU MET FAST 084 19	steel	0.9996 ± 0.0019	0.9979 ± 0.0001	0.9983	0.9	0.9998
HEU MET FAST 084 2	Al2O3	0.9994 ± 0.0021	0.9999 ± 0.0001	1.0005	0.2	1
HEU MET FAST 084 20	Mo	0.9995 ± 0.0025	1.0036 ± 0.0001	1.0041	1.6	1

TABLE I: Summary of k_{eff} ratios of Monte Carlo tests with `Mercury`.

Assembly Name	**Reflector**	**Experiment**	**Calculated**	**C/E**	σ	**C ratio to 9.0.1**
HEU MET FAST 084 21	MoC2	0.9995 ± 0.0045	1.0017 ± 0.0001	1.0022	0.5	1
HEU MET FAST 084 22	Ni	0.9994 ± 0.0020	0.9983 ± 0.0001	0.9989	0.6	1
HEU MET FAST 084 23	polythene(isotopic,not-m)	0.9993 ± 0.0024	0.9958 ± 0.0001	0.9965	1.4	1.0011
HEU MET FAST 084 24	U	0.9996 ± 0.0018	0.9994 ± 0.0001	0.9998	0.1	0.9999
HEU MET FAST 084 25	W	0.9995 ± 0.0020	1.0680 ± 0.0001	1.0685	34.2	1
HEU MET FAST 084 26	Be inner reflector,Fe out	0.9993 ± 0.0022	0.9987 ± 0.0001	0.9994	0.3	1
HEU MET FAST 084 27	Be inner reflector,Fe out	0.9994 ± 0.0020	0.9825 ± 0.0001	0.9831	8.5	1
HEU MET FAST 084 3	Be	0.9993 ± 0.0021	0.9972 ± 0.0001	0.9979	1.0	1
HEU MET FAST 084 4	graphite	0.9994 ± 0.0020	1.0033 ± 0.0001	1.0039	2.0	1
HEU MET FAST 084 5	Co	0.9993 ± 0.0021	1.0517 ± 0.0001	1.0525	24.9	1
HEU MET FAST 084 6	Cu	0.9994 ± 0.0024	0.9988 ± 0.0001	0.9994	0.3	0.9997
HEU MET FAST 084 7	steel	0.9995 ± 0.0020	0.9980 ± 0.0001	0.9985	0.7	0.9998
HEU MET FAST 084 8	Mo	0.9994 ± 0.0034	1.0092 ± 0.0001	1.0098	2.9	1
HEU MET FAST 084 9	MoC2	0.9993 ± 0.0054	1.0052 ± 0.0001	1.0059	1.1	1
HEU MET FAST 085 1	Cu(outer)	0.9998 ± 0.0029	1.0004 ± 0.0001	1.0006	0.2	1.0001
HEU MET FAST 085 2	Cu(outer)	0.9997 ± 0.0031	1.0045 ± 0.0001	1.0048	1.6	0.9999
HEU MET FAST 085 3	Fe(outer)	0.9995 ± 0.0046	0.9982 ± 0.0001	0.9987	0.3	1
HEU MET FAST 085 4	Cu-Ni-Zn-alloy	0.9996 ± 0.0029	1.0122 ± 0.0001	1.0126	4.3	1
HEU MET FAST 085 5	Th	0.9995 ± 0.0024	1.0012 ± 0.0001	1.0017	0.7	0.9999
HEU MET FAST 085 6	W	0.9997 ± 0.0029	1.0068 ± 0.0001	1.0071	2.4	1
IEU MET FAST 005	steel	1.0000 ± 0.0021	1.0043 ± 0.0001	1.0043	2.1	1.0001
IEU MET FAST 007	Unat	0.9948 ± 0.0013	0.9927 ± 0.0003	0.9979	1.6	1.0003
MIX MET FAST 001	bare(Pu core+HEU shell)	1.0000 ± 0.0016	1.0006 ± 0.0001	1.0006	0.4	0.9997
MIX MET FAST 002 1	flattop mixed metal	1.0000 ± 0.0042	1.0078 ± 0.0003	1.0078	1.9	1.0007
MIX MET FAST 002 2	flattop mixed metal	1.0000 ± 0.0044	1.0070 ± 0.0003	1.0070	1.6	0.9999
MIX MET FAST 002 3	flattop mixed metal	1.0000 ± 0.0048	1.0080 ± 0.0003	1.0080	1.7	1.0004
MIX MET FAST 005	Al	0.9990 ± 0.0017	0.9846 ± 0.0001	0.9856	8.5	1
MIX MET FAST 009	bare(Pu core+HEU shell)	1.0000 ± 0.0010	1.0011 ± 0.0001	1.0011	1.1	1
MIX MET FAST 010	bare(Pu core+HEU shell)	1.0000 ± 0.0009	1.0011 ± 0.0001	1.0011	1.2	1
PU MET FAST 001	bare	1.0000 ± 0.0020	1.0010 ± 0.0001	1.0010	0.5	1.0002
PU MET FAST 002	bare	1.0000 ± 0.0020	1.0013 ± 0.0001	1.0013	0.6	1
PU MET FAST 005	W	1.0000 ± 0.0013	1.0037 ± 0.0001	1.0037	2.8	1.0002
PU MET FAST 006	U	1.0000 ± 0.0030	1.0036 ± 0.0001	1.0036	1.2	1.0001
PU MET FAST 008a	Th	1.0000 ± 0.0006	1.0000 ± 0.0001	1.0000	0.0	1
PU MET FAST 009	Al	1.0000 ± 0.0027	1.0061 ± 0.0001	1.0061	2.2	0.9997
PU MET FAST 010	U	1.0000 ± 0.0018	1.0018 ± 0.0001	1.0018	1.0	1.0001
PU MET FAST 011	water	1.0000 ± 0.0010	1.0146 ± 0.0001	1.0146	14.6	0.9998
PU MET FAST 018	Be	1.0000 ± 0.0030	0.9970 ± 0.0001	0.9970	1.0	0.9999
PU MET FAST 019	Be	0.9992 ± 0.0015	0.9988 ± 0.0001	0.9996	0.3	1
PU MET FAST 020	DU	0.9993 ± 0.0017	1.0006 ± 0.0001	1.0013	0.8	1
PU MET FAST 022	bare	1.0000 ± 0.0021	0.9995 ± 0.0001	0.9995	0.2	1
PU MET FAST 023	graphite	1.0000 ± 0.0020	1.0070 ± 0.0001	1.0070	3.5	1.0001
PU MET FAST 024	Polyethylene	1.0000 ± 0.0020	1.0045 ± 0.0001	1.0045	2.2	0.9999
PU MET FAST 025	steel	1.0000 ± 0.0020	0.9995 ± 0.0001	0.9995	0.3	1.0001
PU MET FAST 026	Steel	1.0000 ± 0.0024	0.9997 ± 0.0001	0.9997	0.1	1
PU MET FAST 028	Steel	1.0000 ± 0.0022	1.0007 ± 0.0001	1.0007	0.3	1
PU MET FAST 029	bare	1.0000 ± 0.0020	0.9966 ± 0.0001	0.9966	1.7	1
PU MET FAST 030	graphite	1.0000 ± 0.0021	1.0115 ± 0.0001	1.0115	5.5	1
PU MET FAST 032	Steel	1.0000 ± 0.0020	0.9992 ± 0.0001	0.9992	0.4	1
PU MET FAST 035	Pb	1.0000 ± 0.0016	1.0080 ± 0.0001	1.0080	5.0	1
PU MET FAST 039	Duraluminium	1.0000 ± 0.0022	0.9927 ± 0.0001	0.9927	3.3	1
PU MET FAST 040	Cu	1.0000 ± 0.0038	0.9973 ± 0.0001	0.9973	0.7	1
PU MET FAST 041	D38	1.0000 ± 0.0016	1.0087 ± 0.0001	1.0087	5.5	1
PU SOL THERM 011	solution assembly	1.0000 ± 0.0052	0.9687 ± 0.0001	0.9687	6.0	0.9998
U233 MET FAST 001	bare	1.0000 ± 0.0010	0.9996 ± 0.0001	0.9996	0.4	1.0001
U233 MET FAST 002	HEU(93%U235)	1.0000 ± 0.0010	0.9991 ± 0.0001	0.9991	0.9	1
U233 MET FAST 003	Unat	1.0000 ± 0.0010	0.9998 ± 0.0003	0.9998	0.2	0.9992
U233 MET FAST 004	W	1.0000 ± 0.0007	0.9999 ± 0.0001	0.9999	0.1	1.0002
U233 MET FAST 006	Unat	1.0000 ± 0.0014	1.0004 ± 0.0003	1.0004	0.2	0.9996

