LA-UR-13-28964



Data Testing Revised ²³⁵U and ²³⁹Pu Files with ICSBEP Benchmarks

A. C. (Skip) Kahler Los Alamos National Laboratory L. C. Leal Oak Ridge National Laboratory

2013 Nuclear Data Week / CSEWG Meeting Brookhaven National Laboratory November 18 – 22, 2013

UNCLASSIFIED



Operated by Los Alamos National Security, LLC for the U.S. Department of Energy's NNSA

LA-UR-13-28964



Abstract: We review recent critical benchmark calculations with revised ²³⁵U and ²³⁹Pu evaluated data files.



UNCLASSIFIED

Operated by Los Alamos National Security, LLC for the U.S. Department of Energy's NNSA

LA-UR-13-28964

70

²³⁵U – Primarily Revised Capture



Comparison of ${}^{235}U(n,\gamma)$ and ${}^{235}U(n,f)$ cross sections ... recent ORNL reevaluation, designated ORNL8, based upon new LANL and RPI data versus the current (ENDF/B-VII.1) evaluation ... "a work in progress" per Luiz Leal.



LA-UR-13-28964



HST Benchmarks

 Regression fit to HST benchmarks versus ATLF has been excellent since ENDF/B-VI.3 (Lubitz).

 This excellent fit is retained with the latest (ORNL8)
²³⁵U resolved resonance file.





LA-UR-13-28964

HMF7 (HEU + CH₂) Benchmarks

- HEU + poly system tests xs data over several orders of magnitude.
- E70 & E71 results are near unity at either energy extreme but are biased high in the intermediate energy range.

 This bias is worsened with the latest ORNL8 ²³⁵U evaluated file.





LA-UR-13-28964

²³⁹Pu – WPEC SG34

78

April 2013 | UNCLASSIFIED |

Revised resolved resonance parameters have been defined.

Revised $v_p(E)$ data, up to 650 eV, have been defined.

Revised pfns have been defined.

Differences between JEFF and ENDF remain, ☺.

Although the Sub-Group is near an end, this work remains a "work in progress" that will continue under CIELO.



Operated by Los Alamos National Security, LLC for the U.S. Department of Energy's NNSA

LA-UR-13-28964

0.30

0.35

0.40

April 2013 | UNCLASSIFIED

0.45

0.50

Pu-SOL-THERM Benchmarks - I

1.0250

1.0200

1.0150

1 0100

1.0050

0.9900

0 9850

0.9800

0.9750

0.00

■PST1

PST4

PST7

PST11

■ PST22

PST34

0.05

■ PST2

PST5

PST9

PST12

PST28

0.15

0.10

PST3

■ PST6

PST10

■PST18

PST32

0.20

С/Е

- A ~500 pcm bias in calculated PST reactivity is a long-standing issue.
- WPEC Sub-Group 34 was tasked with defining a new (better?) set of resolved resonance parameters for ²³⁹Pu in an attempt to resolve this issue.
- Can define a sub-set of these 150 benchmarks to test revised data files.

Consider benchmark attributes such as (i) ATLF; (ii) ²³⁹Pu atom-% in Pu; (iii) Above-Thermal Fission Fraction (ATFF); (iv) H/Pu number density (or gPu per liter) to define this sub-set.

0.25

Above-Thermal Leakage Fraction, ATLF

LA-UR-13-28964



Pu-SOL-THERM Benchmarks - II

- A set of seven Pu-SOL-THERM benchmarks have been extracted from the larger set.
 - PST1.4 & PST12.13 span the ATLF space;
 - PST12.10 & PST34.15 span the ATFF space;
 - PST4.1 & PST18.6 span the ²³⁹Pu atom percent space;
 - PST12.10 & PST34.4 span the g Pu per liter space.
- All benchmark experiments are performed in simple geometry
 - PST1.4 & PST4.1 are a water-reflected spheres;
 - PST18.6, PST34.4 & PST34.15 are water-reflected cylinders;
 - PST12.10 & PST12.13 are a water-reflected slabs;



April 2013 | UNCLASSIFIED

LA-UR-13-28964

Pu-SOL-THERM Benchmarks - III



The E71fix 1.00581 k_{calc} average demonstrates that the 8 benchmark subset reflects the larger population.

Data revisions in the "Leal7a" 239 Pu evaluated file have eliminated ~50% of the long-standing k_{calc} bias ...

... but it's the $v_p(E)$ changes that have the largest impact!

Assembly	ENDF/B-VII.1 (w/MT18 fix ^(d))	JEFF-3.1.2 ^(b)	JENDL-4.0 ^(b)	Leal7a ^(c)	Leal7a RR, nu _p , pfns & e71fix ^(d) + e71
PST1.4	1.00500	1.00127	1.00588	1.00199	1.00222
PST4.1	1.00389	0.99907	1.00482	1.00044	1.00035
PST9	1.01930	1.01367	1.02510	1.01543	1.01548
PST12.10	1.00402	0.99973	1.00498	1.00083	1.00060
PST12.13	1.00970	1.00468	1.01069	1.00611	1.00623
PST18.6	1.00462	1.00153	1.00557	1.00202	1.00210
PST34.4	1.00254	0.99999	1.00417	0.99922	0.99927
PST34.15	0.99731	0.99563	0.99844	0.99679	0.99727
Average	1.00581	1.00195	1.00746	1.00285	1.00294

Calculated Eigenvalues^(a) for a Selection of PST Assemblies

Using Various ²³⁹Pu Cross Sections

a) MCNP calculations are for 50M histories; stochastic uncertainty is ~10 pcm.

b) JEFF-3.1.2 and JENDL-4.0 ²³⁹Pu only; remaining nuclides are ENDF/B-VII.1

c) "LEAL7a" evaluation provides revised resolved resonance parameters coupled to a joint ORNL/CEA evaluated ²³⁹Pu file; remaining nuclides are ENDF/B-VII.1. The "LEAL7a (RR,nu_p,pfns)" file couples just these data to the existing ENDF/B-VII.1(fix) ²³⁹Pu file.

d) "MT18fix" is removal of ²³⁹Pu(n,f) background cross sections near 1-to-2 keV (Kawano).



LA-UR-13-28964

Summary



- Evaluation and data testing for the major actinides remains a "work in progress".
- Multi-national efforts are currently underway under the CIELO Project.

- The work continues ...

