Application of the ROSFOND Evaluated Nuclear Data Library for Criticality Calculations in Continuous-Energy Approximation with SCALE-6.2

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Introduction

1. Modern version of the SCALE Code System contains AMPX-6 – A Modular Code System for Processing ENDF
2. AMPX-6 can produce CE libraries to use with KENO for criticality calculations
3. There are ~4500 ICSBEP benchmark inputs for KENO and 299-group ABBN-93 cross sections
4. If we process the required nuclear data library and adapt the inputs to work with it, we will get many new benchmarks which were not used for validation before due to lack of the MCNP inputs

Studying AMPX – 1/2

1. ENDF/B-7.1 files were processed with AMPX-6
2. k-inf of U-235, U-238, and SCHERZO were calculated
3. Eigenvalues, spectra, and cross-sections were compared with the results calculated with the Original ENDF/B-7.1 CE library from the SCALE-6.2 package
4. Differences were observed

k-inf of → / library ↓	U-235	U-238	SCHERZO
Original	2.2766	0.3059	0.9943
Homemade	+.0001	+.0010	- .0009
Original w/o PT		0.3059	0.9824
Homemade w/o PT		No difference	No difference

Studying AMPX – 2/2

5. U-238 in the Original library contains Probability Tables for MT=1 (total), MT=2 (elastic), MT=102 (n,γ), and MT=51 (n,n’1)
6. U-238 in the Homemade library contains MT=18 (fission) instead of MT=51 (n,n’1)
7. An option found in AMPX-6 was allowed to process U-238 in the same approach as in the Original library and get the same results as the Original library
8. Calculations of a number of benchmarks with fast and intermediate neutron spectra demonstrated agreement between the Original and Homemade ENDF/B-7.1 CE libraries within ~0.01%