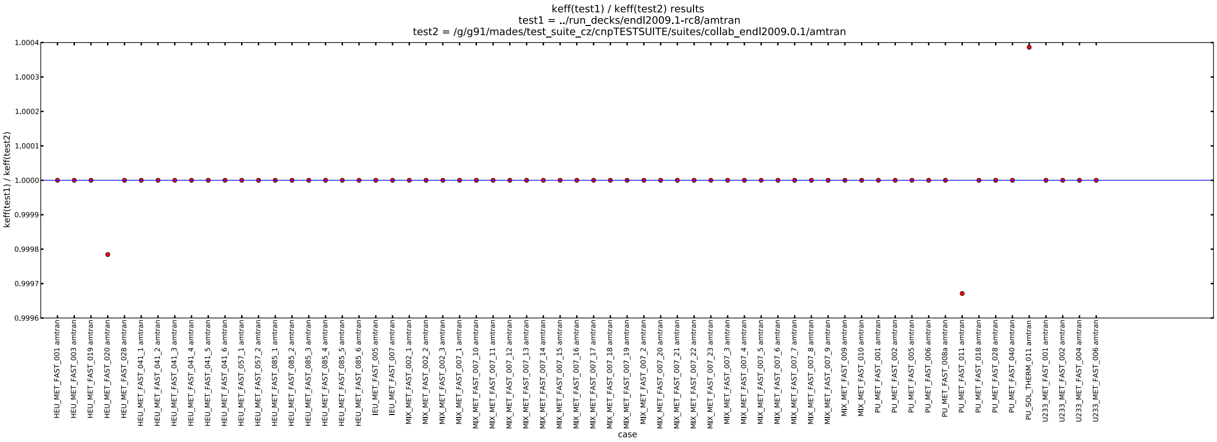

FIG. 1: Ratios of k_{eff} criticality coefficients using ENDL2009.1 to those using ENDL2009.0.1, from deterministic modeling.

