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Spectral Indices Benchmarks for Nine Los Alamos Fast Critical Assemblies:

Godiva, Flattop-25, Big Ten, Jezebel, Flattop-Pu, Thor, Jezebel-23, Flattop-23, and Dirty Jezebel

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Auspices

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Introduction:

Measured values for cross section (reaction rate) ratios at the center of Godiva, Flattop-25, Big Ten, Jezebel, Flattop-Pu, Thor, Jezebel-23, Flattop-23, and Dirty Jezebel have been reported by Alwin, Trkov and Pelloni. This document provides the corresponding calculational results using COG 11.3 with ENDF/B-VIII.0, IRDFF-II, and JEFF-3.3 cross-section libraries.

Methodology:

The dimensions and materials for each assembly are specified in the ICSBEP Handbook using simplified models. Each spectral index is calculated as the ratio of the reaction rate (<RR>) of interest relative to the U-235 fission reaction rate – or in a few cases relative to the P-31(n,p), U235(n,g) or U238(n,ng) reaction rate. The reaction rate is simply the flux within a spherical diameter of 0.5 cm at the center of each assembly (*a la* Trkov) weighted by the reaction cross section used as a detector response function, which in no way perturbs the flux.

Therefore, two detectors are used to calculate a spectral index. In all cases, a reaction detector (e.g., number=#0000015 for ^{239}Pu fission) is used to score a reaction rate (<RR>) of interest averaged over all energies, and another (e.g., number=#0000012) is used to score the fission reaction rate in ^{235}U over all energies:

```
number=#0000012 title="Godiva spectrum averaged   U-235(n,f) reaction rate" reaction 1 0.065449847 drf-e neutron r-rate 12 15
number=#0000015 title="Godiva spectrum averaged Pu-239(n,f) reaction rate" reaction 1 0.065449847 drf-e neutron r-rate 15 15
```

The spectral index (in this case for ^{239}Pu fission relative to ^{235}U fission) is then just the ratio of the two (reaction rate) detector results. Complete sample input files are provided in Appendices F.1-F.7.

Note that "r-rate" corresponds to a reaction number for a material specified using the nlib parameter in the MIX block; e.g., nlib=ENDFB8R0. This library corresponds to a complete library suitable for particle transport. COG11.3 also provides a doslib parameter; e.g., doslib=IRDFF-II. In this case "irdff-r-r" is used to specify reaction rates from an incomplete library of partial (dosimetry) reactions.

Results:

COG11.3 results for various libraries for particle transport and reaction rate calculations are provided in the detailed tables in Appendices A-E as summarized in Table 1.

Table 1. COG11.3 Results

Appendix	Particle Transport	Reaction Rate	Comments
A	ENDFB8R0	ENDFB8R0	P31(n,p)*
B	ENDFB8R0	IRDFF-II	
C	JEFF3.3	JEFF3.3	P31(n,p)*
D	ENDFB8R0	IRDFF1.05	In115(n,ng)
E	ENDFB8R0	ENDFBV	Co59(n,g)

*IRDFF-II used for P31(n,p) reaction rate.

The detailed results in Appendices A-E also provide the ratio of calculated-to-experimental values (i.e., C/E values) together with combined experimental and calculational uncertainties. Table 2 identifies the libraries which produced reliable results, i.e., with $|C/E-1| \leq 3\sigma$.

Table 2. Recommended Libraries for Reaction Rate Calculations

Th232(n,f)	None
U233(n,f)	ENDFB8R0 JEFF3.3
U235(n,f)	ENDFB8R0 IRDFF-II JEFF3.3
U238(n,f)	ENDFB8R0 IRDFF-II [a]
Np237(n,f)	ENDFB8R0 IRDFF-II JEFF3.3
Pu239(n,f)	ENDFB8R0 IRDFF-II JEFF3.3
Am241(n,f)	ENDFB8R0 IRDFF-II JEFF3.3

Th232(n,2n)	None
U238(n,2n)	None

B10(n,a)	ENDFB8R0 [b] JEFF3.3
Al27(n,a)	ENDFB8R0 JEFF3.3

Al27(n,p)	ENDFB8R0 IRDFF-II JEFF3.3
P31(n,p)	IRDFF-II
S32(n,p)	IRDFF-II
Sc45(n,p)	None
Ti46(n,p)	IRDFF-II
Ti47(n,p)	IRDFF-II
Ti48(n,p)	IRDFF-II
Fe54(n,p)	ENDFB8R0
Fe56(n,p)	ENDFB8R0 IRDFF-II JEFF3.3
Ni58(n,p)	IRDFF-II

Mn55(n,g)	ENDFB8R0
Fe58(n,g)	None
Co59(n,g)	None [c]
Cu63(n,g)	ENDFB8R0 [d] IRDFF-II [d]
Nb93(n,g)	ENDFB8R0 IRFF-II JEFF3.3
La139(n,g)	ENDFB8R0 IRDFF-II JEFF3.3
Ta181(n,g)	ENDFB8R0 IRDFF-II JEFF3.3
Au197(n,g)	ENDFB8R0 [e] IRDFF-II [e] JEFF3.3
In115(n,ng)	None
Th232(n,g)	None
U238(n,g)	None

Notes:

[a] $|C/E-1| > 3\sigma$ (slightly) for Godiva.
[b] $|C/E-1| > 3\sigma$ (slightly) for Big-Ten.
[c] Inconsistent results for Big-Ten (good) and Godiva (bad).
[d] Trkov uncertainty is ten times larger than that of Pelloni for Big-Ten and therefore ignored. $|C/E-1| > 3\sigma$ (slightly) for Jezebel.
[e] Trkov value is inconsistent with Pelloni for Jezebel with good results for other assemblies; therefore, ignored as suspect.

Remarks:

The references are not primary sources of the experimental data and inconsistency in the reported values are noted. For example, Alwin and Trkov have identical values for U238(n,f)/U235(n,f) for Jezebel but different values for Flattop-Pu. Similarly for Big-Ten, Trkov and Pelloni have identical values for U238(n,g)/U235(n,f) but different values for Pu239(n,f)/U235(n,f).

In most cases these discrepancies are small and do not impact C/E values by more than a few percent. However, in some cases, such as Cu63(n,g)/U235(n,f) for Big-Ten, and Aug197(n,g)/U235(n,f) for Jezebel, these discrepancies are significant.

The limited set of values published by Capote are identical with those of Alwin. The "Exp-A" and "Exp-B" values reported by Brown appear to be mostly consistent with those of Pelloni and Alwin, respectively. Those values that are unique to Brown for Big-Ten, Jezebel-23 and Flattop-23 are included in the tables.

In all cases, the uncertainty in the spectral indices due to assembly materials, dimensions, and model simplifications is unknown as are uncertainties due to sample self-shielding, positioning, sample holders, fission product buildup and decay, decay of activation products, detector efficiency, and independent measurements. Some of these components to total uncertainty may be significant thereby limiting the value of these benchmarks to assessments of the quality of nuclear data.