Benchmarks with Fast and Intermediate Neutron Spectra – 1/3

Small-size Metal Assemblies – SMA

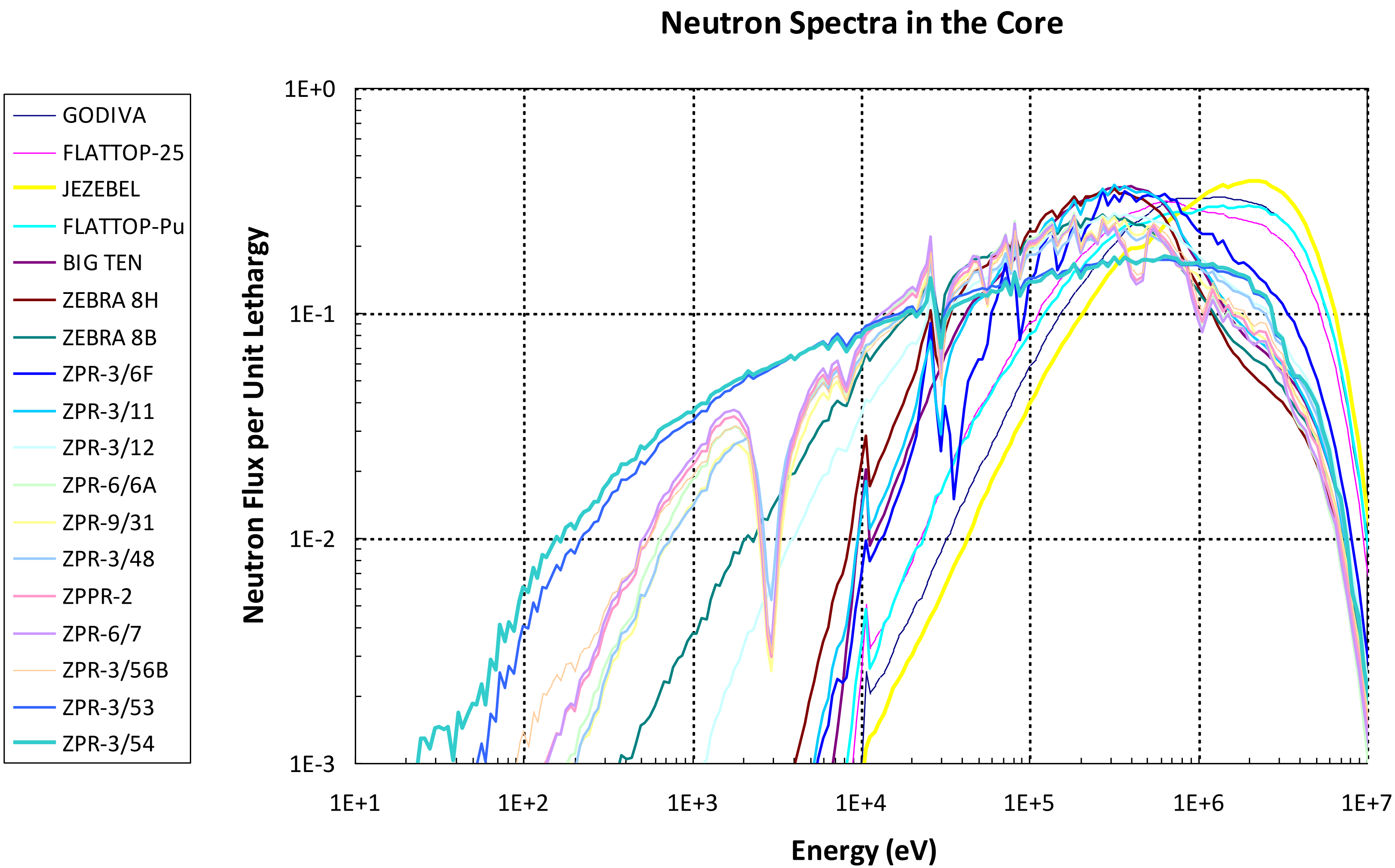
Experiment Name	**ICSBEP Benchmark Identification**	**Fuel**	**Configuration**
GODIVA	HMF-001	U (93% ^{235}U /U)	Unreflected Sphere
FLATTOP-25	HMF-028	U (98% ^{235}U /U)	Uranium-Reflected Sphere
JEZEBEL	PMF-001	Pu (95% ^{239}Pu /Pu)	Unreflected Sphere
FLATTOP-Pu	PMF-006	Pu (95% ^{239}Pu /Pu)	Uranium-Reflected Sphere
BIG TEN	IMF-007	U (10% ^{235}U /U)	Uranium-Reflected Cylinder
ZEBRA 8H	MMF-008-07	U (6% ^{235}U /U)	Infinite Cell
ZEBRA 8B	MMF-008-02	Pu (4.3% ^{239}Pu /U)	Infinite Cell

Benchmarks with Fast and Intermediate Neutron Spectra – 2/3

Reactor Assemblies – RA

Experiment Name	ICSBEP Benchmark Identification	Fuel	Volume, l	N_{U8}/N_{fis}	Core Composition*, at.%					
					FM	O	C	Na	Al	ST
ZPR-3/6F	IMF-015	U	50	1.13	32				45	23
ZPR-3/11	IMF-016	U	138	7.55	83					17
ZPR-3/12	ICF-004	U	101	3.71	38		48			14
ZPR-6/6A	ICI-005	U	3990	5.06	14	29		19		37
ZPR-9/31	MCF-005	Pu	1004	7.37	24		23	19		33
ZPR-3/48	MCF-003	Pu	391	4.36	18		41	12		28
ZPPR-2	MCF-006	Pu	2406	5.08	14	28		20		37
ZPR-6/7	MCF-001	Pu	3120	6.55	14	30		19		36
ZPR-3/56B	MCF-004	Pu	615	4.65	15	30	2	17		36
ZPR-3/53	MMI-004	Pu	198	1.57	6		79			15
ZPR-3/54	MMI-003	Pu	227	1.57	6		79			15
* FM = fissile materials, ST = stainless steel										