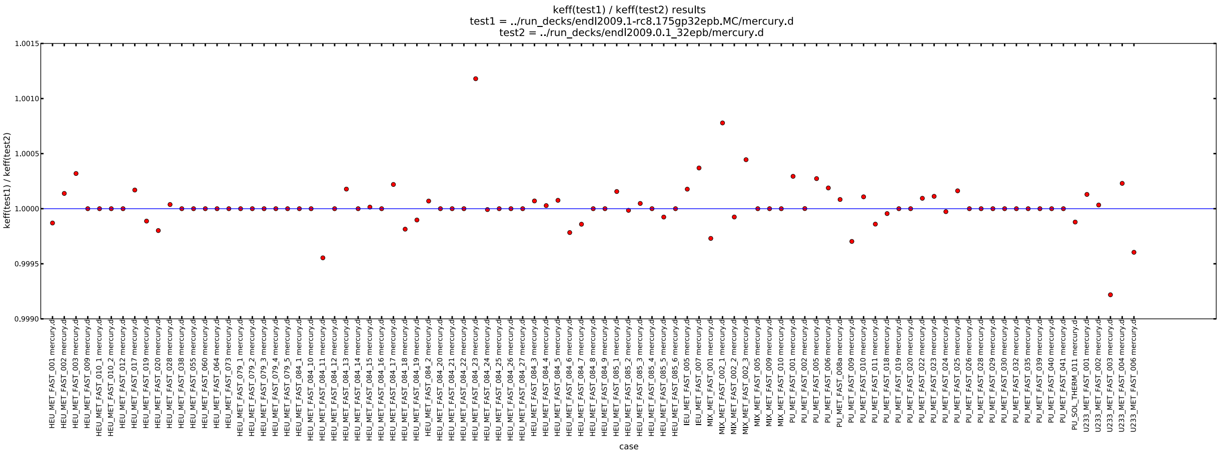

FIG. 2: Ratios of k_{eff} criticality coefficients using ENDL2009.1 to those using ENDL2009.0.1, from Monte Carlo modeling.