References:

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Appendix A

COG 11.3 Results Using ENDF/B-VIII.0 for Transport and Reaction Rates

Table A-1. Godiva (HMF001)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
Mn55(n,g)/U235(n,f)	(5.5619-5 ± 0.83%) / (1.6436-2 ± 0.25%) = 0.0034 ± 0.87%	0.0027 ± 7.41%	Trkov Pelloni	1.25 ± 7.46%
Co59(n,g)/U235(n,f)	(8.4965-5 ± 0.69%) / (1.6436-2 ± 0.25%) = 0.0052 ± 0.73%	0.0380 ± 7.89%	Trkov Pelloni	**0.14** ± 7.92%
Cu63(n,g)/U235(n,f)	(1.9353-4 ± 0.41%) / (1.6436-2 ± 0.25%) = 0.0118 ± 0.48%	0.0117 ± 5.13%	Trkov Pelloni	1.01 ± 5.15%
Nb93(n,g)/U235(n,f)	(5.5548-4 ± 0.39%) / (1.6436-2 ± 0.25%) = 0.0338 ± 0.46%	0.0300 ± 10.0%	Trkov Pelloni	1.13 ± 10.0%
La139(n,g)/U235(n,f)	(1.1011-4 ± 0.34%) / (1.6436-2 ± 0.25%) = 0.0067 ± 0.42%	0.0073 ± 8.22%	Trkov	0.92 ± 8.23%
Ta181(n,g)/U235(n,f)	(1.9726-3 ± 0.33%) / (1.6436-2 ± 0.25%) = 0.1200 ± 0.41%	0.1230 ± 9.76%	Trkov	0.98 ± 9.77%
Au197(n,g)/U235(n,f)	(1.5486-3 ± 0.34%) / (1.6436-2 ± 0.25%) = 0.0942 ± 0.42%	0.1000 ± 2.00%	Trkov Pelloni	0.94 ± 2.04%
U233(n,f)/U235(n,f)	(2.5951-2 ± 0.25%) / (1.6436-2 ± 0.25%) = 1.5789 ± 0.35%	1.59 ± 1.89%	Alwin Pelloni	0.99 ± 1.92%
U238(n,f)/U235(n,f)	(2.6091-3 ± 0.40%) / (1.6436-2 ± 0.25%) = 0.1587 ± 0.47%	0.1643 ± 1.10% 0.1647 ± 1.09%	Alwin Pelloni	0.97 ± 1.20% 0.96 ± 1.19%
Np237(n,f)/U235(n,f)	(1.3683-2 ± 0.29%) / (1.6436-2 ± 0.25%) = 0.8325 ± 0.38%	0.8516 ± 1.41% 0.837 ± 1.55%	Alwin Pelloni	0.98 ± 1.44% 0.99 ± 1.63%
Pu239(n,f)/U235(n,f)	(2.2758-2 ± 0.25%) / (1.6436-2 ± 0.25%) = 1.3846 ± 0.35%	1.4152 ± 0.99% 1.402 ± 1.78%	Alwin Pelloni	0.98 ± 1.05% 0.99 ± 1.81%
Al27(n,a)/P31(n,p)*	(6.3067-6 ± 2.69%) / (2.7897-4 ± 0.51%) = 0.0226 ± 2.74%	0.0215 ± 3.55%	Trkov	1.05 ± 4.48%
Al27(n,p)/P31(n,p)*	(3.1978-5 ± 1.00%) / (2.7897-4 ± 0.51%) = 0.1146 ± 1.12%	0.1126 ± 4.88%	Trkov	1.02 ± 5.01%
Fe56(n,p)/P31(n,p)*	(9.3250-6 ± 1.87%) / (2.7897-4 ± 0.51%) = 0.0334 ± 1.94%	0.0310 ± 5.80%	Trkov	1.08 ± 6.12%

File: HMF001-1-SI-2. Note: *All ENDF/B-VIII.0 results for P31(n,p) were zero; IRDFF-II used instead – see Table B-1.

Table A-2. Flattop-25 (HMF028)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
S32(n,p)/U235(n,f)	All results were zero	0.0306 ± 5.88%	Trkov	N/A
U233(n,f)/U235(n,f)	(3.8935-2 ± 0.20%) / (2.4679-2 ± 0.20%) = 1.5777 ± 0.28%	1.608 ± 1.87% 1.60 ± 1.87%	Alwin Pelloni	0.98 ± 2.64% 0.99 ± 2.64%
U238(n,f)/U235(n,f)	(3.5840-3 ± 0.34%) / (2.4679-2 ± 0.20%) = 0.1452 ± 0.39%	0.1397 ± 5.01% 0.1492 ± 1.07% 0.149 ± 1.34%	Trkov Alwin Pelloni	1.04 ± 5.03% 0.97 ± 1.14% 0.97 ± 1.40%
Np237(n,f)/U235(n,f)	(1.9075-2 ± 0.24%) / (2.4679-2 ± 0.20%) = 0.7729 ± 0.31%	0.7804 ± 1.28% 0.7804 ± 1.28% 0.76 ± 1.32%	Trkov Alwin Pelloni	0.99 ± 1.32% 0.99 ± 1.32% 1.02 ± 1.36%
Pu239(n,f)/U235(n,f)	(3.3611-2 ± 0.20%) / (2.4679-2 ± 0.20%) = 1.3619 ± 0.28%	1.3070 ± 4.97% 1.3847 ± 0.87% 1.37 ± 1.46%	Trkov Alwin Pelloni	1.04 ± 4.98% 0.98 ± 0.91% 0.99 ± 1.49%
Am241(n,f)/U235(n,f)	(1.7790-2 ± 0.27%) / (2.4679-2 ± 0.20%) = 0.7209 ± 0.34%	0.7540 ± 5.04%	Trkov	0.96 ± 5.05%
Al27(n,a)/P31(n,p)*	(8.3485-6 ± 2.30%) / (3.9081-4 ± 0.44%) = 0.0214 ± 2.34%	0.0202 ± 5.48%	Trkov	1.06 ± 5.96%
Al27(n,p)/P31(n,p)*	(4.3379-5 ± 0.85%) / (3.9081-4 ± 0.44%) = 0.1110 ± 0.96%	0.1128 ± 4.74%	Trkov	0.98 ± 4.84%
Fe56(n,p)/P31(n,p)*	(1.2536-5 ± 1.58%) / (3.9081-4 ± 0.44%) = 0.0321 ± 1.64%	0.0306 ± 5.47%	Trkov	1.05 ± 5.71%
U238(n,f)/P31(n,p)*	(3.5840-3 ± 0.34%) / (3.9081-4 ± 0.44%) = 9.1707 ± 0.56%	8.9810 ± 4.41%	Trkov	1.02 ± 4.44%

File: HMF028-1-SI-2. Note: *All ENDF/B-VIII.0 results for P31(n,p) were zero; IRDFF-II used instead – see Table B-2.