Benchmarks with Fast and Intermediate Neutron Spectra – 3/3

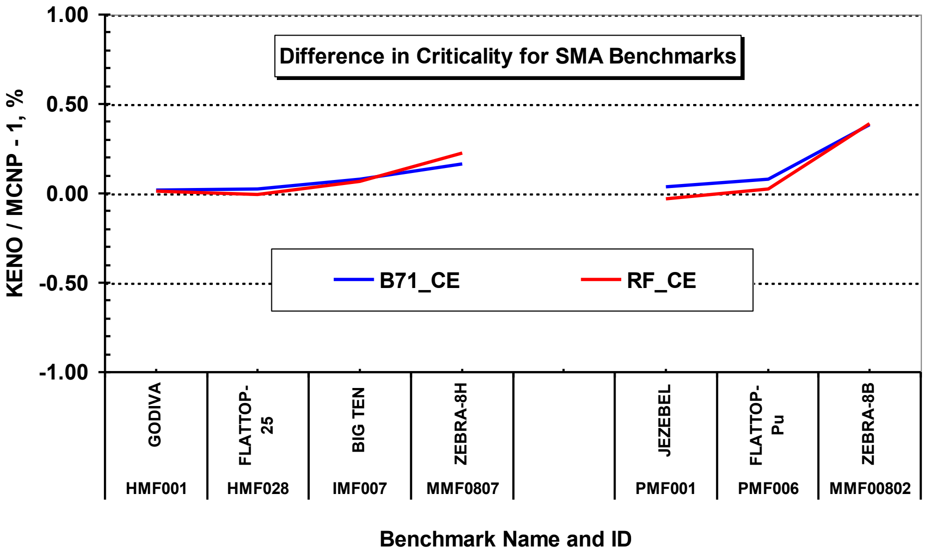


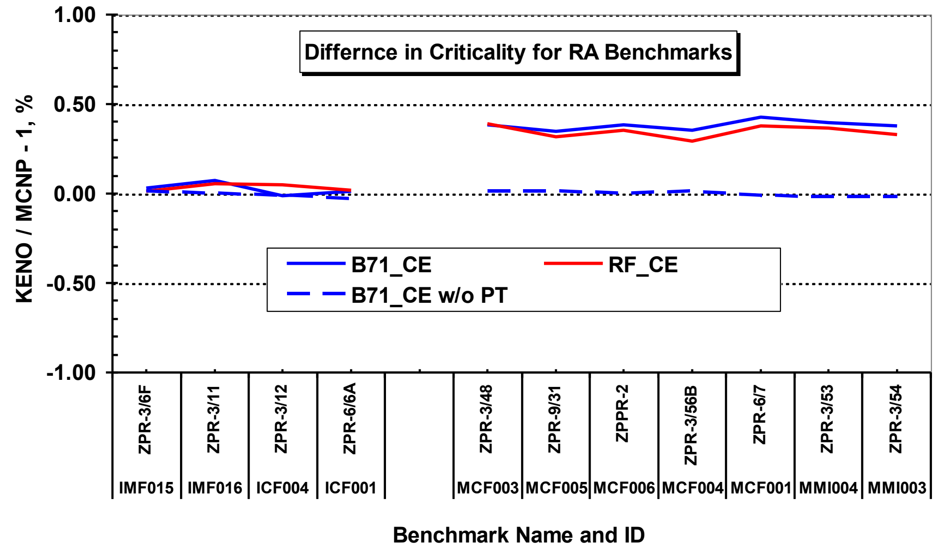
Verification – 1/4

Comparison with MCNP was used for verification

1. ROSFOND files were processed with AMPX-6
2. Benchmarks were calculated with KENO using the ROSFOND CE library
3. Results of KENO/B71_CE and KENO/RF_CE were compared with the results of MCNP/B71_CE and MCNP/RF_CE