TABLE II: Summary of k_{eff} ratios of deterministic tests with `Amtran`

Assembly Name	Reflector	Experiment	Calculated	C/E	σ	C ratio to 9.0.1
HEU MET FAST 001	bare	1.0000 ± 0.0010	$1.0003 \pm 1e{-}06$	1.0003	0.3	1
HEU MET FAST 003	Ni	1.0000 ± 0.0030	$1.0558 \pm 1e{-}06$	1.0558	18.6	1
HEU MET FAST 019	graphite	1.0000 ± 0.0030	$1.0130 \pm 1e{-}06$	1.0130	4.3	0.9999
HEU MET FAST 020	polyethylene	1.0000 ± 0.0030	$1.0009 \pm 1e{-}06$	1.0009	0.3	0.9997
HEU MET FAST 028	U(99%U238)	1.0000 ± 0.0030	$1.0020 \pm 1e{-}06$	1.0020	0.7	1
HEU MET FAST 041 1	be	1.0013 ± 0.0030	$1.0070 \pm 1e{-}06$	1.0057	1.9	1
HEU MET FAST 041 2	be	1.0022 ± 0.0043	$1.0080 \pm 1e{-}06$	1.0058	1.4	1
HEU MET FAST 041 3	graphite	1.0006 ± 0.0029	$1.0094 \pm 1e{-}06$	1.0088	3.0	1
HEU MET FAST 041 4	graphite	1.0006 ± 0.0025	$1.0225 \pm 1e{-}06$	1.0218	8.7	0.9999
HEU MET FAST 041 5	graphite	1.0006 ± 0.0031	$1.0118 \pm 1e{-}06$	1.0112	3.6	1
HEU MET FAST 041 6	graphite	1.0006 ± 0.0045	$1.0140 \pm 1e{-}06$	1.0134	3.0	1
HEU MET FAST 057 1	Pb	1.0000 ± 0.0020	$1.0058 \pm 1e{-}06$	1.0058	2.9	1
HEU MET FAST 057 2	Pb	1.0000 ± 0.0023	$1.0116 \pm 1e{-}06$	1.0116	5.0	1
HEU MET FAST 085 1	Cu(outer)	0.9998 ± 0.0029	$1.0075 \pm 1e{-}06$	1.0077	2.7	1
HEU MET FAST 085 2	Cu(outer)	0.9997 ± 0.0031	$1.0165 \pm 1e{-}06$	1.0168	5.4	1
HEU MET FAST 085 3	Fe(outer)	0.9995 ± 0.0046	$1.0280 \pm 1e{-}06$	1.0285	6.2	1
HEU MET FAST 085 4	Cu-Ni-Zn-alloy	0.9996 ± 0.0029	$1.0164 \pm 1e{-}06$	1.0168	5.8	1
HEU MET FAST 085 5	Th	0.9995 ± 0.0024	$1.0017 \pm 1e{-}06$	1.0022	0.9	1
HEU MET FAST 085 6	W	0.9997 ± 0.0029	$1.0081 \pm 1e{-}06$	1.0084	2.9	0.9999
IEU MET FAST 005	steel	1.0000 ± 0.0021	$1.0365 \pm 1e{-}06$	1.0365	17.4	1
IEU MET FAST 007	Unat	0.9948 ± 0.0013	$0.9891 \pm 1e{-}04$	0.9942	4.4	1
MIX MET FAST 002 1	flattop mixed metal	1.0000 ± 0.0042	$0.9995 \pm 1e{-}06$	0.9995	0.1	1
MIX MET FAST 002 2	flattop mixed metal	1.0000 ± 0.0044	$0.9998 \pm 1e{-}06$	0.9998	0.0	1
MIX MET FAST 002 3	flattop mixed metal	1.0000 ± 0.0048	$1.0002 \pm 1e{-}06$	1.0002	0.0	1
MIX MET FAST 007 1	pu, heu refl by Be (var sph)	1.0000 ± 0.0037	$0.9942 \pm 1e{-}06$	0.9942	1.6	1
MIX MET FAST 007 10	pu, heu refl by Be (var sph)	1.0000 ± 0.0008	$1.0047 \pm 1e{-}06$	1.0047	5.9	1
MIX MET FAST 007 11	pu, heu refl by Be (var sph)	1.0000 ± 0.0010	$1.0037 \pm 1e{-}06$	1.0037	3.7	1
MIX MET FAST 007 12	pu, heu refl by Be (var sph)	1.0000 ± 0.0004	$1.0025 \pm 1e{-}06$	1.0025	6.2	1
MIX MET FAST 007 13	pu, heu refl by Be (var sph)	1.0000 ± 0.0005	$1.0007 \pm 1e{-}06$	1.0007	1.3	1
MIX MET FAST 007 14	pu, heu refl by Be (var sph)	1.0000 ± 0.0003	$1.0069 \pm 1e{-}06$	1.0069	23.0	1
MIX MET FAST 007 15	pu, heu refl by Be (var sph)	1.0000 ± 0.0009	$1.0071 \pm 1e{-}06$	1.0071	7.9	1
MIX MET FAST 007 16	pu, heu refl by Be (var sph)	1.0000 ± 0.0005	$1.0063 \pm 1e{-}06$	1.0063	12.6	1
MIX MET FAST 007 17	pu, heu refl by Be (var sph)	1.0000 ± 0.0006	$1.0061 \pm 1e{-}06$	1.0061	10.1	1
MIX MET FAST 007 18	pu, heu refl by Be (var sph)	1.0000 ± 0.0004	$1.0078 \pm 1e{-}06$	1.0078	19.4	1
MIX MET FAST 007 19	pu, heu refl by Be (var sph)	1.0000 ± 0.0010	$1.0077 \pm 1e{-}06$	1.0077	7.7	1
MIX MET FAST 007 2	pu, heu refl by Be (var sph)	1.0000 ± 0.0003	$1.0031 \pm 1e{-}06$	1.0031	10.2	1
MIX MET FAST 007 20	pu, heu refl by Be (var sph)	1.0000 ± 0.0007	$1.0053 \pm 1e{-}06$	1.0053	7.5	1
MIX MET FAST 007 21	pu, heu refl by Be (var sph)	1.0000 ± 0.0007	$1.0048 \pm 1e{-}06$	1.0048	6.9	1
MIX MET FAST 007 22	pu, heu refl by Be (var sph)	1.0000 ± 0.0003	$1.0049 \pm 1e{-}06$	1.0049	16.5	1
MIX MET FAST 007 23	pu, heu refl by Be (var sph)	1.0000 ± 0.0004	$1.0039 \pm 1e{-}06$	1.0039	9.7	1
MIX MET FAST 007 3	pu, heu refl by Be (var sph)	1.0000 ± 0.0012	$1.0049 \pm 1e{-}06$	1.0049	4.1	1
MIX MET FAST 007 4	pu, heu refl by Be (var sph)	1.0000 ± 0.0007	$1.0048 \pm 1e{-}06$	1.0048	6.9	1
MIX MET FAST 007 5	pu, heu refl by Be (var sph)	1.0000 ± 0.0009	$1.0025 \pm 1e{-}06$	1.0025	2.8	1
MIX MET FAST 007 6	pu, heu refl by Be (var sph)	1.0000 ± 0.0009	$1.0010 \pm 1e{-}06$	1.0010	1.1	1
MIX MET FAST 007 7	pu, heu refl by Be (var sph)	1.0000 ± 0.0005	$1.0008 \pm 1e{-}06$	1.0008	1.6	1
MIX MET FAST 007 8	pu, heu refl by Be (var sph)	1.0000 ± 0.0005	$1.0026 \pm 1e{-}06$	1.0026	5.1	1
MIX MET FAST 007 9	pu, heu refl by Be (var sph)	1.0000 ± 0.0003	$1.0035 \pm 1e{-}06$	1.0035	11.6	1
MIX MET FAST 009	bare(Pu core+HEU shell)	1.0000 ± 0.0010	$1.0003 \pm 1e{-}06$	1.0003	0.3	1
MIX MET FAST 010	bare(Pu core+HEU shell)	1.0000 ± 0.0009	$0.9995 \pm 1e{-}06$	0.9995	0.6	1
PU MET FAST 001	bare	1.0000 ± 0.0020	$1.0006 \pm 1e{-}06$	1.0006	0.3	1
PU MET FAST 002	bare	1.0000 ± 0.0020	$1.0011 \pm 1e{-}06$	1.0011	0.5	1
PU MET FAST 005	W	1.0000 ± 0.0013	$1.0038 \pm 1e{-}06$	1.0038	2.9	1
PU MET FAST 006	U	1.0000 ± 0.0030	$0.9995 \pm 1e{-}06$	0.9995	0.2	1
PU MET FAST 008a	Th	1.0000 ± 0.0006	$1.0000 \pm 1e{-}06$	1.0000	0.1	1
PU MET FAST 011	water	1.0000 ± 0.0010	$0.9738 \pm 1e{-}06$	0.9738	26.2	0.9996
PU MET FAST 018	Be	1.0000 ± 0.0030	$1.0014 \pm 1e{-}06$	1.0014	0.5	1
PU MET FAST 028	Steel	1.0000 ± 0.0022	$1.0450 \pm 1e{-}06$	1.0450	20.4	1
PU MET FAST 040	Cu	1.0000 ± 0.0038	$0.9990 \pm 1e{-}06$	0.9990	0.3	1
PU SOL THERM 011	solution assembly	1.0000 ± 0.0052	$1.0123 \pm 1e{-}06$	1.0123	2.4	1.0003
U233 MET FAST 001	bare	1.0000 ± 0.0010	$1.0001 \pm 1e{-}06$	1.0001	0.1	1
U233 MET FAST 002	HEU(93%U235)	1.0000 ± 0.0010	$0.9988 \pm 1e{-}06$	0.9988	1.2	1
U233 MET FAST 004	W	1.0000 ± 0.0007	$1.0006 \pm 1e{-}06$	1.0006	0.8	1
U233 MET FAST 006	Unat	1.0000 ± 0.0014	$1.0083 \pm 1e{-}06$	1.0083	5.9	1