Table A-3. Big-Ten (IMF007)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
Li6(n,a)/U235(n,f)	All results were zero	0.7100 ± 1.41%	Trkov Pelloni	N/A
B10(n,a)/U235(n,f)	(2.0962-3 ± 0.91%) / (2.2453-3 ± 0.75%) = 0.9336 ± 1.18%	1.0110 ± 1.38%	Trkov Pelloni	**0.92** ± 1.82%
Al27(n,a)/U235(n,f)	(2.0056-7 ± 15.6%) / (2.2453-3 ± 0.75%) = 8.9E-5 ± 15.6%	7.8E-5 ± 2.56%	Trkov Pelloni	1.15 ± 15.8%
Sc45(n,p)/U235(n,f)	All results were zero	0.0132 ± 2.27%	Trkov Pelloni	N/A
Ti46(n,p)/U235(n,f)	All results were zero	0.0013 ± 2.31%	Trkov Pelloni	N/A
Ti47(n,p)/U235(n,f)	All results were zero	0.0022 ± 4.19% 0.0022 ± 1.40%	Trkov Pelloni	N/A
Ti48(n,p)/U235(n,f)	All results were zero	3.6E-5 ± 2.78%	Trkov Pelloni	N/A
Fe54(n,p)/U235(n,f)	(1.7412-5 ± 3.74%) / (2.2453-3 ± 0.75%) = 0.0078 ± 3.81%	0.0090 ± 3.33%	Trkov Pelloni	0.86 ± 5.06%
Fe58(n,g)/U235(n,f)	(1.1692-5 ± 4.75%) / (2.2453-3 ± 0.75%) = 0.0052 ± 4.81%	0.0031 ± 3.23%	Trkov Pelloni	**1.68** ± 5.74%
Co59(n,g)/U235(n,f)	(1.8487-5 ± 1.99%) / (2.2453-3 ± 0.75%) = 0.0082 ± 2.13%	0.0095 ± 2.11%	Trkov Pelloni	**0.87** ± 3.00%
Ni58(n,p)/U235(n,f)	All results were zero	0.0123 ± 1.63%	Trkov Pelloni	N/A
Cu63(n,g)/U235(n,f)	(4.0048-5 ± 1.67%) / (2.2453-3 ± 0.75%) = 0.0178 ± 1.83%	0.0164 ± 0.61% 0.0164 ± 6.10%	Trkov Pelloni	**1.09** ± 1.93% 1.09 ± 6.37%
In115(n,ng)/U235(n,f)	(2.4260-4 ± 2.19%) / (2.2453-3 ± 0.75%) = 0.1080 ± 2.31%	0.0271 ± 2.21%	Pelloni	**3.99** ± 3.20%
Au197(n,g)/U235(n,f)	(3.7015-4 ± 0.91%) / (2.2453-3 ± 0.75%) = 0.1649 ± 1.18%	0.1670 ± 1.80%	Trkov Pelloni	0.99 ± 2.15%
U233(n,f)/U235(n,f)	(3.4873-3 ± 0.74%) / (2.2453-3 ± 0.75%) = 1.5532 ± 1.05%	1.580 ± 1.90%	Pelloni	0.98 ± 2.17%
U238(n,g)/U235(n,f)	(2.4041-4 ± 0.92%) / (2.2453-3 ± 0.75%) = 0.1071 ± 1.19%	0.1100 ± 2.73%	Trkov Pelloni	0.97 ± 2.98%
U238(n,f)/U235(n,f)	(7.8651-5 ± 2.31%) / (2.2453-3 ± 0.75%) = 0.0350 ± 2.43%	0.0375 ± 2.40% 0.0374 ± 0.90% 0.0373 ± 1.07%	Brown Trkov Pelloni	0.93 ± 3.42% 0.94 ± 2.59% 0.94 ± 2.65%
Np237(n,f)/U235(n,f)	(7.0121-4 ± 1.20%) / (2.2453-3 ± 0.75%) = 0.3123 ± 1.42%	0.3223 ± 1.20% 0.316 ± 1.58%	Trkov Pelloni	0.97 ± 1.86% 0.99 ± 2.12%
Pu239(n,f)/U235(n,f)	(2.6293-3 ± 0.73%) / (2.2453-3 ± 0.75%) = 1.1710 ± 1.05%	1.198 ± 2.34% 1.1936 ± 0.70% 1.185 ± 1.69%	Brown Trkov Pelloni	0.98 ± 2.56% 0.98 ± 1.26% 0.99 ± 1.99%

File: IMF007-1s-SI-2.

Table A-4. Jezebel (PMF001)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
Mn55(n,g)/U235(n,f)	$\frac{(8.9420\text{-}5 \pm 0.64\%)}{(3.1897\text{-}2 \pm 0.17\%)} = 0.0028 \pm 0.66\%$	$0.0028 \pm 6.90\%$	Trkov	$1.00 \pm 6.93\%$
Cu63(n,g)/U235(n,f)	$\frac{(3.2061\text{-}4 \pm 0.47\%)}{(3.1897\text{-}2 \pm 0.17\%)} = 0.0101 \pm 0.50\%$	$0.0122 \pm 4.92\%$	Trkov	**0.82** $\pm 4.95\%$
Nb93(n,g)/U235(n,f)	$\frac{(8.7373\text{-}4 \pm 0.31\%)}{(3.1897\text{-}2 \pm 0.17\%)} = 0.0274 \pm 0.35\%$	$0.0276 \pm 10.87\%$ $0.023 \pm 8.70\%$	Trkov Pelloni	$0.99 \pm 10.9\%$ $1.19 \pm 8.7\%$
Aug197(n,g)/U235(n,f)	$\frac{(2.4482\text{-}3 \pm 0.26\%)}{(3.1897\text{-}2 \pm 0.17\%)} = 0.0768 \pm 0.31\%$	$0.1012 \pm 2.47\%$ $0.083 \pm 2.41\%$	Trkov Pelloni	**0.76** $\pm 2.49\%$ $0.92 \pm 2.43\%$
U233(n,f)/U235(n,f)	$\frac{(4.9949\text{-}2 \pm 0.17\%)}{(3.1897\text{-}2 \pm 0.17\%)} = 1.5659 \pm 0.24\%$	$1.578 \pm 1.71\%$	Alwin Pelloni	$0.99 \pm 1.73\%$
U238(n,f)/U235(n,f)	$\frac{(6.7659\text{-}3 \pm 0.24\%)}{(3.1897\text{-}2 \pm 0.17\%)} = 0.2121 \pm 0.29\%$	$0.2133 \pm 1.08\%$ $0.2133 \pm 1.08\%$ $0.2137 \pm 1.08\%$	Alwin Trkov Pelloni	$0.99 \pm 1.12\%$ $0.99 \pm 1.12\%$ $0.99 \pm 1.12\%$
Np237(n,f)/U235(n,f)	$\frac{(3.1177\text{-}2 \pm 0.19\%)}{(3.1897\text{-}2 \pm 0.17\%)} = 0.9774 \pm 0.25\%$	$0.9835 \pm 1.42\%$ $0.9835 \pm 1.42\%$ $0.962 \pm 1.66\%$	Alwin Trkov Pelloni	$0.99 \pm 1.44\%$ $0.99 \pm 1.44\%$ $1.02 \pm 1.68\%$
Pu239(n,f)/U235(n,f)	$\frac{(4.5528\text{-}2 \pm 0.17\%)}{(3.1897\text{-}2 \pm 0.17\%)} = 1.4273 \pm 0.24\%$	$1.4609 \pm 0.89\%$ $1.4609 \pm 0.89\%$ $1.448 \pm 2.00\%$	Alwin Trkov Pelloni	$0.98 \pm 0.92\%$ $0.98 \pm 0.92\%$ $0.99 \pm 2.01\%$

File: pmf001-SI-2.

Table A-5. Flattop-Pu (PMF006)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
U238(n,f)/U235(n,f)	$\frac{(8.2529\text{-}3 \pm 0.20\%)}{(4.5742\text{-}2 \pm 0.14\%)} = 0.1804 \pm 0.24\%$	$0.1772 \pm 1.13\%$ $0.1799 \pm 1.11\%$ $0.180 \pm 1.67\%$	Trkov Alwin Pelloni	$1.02 \pm 1.16\%$ $1.00 \pm 1.14\%$ $1.00 \pm 1.69\%$
Np237(n,f)/U235(n,f)	$\frac{(3.9272\text{-}2 \pm 0.16\%)}{(4.5742\text{-}2 \pm 0.14\%)} = 0.8586 \pm 0.21\%$	$0.8561 \pm 1.40\%$ $0.8561 \pm 1.40\%$ $0.84 \pm 1.19\%$	Alwin Trkov Pelloni	$1.00 \pm 1.42\%$ $1.00 \pm 1.42\%$ $1.02 \pm 1.21\%$

File: pmf006-SI-2.

