

Table 1: MCNP Criticality Validation Suite.

Spectrum	Fast			Intermediate	Thermal	
Geometry	Bare	Heavy Reflector	Light Reflector	Any	Lattice of Fuel Pins in Water	Solution
HEU	Godiva Tinkertoy-2 (c-11)	Flattop-25	Godiver	UH ₃ (6) Zeus (2)	SB-5	ORNL-10
IEU	IEU-MF-03	BIG TEN	IEU-MF-04	Zebra-8H [‡]	IEU-CT-02 (3)	STACY-36
LEU					BaW XI (2)	LEU-ST-02 (2)
²³³ U	Jezebel-233	Flattop-23	U233-MF-05 (2)*	Falstaff (1) [†]	SB-2½	ORNL-11
Pu	Jezebel Jezebel-240 Pu Buttons (3)	Flattop-Pu THOR	Pu-MF-11	HISS/HPG [‡]	PNL-33	PNL-2

* Numbers in parentheses identify a specific case within a sequence of benchmarks

† Extrapolated to critical

‡ k_∞ measurement

Table 2: MCNP5 results for the HEU, IEU, and LEU benchmarks in the Criticality Validation Suite.

Case	Benchmark k_{eff}	Calculated k_{eff}			
		ENDF/B-VII β -2	ENDF/B-VII β -1	ENDF/B-VI	JENDFL-3.3
Godiva	1.0000 ± 0.0010	1.0004 ± 0.0003	0.9999 ± 0.0003	0.9963 ± 0.0003	1.0033 ± 0.0003
Tinkertoy-2 (c-11)	1.0000 ± 0.0038	1.0006 ± 0.0004	1.0006 ± 0.0003	0.9973 ± 0.0004	1.0042 ± 0.0003
Flattop-25	1.0000 ± 0.0030	1.0034 ± 0.0003	1.0033 ± 0.0003	1.0021 ± 0.0003	0.9974 ± 0.0003
Godiver	0.9985 ± 0.0011	1.0005 ± 0.0004	0.9988 ± 0.0004	0.9948 ± 0.0003	1.0019 ± 0.0004
UH ₃ (6)	1.0000 ± 0.0047	0.9953 ± 0.0004	0.9947 ± 0.0004	0.9914 ± 0.0003	0.9967 ± 0.0004
Zeus (2)	0.9997 ± 0.0008	0.9966 ± 0.0003	0.9963 ± 0.0003	0.9942 ± 0.0003	0.9956 ± 0.0003
SB-5	1.0015 ± 0.0028	0.9962 ± 0.0006	0.9959 ± 0.0005	0.9965 ± 0.0005	0.9990 ± 0.0006
ORNL-10	1.0015 ± 0.0026	0.9996 ± 0.0002	0.9987 ± 0.0002	0.9992 ± 0.0002	0.9999 ± 0.0002
IEU-MF-03	1.0000 ± 0.0017	1.0022 ± 0.0003	1.0030 ± 0.0003	0.9987 ± 0.0003	0.9969 ± 0.0002
BIG TEN	0.9948 ± 0.0013	0.9952 ± 0.0002	0.9954 ± 0.0002	1.0071 ± 0.0003	0.9851 ± 0.0002
IEU-MF-04	1.0000 ± 0.0030	1.0078 ± 0.0003	1.0075 ± 0.0003	1.0036 ± 0.0003	1.0024 ± 0.0003
Zebra-8H	1.0300 ± 0.0025	1.0189 ± 0.0002	1.0199 ± 0.0003	1.0406 ± 0.0002	1.0152 ± 0.0002
IEU-CT-02 (3)	1.0017 ± 0.0044	1.0034 ± 0.0003	1.0002 ± 0.0003	1.0004 ± 0.0003	1.0014 ± 0.0003
STACY-36	0.9988 ± 0.0013	0.9989 ± 0.0003	0.9981 ± 0.0003	0.9986 ± 0.0003	0.9999 ± 0.0003
BaW XI (2)	1.0007 ± 0.0012	1.0012 ± 0.0003	1.0005 ± 0.0003	0.9968 ± 0.0003	0.9991 ± 0.0003
LEU-ST-02 (2)	1.0024 ± 0.0037	0.9954 ± 0.0003	0.9951 ± 0.0003	0.9953 ± 0.0003	0.9963 ± 0.0003

$\sigma < |\Delta k| \leq 2\sigma$

$|\Delta k| > 2\sigma$

Table 3: MCNP5 results for the ^{233}U and Pu benchmarks in the Criticality Validation Suite.