Verification – 2/4



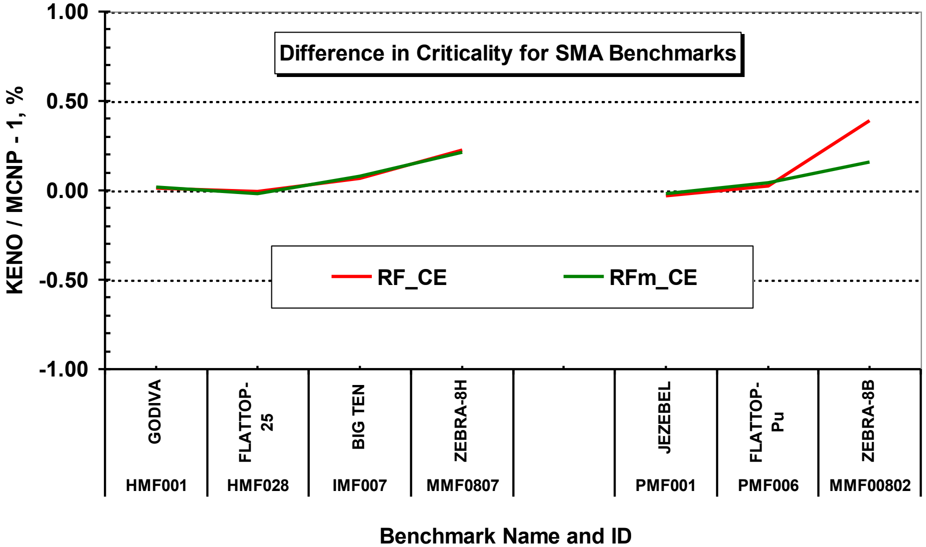


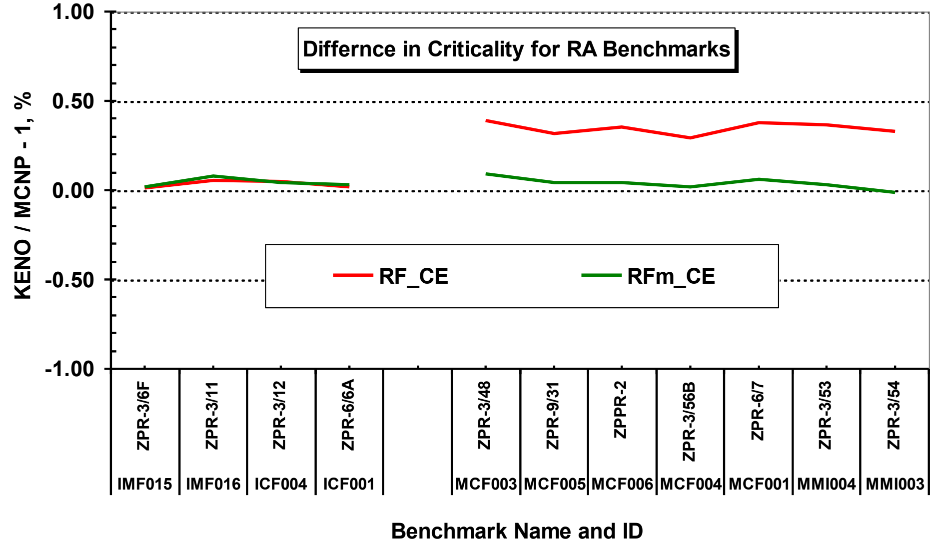
1. Excellent agreement for GODIVA, JEZEBEL, FT-25, FT-Pu
2. Difference ~0.2% for U assemblies with high content of U-238 (BIG TEN, ZEBRA-8H)
3. Good agreement for U reactor assemblies
4. Difference ~0.4% for Pu reactor assemblies

Verification – 3/4

- ENDF/B-7.1 and ROSFOND demonstrates the same trends
- KENO and MCNP results are coincided when probability tables are turned off – so the difference is in the treatment of the unresolved resonance range
- Resonance parameters in the Pu-239 nuclear data files of ENDF/B-7.1 and ROSFOND are specified for reconstruction of the average cross sections while in U-235 they are intended to be used only for self-shielding
- Pu-239 nuclear data file of ROSFOND was modified

Verification – 4/4





1. Excellent agreement for GODIVA, JEZEBEL, FT-25, FT-Pu
2. Difference ~0.2% for U and Pu assemblies with high content of U-238 (BIG TEN, ZEBRA-8H, ZEBRA-8B)
3. Good agreement (+0.04%) for U reactor assemblies
4. Good agreement (+0.04%) for Pu reactor assemblies

Issues Found

- Different processing of the resonance parameters in NJOY and AMPX
- Different approach for self-shielding of inelastic scattering in NJOY and AMPX
- We were not able to process U-235, U-238, Pu-239 from ENDF/B-8 with AMPX

Conclusion

- The AMPX-6 nuclear data processing system was successfully used for processing of the ROSFOND evaluated nuclear data files
- The results of criticality calculations are in a good agreement with MCNP
- The work allowed to involve many new criticality benchmarks in the nuclear data validation process
- The approach will be used for validation of the next version of ROSFOND