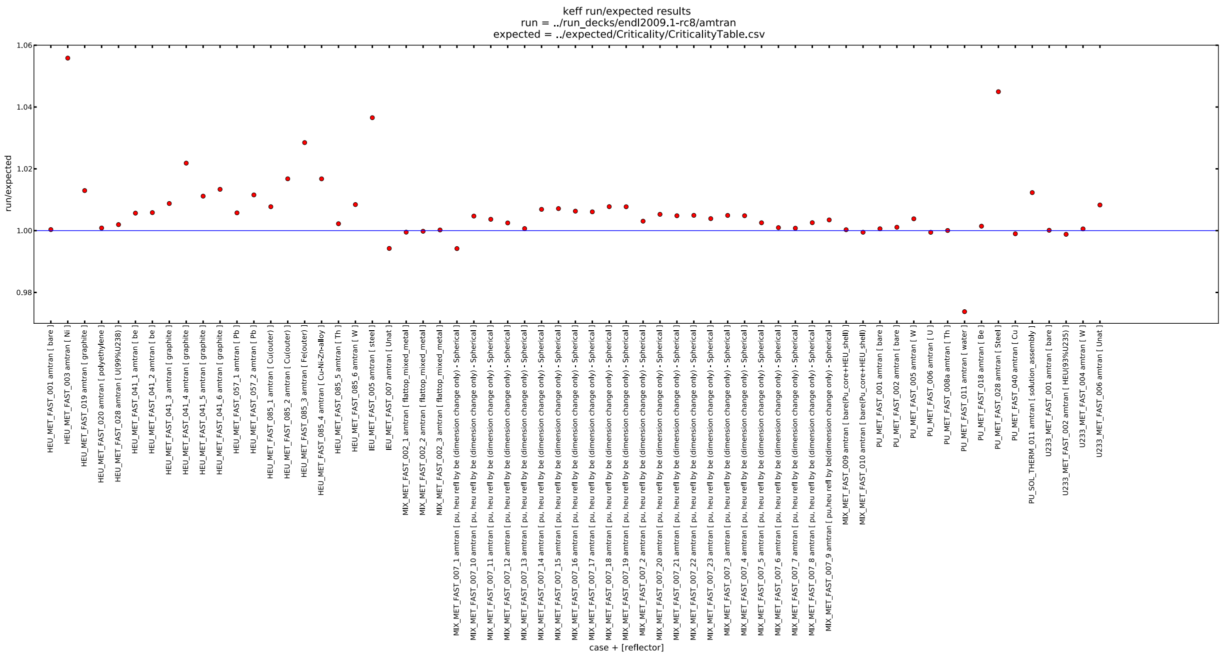

FIG. 3: Ratios of $k_{\rm eff}$ criticality coefficients using ENDL2009.1 with deterministic modeling to measured values.