Table A-6. Thor (PMF008)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
Th232(n,g)/U235(n,g)	$\frac{(3.9739\text{-}3 \pm 0.19\%)}{(4.4239\text{-}3 \pm 0.21\%)} = 0.8983 \pm 0.28\%$	$1.20 \pm 5.00\%$	Pelloni	**0.75** $\pm 5.01\%$
Th232(n,2n)/U238(n,ng)	$\frac{(5.9568\text{-}4 \pm 1.34\%)}{(8.2132\text{-}2 \pm 0.15\%)} = 0.0073 \pm 1.35\%$	$1.04 \pm 2.88\%$	Pelloni	**0.01** $\pm 3.18\%$
Th232(n,f)/U235(n,f)	$\frac{(2.0680\text{-}3 \pm 0.22\%)}{(4.3405\text{-}2 \pm 0.14\%)} = 0.0476 \pm 0.26\%$	$0.26 \pm 3.85\%$	Pelloni	**0.18** $\pm 3.86\%$
U238(n,2n)/U235(n,f)	$\frac{(5.2191\text{-}4 \pm 0.12\%)}{(4.3405\text{-}2 \pm 0.14\%)} = 0.0120 \pm 0.18\%$	$0.053 \pm 5.66\%$	Pelloni	**0.23** $\pm 5.66\%$
U238(n,g)/U235(n,f)	$\frac{(2.9564\text{-}3 \pm 0.20\%)}{(4.3405\text{-}2 \pm 0.14\%)} = 0.0681 \pm 0.24\%$	$0.0830 \pm 3.61\%$	Trkov Pelloni	**0.82** $\pm 3.62\%$
U238(n,f)/U235(n,f)	$\frac{(8.4546\text{-}3 \pm 0.21\%)}{(4.3405\text{-}2 \pm 0.14\%)} = 0.1948 \pm 0.25\%$	$0.1962 \pm 1.10\%$ $0.195 \pm 1.54\%$	Trkov Pelloni	$0.99 \pm 1.13\%$ $1.00 \pm 1.56\%$
Np237(n,f)/U235(n,f)	$\frac{(3.9771\text{-}2 \pm 0.16\%)}{(4.3405\text{-}2 \pm 0.14\%)} = 0.9163 \pm 0.21\%$	$0.9419 \pm 1.17\%$ $0.92 \pm 2.17\%$	Trkov Pelloni	$0.97 \pm 1.19\%$ $1.00 \pm 2.18\%$

Files: pmf008-SI-2.

Table A-7. Jezebel-23 (UMF001)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
U238(n,f)/U235(n,f)	$\frac{(6.1987\text{-}3 \pm 0.25\%)}{(2.9252\text{-}2 \pm 0.18\%)} = 0.2119 \pm 0.31\%$	$0.213 \pm 1.08\%$	Pelloni	$0.99 \pm 1.12\%$
Np237(n,f)/U235(n,f)	$\frac{(2.8792\text{-}2 \pm 0.20\%)}{(2.9252\text{-}2 \pm 0.18\%)} = 0.9843 \pm 0.27\%$	$0.997 \pm 1.50\%$ $0.977 \pm 1.64\%$	Brown Pelloni	$0.99 \pm 1.52\%$ $1.01 \pm 1.66\%$

Files: u233mf001-SI-2.

Table A-8. Flattop-23 (UMF006)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
U238(n,f)/U235(n,f)	$\frac{(8.1660\text{-}3 \pm 0.22\%)}{(4.3308\text{-}2 \pm 0.15\%)} = 0.1886 \pm 0.27\%$	$0.1916 \pm 1.10\%$ $0.191 \pm 1.57\%$	Brown Pelloni	$0.98 \pm 1.13\%$ $0.99 \pm 1.59\%$
Np237(n,f)/U235(n,f)	$\frac{(3.9017\text{-}2 \pm 0.17\%)}{(4.3308\text{-}2 \pm 0.15\%)} = 0.9009 \pm 0.23\%$	$0.9103 \pm 1.43\%$ $0.89 \pm 1.12\%$	Brown Pelloni	$0.99 \pm 1.45\%$ $1.01 \pm 1.14\%$

File: u233mf006-SI-2.

Table A-9. Dirty Jezebel (PMF002)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
U238(n,f)/U235(n,f)	$\frac{(6.1402\text{-}3 \pm 0.24\%)}{(2.9730\text{-}2 \pm 0.17\%)} = 0.2065 \pm 0.29\%$	$0.206 \pm 1.46\%$	Pelloni	$1.00 \pm 1.49\%$
Np237(n,f)/U235(n,f)	$\frac{(2.8515\text{-}2 \pm 0.19\%)}{(2.9730\text{-}2 \pm 0.17\%)} = 0.9591 \pm 0.25\%$	$0.92 \pm 2.17\%$	Pelloni	$1.04 \pm 2.18\%$

File: pmf002-SI-2.

Appendix B

COG 11.3 Results Using ENDF/B-VIII.0 for Transport and IRDFF-II for Reaction Rates

Table B-1. Godiva (HMF001)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
Mn55(n,g)/U235(n,f)	$\frac{(5.5971\text{-}5 \pm 0.74\%)}{(1.6448\text{-}2 \pm 0.25\%)} = 0.0034 \pm 0.78\%$	$0.0027 \pm 7.41\%$	Trkov Pelloni	**1.26** $\pm 7.45\%$
Co59(n,g)/U235(n,f)	$\frac{(1.0267\text{-}4 \pm 0.53\%)}{(1.6448\text{-}2 \pm 0.25\%)} = 0.0062 \pm 0.59\%$	$0.0380 \pm 7.89\%$	Trkov Pelloni	**0.16** $\pm 7.91\%$
Cu63(n,g)/U235(n,f)	$\frac{(1.8740\text{-}4 \pm 0.55\%)}{(1.6448\text{-}2 \pm 0.25\%)} = 0.0114 \pm 0.60\%$	$0.0117 \pm 5.13\%$	Trkov Pelloni	$0.97 \pm 5.17\%$
Nb93(n,g)/U235(n,f)	$\frac{(5.2523\text{-}4 \pm 0.50\%)}{(1.6448\text{-}2 \pm 0.25\%)} = 0.0319 \pm 0.56\%$	$0.0300 \pm 10.0\%$	Trkov Pelloni	$1.06 \pm 10.0\%$
La139(n,g)/U235(n,f)	$\frac{(1.0459\text{-}4 \pm 0.39\%)}{(1.6448\text{-}2 \pm 0.25\%)} = 0.0064 \pm 0.46\%$	$0.0073 \pm 8.22\%$	Trkov	$0.87 \pm 8.23\%$
Ta181(n,g)/U235(n,f)	$\frac{(1.6772\text{-}3 \pm 0.44\%)}{(1.6448\text{-}2 \pm 0.25\%)} = 0.1020 \pm 0.51\%$	$0.1230 \pm 9.76\%$	Trkov	$0.83 \pm 9.77\%$
Au197(n,g)/U235(n,f)	$\frac{(1.5583\text{-}3 \pm 0.34\%)}{(1.6448\text{-}2 \pm 0.25\%)} = 0.0947 \pm 0.42\%$	$0.1000 \pm 2.00\%$	Trkov Pelloni	$0.95 \pm 2.04\%$
U233(n,f)/U235(n,f)	U233(n,f) not available in IRDFF-II	$1.59 \pm 1.89\%$	Alwin Pelloni	N/A
U238(n,f)/U235(n,f)	$\frac{(2.5764\text{-}3 \pm 0.39\%)}{(1.6448\text{-}2 \pm 0.25\%)} = 0.1566 \pm 0.46\%$	$0.1643 \pm 1.10\%$ $0.1647 \pm 1.09\%$	Alwin Pelloni	**0.95** $\pm 1.19\%$ **0.95** $\pm 1.18\%$
Np237(n,f)/U235(n,f)	$\frac{(1.3685\text{-}2 \pm 0.29\%)}{(1.6448\text{-}2 \pm 0.25\%)} = 0.8320 \pm 0.38\%$	$0.8516 \pm 1.41\%$ $0.837 \pm 1.55\%$	Alwin Pelloni	$0.98 \pm 1.46\%$ $0.99 \pm 1.60\%$
Pu239(n,f)/U235(n,f)	$\frac{(2.2765\text{-}2 \pm 0.24\%)}{(1.6448\text{-}2 \pm 0.25\%)} = 1.3841 \pm 0.35\%$	$1.4152 \pm 0.99\%$ $1.402 \pm 1.78\%$	Alwin Pelloni	$0.98 \pm 1.05\%$ $0.99 \pm 1.81\%$
Al27(n,a)/P31(n,p)	Al27(n,a) not available in IRDFF-II	$0.0215 \pm 3.55\%$	Trkov	N/A
Al27(n,p)/P31(n,p)	$\frac{(3.1300\text{-}5 \pm 1.02\%)}{(2.7897\text{-}4 \pm 0.51\%)} = 0.1122 \pm 1.14\%$	$0.1126 \pm 4.88\%$	Trkov	$1.00 \pm 5.01\%$
Fe56(n,p)/P31(n,p)	$\frac{(8.7986\text{-}6 \pm 1.88\%)}{(2.7897\text{-}4 \pm 0.51\%)} = 0.0315 \pm 1.95\%$	$0.0310 \pm 5.80\%$	Trkov	$1.02 \pm 6.12\%$