Case	Benchmark k_{eff}	Calculated k_{eff}			
		ENDF/B-VII β -2	ENDF/B-VII β -1	ENDF/B-VI	JENDFL-3.3
Jezebel-233	1.0000 ± 0.0010	0.9996 ± 0.0003	0.9997 ± 0.0003	0.9926 ± 0.0003	1.0041 ± 0.0003
Flattop-23	1.0000 ± 0.0014	0.9990 ± 0.0003	0.9992 ± 0.0003	1.0003 ± 0.0003	0.9985 ± 0.0003
U233-MF-05 (2)	1.0000 ± 0.0030	0.9977 ± 0.0003	0.9979 ± 0.0003	0.9972 ± 0.0003	1.0019 ± 0.0003
Falstaff (1)	1.0000 ± 0.0083	0.9910 ± 0.0005	0.9897 ± 0.0005	0.9895 ± 0.0005	0.9879 ± 0.0005
SB-2½	1.0000 ± 0.0024	1.0042 ± 0.0005	1.0015 ± 0.0005	0.9964 ± 0.0004	0.9979 ± 0.0005
ORNL-11	1.0006 ± 0.0029	1.0046 ± 0.0002	1.0037 ± 0.0002	0.9974 ± 0.0002	0.9989 ± 0.0002
Jezebel	1.0000 ± 0.0020	1.0001 ± 0.0003	1.0002 ± 0.0003	0.9971 ± 0.0003	0.9966 ± 0.0003
Jezebel-240	1.0000 ± 0.0020	0.9996 ± 0.0003	0.9999 ± 0.0003	0.9980 ± 0.0003	1.0009 ± 0.0003
Pu Buttons (3)	1.0000 ± 0.0030	0.9988 ± 0.0003	0.9992 ± 0.0003	0.9962 ± 0.0003	0.9958 ± 0.0003
Flattop-Pu	1.0000 ± 0.0030	0.9999 ± 0.0003	1.0002 ± 0.0003	1.0016 ± 0.0003	0.9904 ± 0.0003
THOR	1.0000 ± 0.0006	0.9993 ± 0.0003	0.9997 ± 0.0003	1.0057 ± 0.0003	1.0066 ± 0.0003
Pu-MF-11	1.0000 ± 0.0010	1.0003 ± 0.0003	0.9998 ± 0.0003	0.9966 ± 0.0004	0.9982 ± 0.0003
HISS/HPG	1.0000 ± 0.0110	1.0116 ± 0.0002	1.0114 ± 0.0002	1.0106 ± 0.0003	1.0134 ± 0.0003
PNL-33	1.0024 ± 0.0021	1.0066 ± 0.0003	1.0063 ± 0.0003	1.0029 ± 0.0003	1.0069 ± 0.0003
PNL-2	1.0000 ± 0.0065	1.0045 ± 0.0004	1.0028 ± 0.0005	1.0031 ± 0.0005	1.0062 ± 0.0005

$\sigma < |\Delta k| \leq 2\sigma$

$|\Delta k| > 2\sigma$

Table 4: MCNP5 results for Other Cases

Case	Benchmark k_{eff}	Calculated k_{eff}			
		ENDF/B-VII β -2	ENDF/B-VII β -1	ENDF/B-VI	JENDFL-3.3
Unmoderated Zeus	1.0004 \pm 0.0016	1.0113 \pm 0.0003 0.9998 \pm 0.0003*	1.0116 \pm 0.0003 0.9998 \pm 0.0003*	1.0077 \pm 0.0003 0.9971 \pm 0.0003*	1.0041 \pm 0.0003 1.0000 \pm 0.0003*
Pu-MF-09 (3a)	1.0003 \pm 0.0033	1.0189 \pm 0.0002	1.0189 \pm 0.0002	1.0189 \pm 0.0002	1.0227 \pm 0.0002
Np sphere	1.0019 \pm 0.0036	0.9954 \pm 0.0002	0.9920 \pm 0.0002	0.9889 \pm 0.0003	0.9967 \pm 0.0002

$$\sigma < |\Delta k| \leq 2\sigma$$

$$|\Delta k| > 2\sigma$$

* ENDF/B-V cross sections for copper

The unmoderated Zeus benchmark is a short, squat cylinder of HEU reflected by copper (fast spectrum)