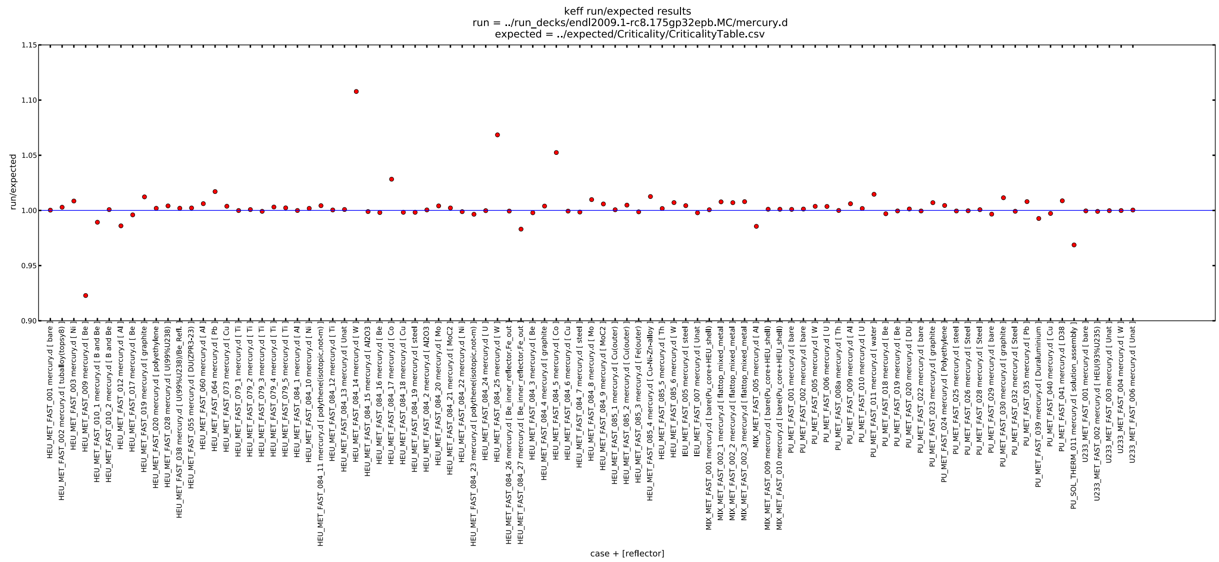

FIG. 4: Ratios of $k_{\rm eff}$ criticality coefficients using ENDL2009.1 with Monte Carlo modeling to measured values.

Appendix C: Release Checklist

Here we reproduce the release checklist that accompanies this release.

ENDL2009.1 Data Release Checklist

Basic Tests

Check/Test	Success	Failure	Comments
python checker on ascii data		1	4 errors for ^{7}Be, as described in Appendix A of the revision-release document.
Check the processing errors/ warning messages	✓		
ndf checker	✓		
mcapm checker	✓		

Amtran Tests (ndf)

Check/Test	Success	Failure	Comments
za-loop	✓		
k_{eff}	✓		
Activation foils	✓		

Mercury Tests (mcf)

Check/Test	Success	Failure	Comments
za-loop	✓		
k_{eff}	✓		
LLNL pulsed spheres	✓		
Oktavian spheres	✓		

Other Release Tasks

	Complete	Comments
Add correct bdfls file	OCF: ✓ SCF: ✓	
Add/Edit README.txt	✓	
Check directory layout	OCF: ✓ SCF: ✓	
Check file permissions	OCF: ✓ SCF: ✓	
Post on NADS	Not yet	
Tag release in svn repo	✓	endl/tags/endl2009.1
Release documentation	✓	endl2009.1_release.pdf

Release Features

	Present?	Comments
Momentum deposition	✓	
Energy deposition	✓	
Energy-dependent Q-values for (n,f)	✓	
Multi-temperature data	✓	In mcf files
Large-Angle Coulomb Scattering (LACS) data	✓	Not present in ndf files
Thermal scattering ($S_{\alpha\beta}$) data	✓	For p,d,^{4}He, ^{12}C, and ^{16}O
Unresolved Resonance (URR) data (probability tables)	x	Removed since codes can't currently use it, but will be possible in the future
Uncertainty/Covariance data	about half	
Isomers	2, 1 processed	ASCII files have 2 isomer targets: ^{242m,244m}Am. However, only ^{242m}Am is processed: it replaces the ground state

Available Formats

	Present?	Comments
mcf	✓	mcf1.pdb.175 mcf1.pdb.230 mcf2.pdb mcf3.pdb mcf4.pdb mcf5.pdb mcf6.pdb mcf7.pdb
ndf	✓	ndf1.175 ndf1.230 ndf2.063 ndf3.063 ndf4.063 ndf5.063 ndf6.063 ndf7.040
tdf	✓	17 reactions
ENDF/B	some	ENDF for evaluation starting points for neutrons
gnd	x	
other	x	