File: HMF001-1-SI-0.

Table B-2. Flattop-25 (HMF028)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
S32(n,p)/U235(n,f)	$\frac{(7.4891\text{-}4 \pm 0.48\%)}{(2.4663\text{-}2 \pm 0.20\%)} = 0.0304 \pm 0.52\%$	$0.0306 \pm 5.88\%$	Trkov	$0.99 \pm 5.90\%$
U233(n,f)/U235(n,f)	U233(n,f) not available in IRDFF-II	$1.608 \pm 1.87\%$ $1.60 \pm 1.87\%$	Alwin Pelloni	N/A
U238(n,f)/U235(n,f)	$\frac{(3.5914\text{-}3 \pm 0.33\%)}{(2.4663\text{-}2 \pm 0.20\%)} = 0.1456 \pm 0.39\%$	$0.1397 \pm 5.01\%$ $0.1492 \pm 1.07\%$ $0.149 \pm 1.34\%$	Trkov Alwin Pelloni	$1.04 \pm 5.02\%$ $0.98 \pm 1.14\%$ $0.98 \pm 1.39\%$
Np237(n,f)/U235(n,f)	$\frac{(1.9094\text{-}2 \pm 0.24\%)}{(2.4663\text{-}2 \pm 0.20\%)} = 0.7742 \pm 0.31\%$	$0.7804 \pm 1.28\%$ $0.7804 \pm 1.28\%$ $0.76 \pm 1.32\%$	Trkov Alwin Pelloni	$0.99 \pm 1.32\%$ $0.99 \pm 1.32\%$ $1.02 \pm 1.36\%$
Pu239(n,f)/U235(n,f)	$\frac{(3.3579\text{-}2 \pm 0.20\%)}{(2.4663\text{-}2 \pm 0.20\%)} = 1.3615 \pm 0.28\%$	$1.3070 \pm 4.97\%$ $1.3847 \pm 0.87\%$ $1.37 \pm 1.46\%$	Trkov Alwin Pelloni	$1.04 \pm 4.98\%$ $0.98 \pm 0.91\%$ $0.99 \pm 1.49\%$
Am241(n,f)/U235(n,f)	$\frac{(1.7881\text{-}2 \pm 0.27\%)}{(2.4663\text{-}2 \pm 0.20\%)} = 0.7250 \pm 0.34\%$	$0.7540 \pm 5.04\%$	Trkov	$0.96 \pm 5.05\%$
Al27(n,a)/P31(n,p)	Al27(n,a) not available in IRDFF-II	$0.0202 \pm 5.48\%$	Trkov	N/A
Al27(n,p)/P31(n,p)	$\frac{(4.4617\text{-}5 \pm 0.85\%)}{(3.9081\text{-}4 \pm 0.44\%)} = 0.1142 \pm 0.96\%$	$0.1128 \pm 4.74\%$	Trkov	$1.01 \pm 4.84\%$
Fe56(n,p)/P31(n,p)	$\frac{(1.2754\text{-}5 \pm 1.55\%)}{(3.9081\text{-}4 \pm 0.44\%)} = 0.0326 \pm 1.61\%$	$0.0306 \pm 5.47\%$	Trkov	$1.07 \pm 5.70\%$
U238(n,f)/P31(n,p)	$\frac{(3.5744\text{-}3 \pm 0.33\%)}{(3.9081\text{-}4 \pm 0.44\%)} = 9.1461 \pm 0.55\%$	$8.9810 \pm 4.41\%$	Trkov	$1.02 \pm 4.44\%$

File: HMF028-1-SI-0.

Table B-3. Big-Ten (IMF007)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
Li6(n,a)/U235(n,f)	Li6(n,a) not available in IRDFF-II	0.7100 ± 1.41%	Trkov Pelloni	N/A
B10(n,a)/U235(n,f)	(2.6238-4 ± 0.78%) / (2.2673-3 ± 0.76%) = 0.1157 ± 1.09%	1.0110 ± 1.38%	Trkov Pelloni	**0.11** ± 1.76%
Al27(n,a)/U235(n,f)	Al27(n,a) not available in IRDFF-II	7.8E-5 ± 2.56%	Trkov Pelloni	N/A
Sc45(n,p)/U235(n,f)	Sc45(n,p) not available in IRDFF-II	0.0132 ± 2.27%	Trkov Pelloni	N/A
Ti46(n,p)/U235(n,f)	(2.5743-6 ± 6.41%) / (2.2673-3 ± 0.76%) = 0.0011 ± 6.45%	0.0013 ± 2.31%	Trkov Pelloni	0.87 ± 6.86%
Ti47(n,p)/U235(n,f)	(4.3706-6 ± 2.97%) / (2.2673-3 ± 0.76%) = 0.0019 ± 3.07%	0.0022 ± 4.19% 0.0022 ± 1.40%	Trkov Pelloni	0.88 ± 5.19% 0.88 ± 3.37%
Ti48(n,p)/U235(n,f)	(6.9432-8 ± 14.6%) / (2.2673-3 ± 0.76%) = 3.1E-5 ± 14.6%	3.6E-5 ± 2.78%	Trkov Pelloni	0.85 ± 14.9%
Fe54(n,p)/U235(n,f)	(1.8471-5 ± 3.67%) / (2.2673-3 ± 0.76%) = 0.0081 ± 3.75%	0.0090 ± 3.33%	Trkov Pelloni	0.91 ± 5.01%
Fe58(n,g)/U235(n,f)	(1.1739-5 ± 8.36%) / (2.2673-3 ± 0.76%) = 0.0052 ± 8.39%	0.0031 ± 3.23%	Trkov Pelloni	**1.67** ± 8.99%
Co59(n,g)/U235(n,f)	(2.0964-5 ± 5.16%) / (2.2673-3 ± 0.76%) = 0.0092 ± 5.22%	0.0095 ± 2.11%	Trkov Pelloni	0.97 ± 5.63%
Ni58(n,p)/U235(n,f)	(2.5552-5 ± 3.37%) / (2.2673-3 ± 0.76%) = 0.0113 ± 3.45%	0.0123 ± 1.63%	Trkov Pelloni	0.92 ± 3.82%
Cu63(n,g)/U235(n,f)	(4.1906-5 ± 2.46%) / (2.2673-3 ± 0.76%) = 0.0185 ± 2.57%	0.0164 ± 0.61% 0.0164 ± 6.10%	Trkov Pelloni	**1.13** ± 2.65% 1.13 ± 6.62%
In115(n,ng)/U235(n,f)	In115(n,ng) not available in IRDFF-II	0.0271 ± 2.21%	Pelloni	N/A
Au197(n,g)/U235(n,f)	(3.7682-4 ± 1.04%) / (2.2673-3 ± 0.76%) = 0.1662 ± 1.29%	0.1670 ± 1.80%	Trkov Pelloni	1.00 ± 2.21%
U233(n,f)/U235(n,f)	U233(n,f) not available in IRDFF-II	1.580 ± 1.90%	Pelloni	N/A
U238(n,g)/U235(n,f)	(2.4383-4 ± 0.93%) / (2.2673-3 ± 0.76%) = 0.1075 ± 1.20%	0.1100 ± 2.73%	Trkov Pelloni	0.98 ± 2.98%
U238(n,f)/U235(n,f)	(7.9434-5 ± 2.30%) / (2.2673-3 ± 0.76%) = 0.0350 ± 2.42%	0.0375 ± 2.40% 0.0374 ± 0.90% 0.0373 ± 1.07%	Brown Trkov Pelloni	0.93 ± 3.41% 0.94 ± 2.58% 0.94 ± 2.65%
Np237(n,f)/U235(n,f)	(7.1136-4 ± 1.21%) / (2.2673-3 ± 0.76%) = 0.3137 ± 1.43%	0.3223 ± 1.20% 0.316 ± 1.58%	Trkov Pelloni	0.97 ± 1.87% 0.99 ± 2.13%
Pu239(n,f)/U235(n,f)	(2.6513-3 ± 0.74%) / (2.2673-3 ± 0.76%) = 1.1694 ± 1.06%	1.198 ± 2.34% 1.1936 ± 0.70% 1.185 ± 1.69%	Brown Trkov Pelloni	0.98 ± 2.57% 0.98 ± 1.27% 0.99 ± 2.00%