Pu-MF-09 (3a) is a sphere of plutonium nitrate, the same size as ORNL-10 and ORNL-11 (very thermal spectrum)

The Np sphere is a sphere of neptunium reflected by HEU (fast spectrum)

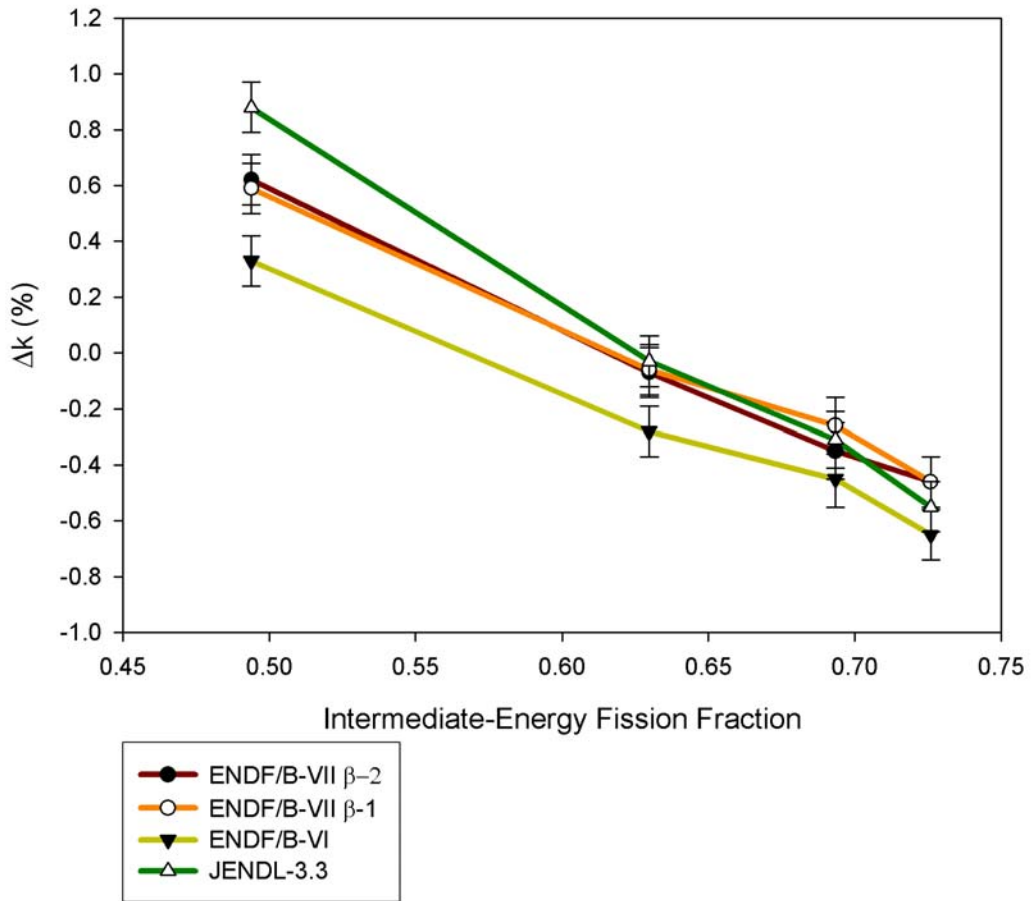


Figure 1. Reactivity Bias for Zeus Graphite Benchmarks.

The four Zeus graphite benchmarks have a cylindrical core of HEU platters interspersed with graphite platters for moderation. The core is reflected on all sides by copper. As the figure indicates, all of them have intermediate spectra.