Appendix D: The README file

Here we reproduce the README file that accompanies the release.

```
        2009.1 Release of the Evaluated Nuclear Data Library (ENDL2009.1)


           Neil Summers, Bret Beck, Caleb Mattoon, Ian Thompson,
                          Marie-Anne Descalle,
                             (S&T/NACS/NDTG)

                               April 2015


LLNL's Computational Nuclear Physics Group and Nuclear Theory and Modeling Group have collaborated to
create the 2009.1 revised release of the Evaluated Nuclear Data Library (ENDL2009.1). ENDL2009 is
designed to support LLNL's current and future nuclear data needs and will be employed in nuclear
reactor, nuclear security and stockpile stewardship simulations with ASC codes. This database is
currently the most complete nuclear database for Monte Carlo and deterministic transport of neutrons
and charged particles. This library was assembled with strong support from the ASC PEM and Attribution
programs, leveraged with support from Campaign 4 and the DOE/Office of Science's US Nuclear Data Program.
This document lists the revisions made in ENDL2009.1 compared with the data existing in the original
ENDL2009.0 release. These changes are made in conjunction with the revisions for ENDL2011.1, so that
both the .1 releases are as free as possible of known defects.

The new libraries can be found on LC in:
    /collab/usr/gapps/data/nuclear/endl_official/endl2009.1
 which in CZ and RZ is linked as:
    /usr/gapps/data/nuclear/endl_official/endl2009.1/ascii for the ENDL ASCII formatted data,
    /usr/gapps/data/nuclear/endl_official/endl2009.1/ndf for deterministic data and
    /usr/gapps/data/nuclear/endl_official/endl2009.1/mcf for Monte-Carlo data.
    /usr/gapps/data/nuclear/endl_official/endl2009.1/tdf for thermonuclear data.
In addition, the data may be viewed in the Nuclear and Atomic Data System data viewer
at http://nuclear.llnl.gov/NADS.

Documentation for the release can be found in
    /usr/gapps/data/nuclear/endl_official/endl2009.1/doc
which contains a LLNL report detailing the changes in this release.
While the source ENDF-6 formatted files for many of the evaluations can be found in
    /usr/gapps/data/nuclear/endl_official/endl2009.1/endf
note that these may differ from the ENDL ascii data, since many modifications are performed
on the data during conversion to the ENDL format.



                               Release Notes
                               -------------

04/??/2015 Release ENDL2009.1:

    The new files have been posted in /usr/gapps/data/nuclear/endl_official/endl2009.1.
    The ascii, mcf, ndf and tdf files are present in subdirectories.

    New Features:

        1. Deterministic data (ndf) are now processed with lMax=9 for distributions where the outoing
           particle is the same as the incident particle.

    Resolved Issues [see https://lc.llnl.gov/jira/browse/ND for more details]:

        ND-2    1002 data is negative
        ND-23   problem with phase space translation from ENDF

            Both ND-2 and ND-23 were determined to be the same problem.
            Problems were encountered with the phase-space representation used in the n+d -> 2n +p ENDF-B/VII.0 evaluation,
            used as the source for the ENDL2009.0 evaluation. In the end, the evaluation for yi01/za001002 was replaced
            with the JENDL-4 evaluation, which is the evaluation used in ENDL2011.0.

        ND-6    n+1H: elastic cross section is incorrect, does not match ENDF

            Elastic + capture does not add up to total cross section. Problem found with SIGMA1 in PREPRO.
            Was fixed by using fudge to convert the ENDF file to GND and then use fudge to heat cross sections to room
            temperature.

        ND-11   t(d,n)a has a spike

            Spike at E=0.85 MeV, mu=0.96111. Replaced with interpolated value from surrounding points.

        ND-15   ascii data does not match processed data

            The ENDL2009.0 data available at /usr/gapps/data/nuclear/endl_official/endl2009.0 did not match the processed
            data at the same location. By this we mean that when we tried to process the ascii data in endl_official we
            were unable to process the data without crashing. Therefore, changes must have been made to the ascii data to
            get it to process, that were not reflected in the ascii data in endl_official. Care has been taken in the
            building procedure to make sure that this does not happen for ENDL2009.1.

        ND-16   Missing EGDL fluorescence data I=30,32

            EGDL files, yi07, I=30,32 that were in ENDL2008.2 were not included in ENDL2009.0. These files were added back
            in for this release.
```

ND-17   Remove I=20 URR data

The Unresolved Resonsance Region (URR), which is contained in I=20 files, is unable to be processed due to changes to NJOY, and was not included in the ENDL2009.0 processed data. Therefore we removed the URR data from the ascii data to keep the ascii and processed data in sync.

ND-18   endep changes to C=55 not saved in ascii data

When ENDL2008.2 was processed, endepC++ (the code that calculates the average energy deposition from the distribution data) did not worry about energy balance. When ENDL2009.0 was processed, endepC++ (via the -rescale_c5x_cs option which in true by default) attempts to balance energy by rescaling the C55 data.That is, if there is too much (little) outgoing energy, the C55 gamma multiplicity is effectively lowered (raised). Due to the way endlBuilder was coded, these changes to C55 were not saved in the ascii data. endlBuilder has been re-written to save these changes in the ascii data so that the ascii data and processed data are in sync.

ND-19   Separate Am241(n,g) cross section to ground and isomer state in Am242

In translating n+Am241 evaluation from ENDF/B-VII.0, the (n,g) C=46 cross section was given as the sum of the cross sections to the ground and isomer states in Am242. The branching to the ground and isomer states was given elsewhere (MT8), and this was not translated by fete. ENDL format has support for cross sections to final isomer states. The (n,g) cross section has been split into the ground and isomer state cross sections using the ENDF-B/VII.0 branching ratio. The distributions and gamma multiplicities are assumed the same for both states.

ND-20   Separate Sc45(n,g) cross section to ground and isomer state in Sc46

In translating n+Sc45 evaluation from ENDF/B-VII.0, the (n,g) C=46 cross section was given as the sum of the cross sections to the ground and isomer states in Am242. The branching to the ground and isomer states was given elsewhere (MT8), and this was not translated by fete. ENDL format has support for cross sections to final isomer states. The (n,g) cross section has been split into the ground and isomer state cross sections using the ENDF-B/VII.0 branching ratio. The distributions and gamma multiplicities are assumed the same for both states.

ND-21   Move all C=21 files to C=20 when C=20 does not exist

ENDL has both C=20 and C=21 to describe the (n,np) and (n,pn) channels. ENDF only has the sum of both of these channels. Most HF codes only calculate the sum. When have the sum both channels, sometimes this has been put in C=20 and sometimes in C=21. Now put sum in C=20 for uniformity across database.

ND-24   t(n,2n) changed significantly

ENDL2011.0 = ENDL2009.0 = ENDF-B/VII.0, ENDF-B/VII.1 reverted t(n,2n) back to ENDF-B/VI.8.
ENDL2011.1 updated to ENDF-B/VII.1 evaluation. See lab report LLNL-TR-637152.