File: IMF007-1s-SI-0.

Table B-4. Jezebel (PMF001)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
Mn55(n,g)/U235(n,f)	$\frac{(9.0562\text{-}5 \pm 0.69\%)}{(3.1957\text{-}2 \pm 0.16\%)} = 0.0028 \pm 0.71\%$	$0.0028 \pm 6.90\%$	Trkov	$1.01 \pm 6.94\%$
Cu63(n,g)/U235(n,f)	$\frac{(3.1522\text{-}4 \pm 0.42\%)}{(3.1957\text{-}2 \pm 0.16\%)} = 0.0099 \pm 0.45\%$	$0.0122 \pm 4.92\%$	Trkov	**0.81** $\pm 4.94\%$
Nb93(n,g)/U235(n,f)	$\frac{(8.1356\text{-}4 \pm 0.31\%)}{(3.1957\text{-}2 \pm 0.16\%)} = 0.0255 \pm 0.35\%$	$0.0276 \pm 10.87\%$ $0.023 \pm 8.70\%$	Trkov Pelloni	$0.92 \pm 10.9\%$ $1.11 \pm 8.7\%$
Aug197(n,g)/U235(n,f)	$\frac{(2.4518\text{-}3 \pm 0.24\%)}{(3.1957\text{-}2 \pm 0.16\%)} = 0.0767 \pm 0.29\%$	$0.1012 \pm 2.47\%$ $0.083 \pm 2.41\%$	Trkov Pelloni	**0.76** $\pm 2.49\%$ $0.92 \pm 2.43\%$
U233(n,f)/U235(n,f)	U233(n,f) not available in IRDFF-II	$1.578 \pm 1.71\%$	Alwin Pelloni	N/A
U238(n,f)/U235(n,f)	$\frac{(6.7832\text{-}3 \pm 0.23\%)}{(3.1957\text{-}2 \pm 0.16\%)} = 0.2123 \pm 0.28\%$	$0.2133 \pm 1.08\%$ $0.2133 \pm 1.08\%$ $0.2137 \pm 1.08\%$	Alwin Trkov Pelloni	$1.00 \pm 1.12\%$ $1.00 \pm 1.12\%$ $0.99 \pm 1.12\%$
Np237(n,f)/U235(n,f)	$\frac{(3.1283\text{-}2 \pm 0.18\%)}{(3.1957\text{-}2 \pm 0.16\%)} = 0.9789 \pm 0.24\%$	$0.9835 \pm 1.42\%$ $0.9835 \pm 1.42\%$ $0.962 \pm 1.66\%$	Alwin Trkov Pelloni	$1.00 \pm 1.44\%$ $1.00 \pm 1.44\%$ $1.02 \pm 1.68\%$
Pu239(n,f)/U235(n,f)	$\frac{(4.5627\text{-}2 \pm 0.16\%)}{(3.1957\text{-}2 \pm 0.16\%)} = 1.4278 \pm 0.23\%$	$1.4609 \pm 0.89\%$ $1.4609 \pm 0.89\%$ $1.448 \pm 2.00\%$	Alwin Trkov Pelloni	$0.98 \pm 0.92\%$ $0.98 \pm 0.92\%$ $0.99 \pm 2.01\%$

File: pmf001-SI-0.

Table B-5. Flattop-Pu (PMF006)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
U238(n,f)/U235(n,f)	$\frac{(8.2277\text{-}3 \pm 0.21\%)}{(4.5848\text{-}2 \pm 0.14\%)} = 0.1795 \pm 0.25\%$	$0.1772 \pm 1.13\%$ $0.1799 \pm 1.11\%$ $0.180 \pm 1.67\%$	Trkov Alwin Pelloni	$1.01 \pm 1.16\%$ $1.00 \pm 1.14\%$ $1.00 \pm 1.69\%$
Np237(n,f)/U235(n,f)	$\frac{(3.9423\text{-}2 \pm 0.16\%)}{(4.5848\text{-}2 \pm 0.14\%)} = 0.8599 \pm 0.21\%$	$0.8561 \pm 1.40\%$ $0.8561 \pm 1.40\%$ $0.84 \pm 1.19\%$	Alwin Trkov Pelloni	$1.00 \pm 1.42\%$ $1.00 \pm 1.42\%$ $1.02 \pm 1.21\%$

File: pmf006-SI-0.

Table B-6. Thor (PMF008)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
Th232(n,g)/U235(n,g)	U235(n,g) is not available in IRDFF-II	1.20 ± 5.00%	Pelloni	N/A
Th232(n,2n)/U238(n,ng)	Th232(n,2n) not available in IRDFF-II	1.04 ± 2.88%	Pelloni	N/A
Th232(n,f)/U235(n,f)	$\frac{(2.1780\text{-}3 \pm 0.22\%)}{(4.3349\text{-}2 \pm 0.14\%)}$ = 0.0502 ± 0.26%	0.26 ± 3.85%	Pelloni	**0.19** ± 3.86%
U238(n,2n)/U235(n,f)	$\frac{(5.3195\text{-}4 \pm 1.15\%)}{(4.3349\text{-}2 \pm 0.14\%)}$ = 0.0123 ± 1.16%	0.053 ± 5.66%	Pelloni	**0.23** ± 5.78%
U238(n,g)/U235(n,f)	$\frac{(2.9453\text{-}3 \pm 0.19\%)}{(4.3349\text{-}2 \pm 0.14\%)}$ = 0.0679 ± 0.24%	0.0830 ± 3.61%	Trkov Pelloni	**0.82** ± 3.62%
U238(n,f)/U235(n,f)	$\frac{(8.4525\text{-}3 \pm 0.21\%)}{(4.3349\text{-}2 \pm 0.14\%)}$ = 0.1950 ± 0.25%	0.1962 ± 1.10% 0.195 ± 1.54%	Trkov Pelloni	0.99 ± 1.13% 1.00 ± 1.56%
Np237(n,f)/U235(n,f)	$\frac{(3.9865\text{-}2 \pm 0.16\%)}{(4.3349\text{-}2 \pm 0.14\%)}$ = 0.9196 ± 0.21%	0.9419 ± 1.17% 0.92 ± 2.17%	Trkov Pelloni	0.98 ± 1.19% 1.00 ± 2.18%

Files: pmf008-SI-0.

Table B-7. Jezebel-23 (UMF001)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
U238(n,f)/U235(n,f)	$\frac{(6.2135\text{-}3 \pm 0.26\%)}{(2.9402\text{-}2 \pm 0.18\%)}$ = 0.2113 ± 0.32%	0.213 ± 1.08%	Pelloni	0.99 ± 1.13%
Np237(n,f)/U235(n,f)	$\frac{(2.9003\text{-}2 \pm 0.20\%)}{(2.9042\text{-}2 \pm 0.18\%)}$ = 0.9987 ± 0.27%	0.997 ± 1.50% 0.977 ± 1.64%	Brown Pelloni	1.00 ± 1.52% 1.02 ± 1.17%

Files: u233mf001-SI-0.

Table B-8. Flattop-23 (UMF006)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
U238(n,f)/U235(n,f)	$\frac{(8.2109\text{-}3 \pm 0.22\%)}{(4.3344\text{-}2 \pm 0.15\%)}$ = 0.1894 ± 0.27%	0.1916 ± 1.10% 0.191 ± 1.57%	Brown Pelloni	0.99 ± 1.13% 0.99 ± 1.59%
Np237(n,f)/U235(n,f)	$\frac{(3.9237\text{-}2 \pm 0.17\%)}{(4.3344\text{-}2 \pm 0.15\%)}$ = 0.9052 ± 0.23%	0.9103 ± 1.43% 0.89 ± 1.12%	Brown Pelloni	0.99 ± 1.45% 1.02 ± 1.14%

File: u233mf006-SI-0.

Table B-9. Dirty Jezebel (PMF002)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
U238(n,f)/U235(n,f)	$\frac{(6.1852\text{-}3 \pm 0.24\%)}{(2.9811\text{-}2 \pm 0.17\%)} = 0.2075 \pm 0.29\%$	$0.206 \pm 1.46\%$	Pelloni	$1.01 \pm 1.49\%$
Np237(n,f)/U235(n,f)	$\frac{(2.8710\text{-}2 \pm 0.19\%)}{(2.9811\text{-}2 \pm 0.17\%)} = 0.1945 \pm 0.25\%$	$0.92 \pm 2.17\%$	Pelloni	$0.96 \pm 2.18\%$

File: pmf002-SI-0.

Appendix C

COG 11.3 Results Using JEFF-3.3 for Transport and Reaction Rates

Table C-1. Godiva (HMF001)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
Mn55(n,g)/U235(n,f)	(5.9481-5 ± 1.85%) / (1.6490-2 ± 0.24%) = 0.0036 ± 1.87%	0.0027 ± 7.41%	Trkov Pelloni	**1.34** ± 7.64%
Co59(n,g)/U235(n,f)	(9.3754-5 ± 0.74%) / (1.6490-2 ± 0.24%) = 0.0057 ± 0.78%	0.0380 ± 7.89%	Trkov Pelloni	**0.15** ± 7.93%
Cu63(n,g)/U235(n,f)	(2.0458-4 ± 0.65%) / (1.6490-2 ± 0.24%) = 0.0124 ± 0.69%	0.0117 ± 5.13%	Trkov Pelloni	1.06 ± 5.18%
Nb93(n,g)/U235(n,f)	(5.9083-4 ± 0.54%) / (1.6490-2 ± 0.24%) = 0.0358 ± 0.59%	0.0300 ± 10.0%	Trkov Pelloni	1.19 ± 10.0%
La139(n,g)/U235(n,f)	(1.1377-4 ± 0.49%) / (1.6490-2 ± 0.24%) = 0.0069 ± 0.55%	0.0073 ± 8.22%	Trkov	0.95 ± 8.24%
Ta181(n,g)/U235(n,f)	(1.7546-3 ± 0.37%) / (1.6490-2 ± 0.24%) = 0.1064 ± 0.44%	0.1230 ± 9.76%	Trkov	0.87 ± 9.77%
Au197(n,g)/U235(n,f)	(1.6109-3 ± 0.35%) / (1.6490-2 ± 0.24%) = 0.0977 ± 0.42%	0.1000 ± 2.00%	Trkov Pelloni	0.98 ± 2.04%
U233(n,f)/U235(n,f)	(2.5818-2 ± 0.24%) / (1.6490-2 ± 0.24%) = 1.5657 ± 0.34%	1.59 ± 1.89%	Alwin Pelloni	0.98 ± 1.92%
U238(n,f)/U235(n,f)	(2.5484-3 ± 0.39%) / (1.6490-2 ± 0.24%) = 0.1545 ± 0.46%	0.1643 ± 1.10% 0.1647 ± 1.09%	Alwin Pelloni	**0.94** ± 1.19% **0.94** ± 1.18%
Np237(n,f)/U235(n,f)	(1.3436-2 ± 0.29%) / (1.6490-2 ± 0.24%) = 0.8148 ± 0.38%	0.8516 ± 1.41% 0.837 ± 1.55%	Alwin Pelloni	0.96 ± 1.46% 0.97 ± 1.60%
Pu239(n,f)/U235(n,f)	(2.2772-2 ± 0.24%) / (1.6490-2 ± 0.24%) = 1.3810 ± 0.34%	1.4152 ± 0.99% 1.402 ± 1.78%	Alwin Pelloni	0.98 ± 1.05% 0.98 ± 1.81%
Al27(n,a)/P31(n,p)*	(5.8764-6 ± 2.67%) / (2.7897-4 ± 0.51%) = 0.0211 ± 2.72%	0.0215 ± 3.55%	Trkov	0.98 ± 4.47%
Al27(n,p)/P31(n,p)*	(3.1120-5 ± 0.97%) / (2.7897-4 ± 0.51%) = 0.1116 ± 1.10%	0.1126 ± 4.88%	Trkov	0.99 ± 5.00%
Fe56(n,p)/P31(n,p)*	(8.6229-6 ± 1.83%) / (2.7897-4 ± 0.51%) = 0.0309 ± 1.90%	0.0310 ± 5.80%	Trkov	1.00± 6.10%

File: HMF001-1-SI-3. Note: *All JEFF-3.3 results for P31(n,p) were zero; IRDFF-II used instead – see Table B-1.