ND-25   Maxwellian averaged cross section I=80,81,84,89,90,91,92 for charged particle libraries

Maxwellian averaged cross sections are found in files I=80,81,84,89,90,91,92. These are found in the charge particle incident libraries. The evaluations were in ENDL2008.2, but were missing in ENDL2009.0. The missing files that were in ENDL2008.2, have been included in this release.

ND-26   Some distributions missing I=3 data

ENDF has to be only complete for outgoing neutron distributions, while ENDL need outgoing distributions for all tracked particles (n,p,d,t,h,a,g). In ENDL2009.0, we swapped in missing distributions not found in ENDF with distributions found from other evaluations, or we made them ourselves from TALYS.
In ENDL2009.0, it appears this was done incorrectly in some cases. For two-body channels, when there is data as as a sum of levels or data to the continuum, there should be I=1 and I=3 or 4 data together to give the enegy and angular distribion. In ENDL2009.0, only the I=1 file was copied over to the evaluation, when there existed I=3 files for the energy distribution.
Located all evaluations with missing energy distributions, and Searched through JEFF-3.1.1 and TENDL-2013 to find evaluations with distributions for this missing data. Then replace the I=1 and I=3 files together.

ND-48   gamma multiplicity (I=9) file is very different from ENDF file

The ENDL file for some gamma multilicities look very different from the ENDF file that fete translated from. A bug was found in the fete, and the gamma multiplicities and energy distributions were regenerated from an earlier version of fete, and replaced for za027057, za027058, za033075, za068164, za068168, za075189.

ND-51   missing particle angular distributions in 19F

The evaluation for the 19F target from ENDF/B-VII had (n,d) and (n,t) reactions which do not have I=4 exit angular distributions. The I=4 data from ENDL99 was used for this data.

ND-52   The n+67Ni evaluation had elastic and total data only up to 12.8 MeV

The c01 and c10 were extended to 20 MeV with TENDL2009 data.

ND-56   Too much energy deposition in the d+t reaction to the 5He excited state

This was remedied by setting an excitation energy X1=19.815 MeV in the file C=20 s=1 inelastic files.

ND-59   Too much energy in breakup distributions for d -> n+p breakup on protons and alpha-particles

This error resulted from an erroneous translation of the previous data in ECPL for the inverse reactions of protons and -particles on deuterons: the incident energies were scaled as if the breakup distributions depended only on the incident energy in the c.m. frame.
However, the I=4 files describe data in the laboratory frame, so they should not have been changed.

9/30/2009 Release ENDL2009.0:

The new files have been posted in /usr/gapps/data/nuclear/endl_official/endl2009.0.

The ascii, mcf, ndf and tdf files are present in subdirectories, using the new directory layout.

New Features:

1. Unresolved resonance probability tables added to ascii data tables
2. TDF data now produced directly from ascii endl files
3. New structural material evaluations for Al, Ta, W, Re, Pt, Pb
4. New radiochemical diagnostic evaluations for Ar, Kr, Xe, Au
5. New evaluations for Cl, K, Mn, Y, Mo, Bi, Po
6. New actinide evaluations for 240Am, 240Pu, 239U
7. Most evaluations also available in ENDF/B format in endf subdirectory
8. Add uncertainty & covariance data to many evaluations
9. Large-angle Coulomb scattering data added for all targets in charged-particle sublibraries

Resolved Issues:

1. Added resonances to Co evaluations
2. Charged particle data available in forward and inverse kinematics for particles p, d, t, 3He, a
3. 6Li files renamed to get correct two-body kinematics using mcapm

5/15/2009 Release ENDL2008.2:

The new files have been posted in /usr/gapps/data/nuclear/endl_official/endl2008.2. The ascii, mcf and ndf files are present in subdirectories, using the new directory layout.

New Features:

1. Expected value momentum deposition added
2. Large angle Coulomb scattering for yi=2-6 added

Resolved Issues:

1. Addition of the resonance region for 240Am and 73As
2. Fixed unphysical gamma multiplicities in 41Sc, 103Rh, 125Sn amd 240Am
3. Fixed angular grid miss-match issue in 103Rh and 27Al
4. I = 3 data added to natV, natOs, natTl
5. Added missing triton distributions for 70Zn, 71Zn, 63Ni, 72Ga, 66Cu, 61Co
6. Removed extra I=4 files from 9Be, 11Be
7. Other minor issues in t, 7Be

2/17/2009 Release ENDL2008.1:

The new files are posted on the in /usr/gapps/data/nuclear/endl_official/endl2008.1/. The ascii, mcf and ndf files are present in subdirectories, using the new directory layout.

Resolved Issues:

1. The extra files in the d(n,2n) evaluation which produced a factor of 2 change in the cross-section have been removed.
2. The 232Th nubar has been set to the correct value.
3. The 233Pa nubar has been set to the correct value.
4. The missing energy dependent Q-values for fission was forgotten in the previous release and is now added back into the evaluations for all actinides.
5. A mistake in the 48Ti(n,g) outgoing gamma spectrum (taken from the ENDF/B-VII.0 evaluation) produced several *hundred* MeV worth of outgoing gammas. We replaced this unphysical spectrum with one from Hauser-Feshbach model calculations.

10/10/2008 Release ENDL2008.0:

The new files are posted on the in /usr/gapps/data/nuclear/endl_official/endl2008/. The ascii, mcf and ndf files are present in subdirectories, using the new directory layout.