Table C-2. Flattop-25 (HMF028)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
S32(n,p)/U235(n,f)	All results were zero	0.0306 ± 5.88%	Trkov	N/A
U233(n,f)/U235(n,f)	(3.9091-2 ± 0.20%) / (2.4980-2 ± 0.21%) = 1.5649 ± 0.29%	1.608 ± 1.87% 1.60 ± 1.87%	Alwin Pelloni	0.97 ± 1.89% 0.98 ± 1.89%
U238(n,f)/U235(n,f)	(3.5123-3 ± 0.34%) / (2.4980-2 ± 0.21%) = 0.1406 ± 0.40%	0.1397 ± 5.01% 0.1492 ± 1.07% 0.149 ± 1.34%	Trkov Alwin Pelloni	1.01 ± 5.03% **0.94** ± 1.14% **0.94** ± 1.40%
Np237(n,f)/U235(n,f)	(1.8918-2 ± 0.25%) / (2.4980-2 ± 0.21%) = 0.7573 ± 0.33%	0.7804 ± 1.28% 0.7804 ± 1.28% 0.76 ± 1.32%	Trkov Alwin Pelloni	0.97 ± 1.32% 0.97 ± 1.32% 1.00 ± 1.36%
Pu239(n,f)/U235(n,f)	(3.3934-2 ± 0.20%) / (2.4980-2 ± 0.21%) = 1.3584 ± 0.29%	1.3070 ± 4.97% 1.3847 ± 0.87% 1.37 ± 1.46%	Trkov Alwin Pelloni	1.04 ± 4.98% 0.98 ± 0.92% 0.99 ± 1.49%
Am241(n,f)/U235(n,f)	(1.7734-2 ± 0.27%) / (2.4980-2 ± 0.21%) = 0.7099 ± 0.34%	0.7540 ± 5.04%	Trkov	0.94 ± 5.05%
Al27(n,a)/P31(n,p)*	(7.7787-6 ± 2.28%) / (3.9081-4 ± 0.20%) = 0.0199 ± 2.29%	0.0202 ± 5.48%	Trkov	0.99 ± 5.94%
Al27(n,p)/P31(n,p)*	(4.2709-5 ± 0.85%) / (3.9081-4 ± 0.44%) = 0.1093 ± 0.96%	0.1128 ± 4.74%	Trkov	0.97 ± 4.84%
Fe56(n,p)/P31(n,p)*	(1.1772-5 ± 1.56%) / (3.9081-4 ± 0.44%) = 0.0301 ± 1.62%	0.0306 ± 5.47%	Trkov	0.98 ± 5.71%
U238(n,f)/P31(n,p)*	(3.5123-3 ± 0.34%) / (3.9081-4 ± 0.44%) = 8.9872 ± 0.56%	8.9810 ± 4.41%	Trkov	1.00 ± 4.44%

File: HMF028-1-SI-3. Note: *All JEFF-3.3 results for P31(n,p) were zero; IRDFF-II used instead – see Table B-1.

Table C-3. Big-Ten (IMF007)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
Li6(n,a)/U235(n,f)	All results were zero	0.7100 ± 1.41%	Trkov Pelloni	N/A
B10(n,a)/U235(n,f)	(2.1636-3 ± 0.93%) / (2.2687-3 ± 0.76%) = 0.9336 ± 1.20%	1.0110 ± 1.38%	Trkov Pelloni	0.95 ± 1.83%
Al27(n,a)/U235(n,f)	(1.2376-7 ± 18.2%) / (2.2687-3 ± 0.76%) = 5.5E-5 ± 18.2%	7.8E-5 ± 2.56%	Trkov Pelloni	0.70 ± 18.4%
Sc45(n,p)/U235(n,f)	All results were zero	0.0132 ± 2.27%	Trkov Pelloni	N/A
Ti46(n,p)/U235(n,f)	All results were zero	0.0013 ± 2.31%	Trkov Pelloni	N/A
Ti47(n,p)/U235(n,f)	All results were zero	0.0022 ± 4.19% 0.0022 ± 1.40%	Trkov Pelloni	N/A
Ti48(n,p)/U235(n,f)	All results were zero	3.6E-5 ± 2.78%	Trkov Pelloni	N/A
Fe54(n,p)/U235(n,f)	(1.6197-5 ± 3.68%) / (2.2687-3 ± 0.76%) = 0.0071 ± 3.76%	0.0090 ± 3.33%	Trkov Pelloni	**0.79** ± 5.02%
Fe58(n,g)/U235(n,f)	(1.0336-5 ± 6.81%) / (2.2687-3 ± 0.76%) = 0.0046 ± 6.85%	0.0031 ± 3.23%	Trkov Pelloni	**1.47** ± 7.58%
Co59(n,g)/U235(n,f)	(1.9913-5 ± 1.90%) / (2.2687-3 ± 0.76%) = 0.0088 ± 2.05%	0.0095 ± 2.11%	Trkov Pelloni	0.92 ± 2.94%
Ni58(n,p)/U235(n,f)	All results were zero	0.0123 ± 1.63%	Trkov Pelloni	N/A
Cu63(n,g)/U235(n,f)	(4.1612-5 ± 1.90%) / (2.2687-3 ± 0.76%) = 0.0183 ± 2.05%	0.0164 ± 0.61% 0.0164 ± 6.10%	Trkov Pelloni	**1.12** ± 2.14% 1.12 ± 6.43%
In115(n,ng)/U235(n,f)	(2.6855-4 ± 2.19%) / (2.2687-3 ± 0.76%) = 0.1184 ± 2.32%	0.0271 ± 2.21%	Pelloni	**4.37** ± 3.20%
Au197(n,g)/U235(n,f)	(3.7934-4 ± 1.06%) / (2.2687-3 ± 0.76%) = 0.1672 ± 1.30%	0.1670 ± 1.80%	Trkov Pelloni	1.00 ± 2.22%
U233(n,f)/U235(n,f)	(3.5116-3 ± 0.75%) / (2.2687-3 ± 0.76%) = 1.5478 ± 1.07%	1.580 ± 1.90%	Pelloni	0.98 ± 2.18%
U238(n,g)/U235(n,f)	(2.3515-4 ± 0.92%) / (2.2687-3 ± 0.76%) = 0.1036 ± 1.19%	0.1100 ± 2.73%	Trkov Pelloni	0.964± 2.98%
U238(n,f)/U235(n,f)	(7.4923-5 ± 2.36%) / (2.2687-3 ± 0.76%) = 0.0330 ± 2.48%	0.0375 ± 2.40% 0.0374 ± 0.90% 0.0373 ± 1.07%	Brown Trkov Pelloni	**0.88** ± 3.45% **0.88** ± 2.64% **0.89** ± 2.70%
Np237(n,f)/U235(n,f)	(6.9533-4 ± 1.21%) / (2.2687-3 ± 0.76%) = 0.3065 ± 1.43%	0.3223 ± 1.20% 0.316 ± 1.58%	Trkov Pelloni	0.95 ± 1.87% 0.97 ± 2.13%
Pu239(n,f)/U235(n,f)	(2.6594-3 ± 0.74%) / (2.2687-3 ± 0.76%) = 1.1722 ± 1.06%	1.198 ± 2.34% 1.1936 ± 0.70% 1.185 ± 1.69%	Brown Trkov Pelloni	0.98 ± 2.57% 0.98 ± 1.27% 0.99 ± 2.00%

File: IMF007-1s-SI-3.

Table C-4. Jezebel (PMF001)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
Mn55(n,g)/U235(n,f)	$\frac{(8.8456\text{-}5 \pm 0.62\%)}{(3.1629\text{-}2 \pm 0.17\%)} = 0.0028 \pm 0.64\%$	$0.0028 \pm 6.90\%$	Trkov	$1.00 \pm 6.93\%$
Cu63(n,g)/U235(n,f)	$\frac{(3.2329\text{-}4 \pm 0.47\%)}{(3.1629\text{-}2 \pm 0.17\%)} = 0.0102 \pm 0.50\%$	$0.0122 \pm 4.92\%$	Trkov	**0.84** $\pm 4.95\%$
Nb93(n,g)/U235(n,f)	$\frac{(8.6672\text{-}4 \pm 0.29\%)}{(3.1629\text{-}2 \pm 0.17\%)} = 0.0274 \pm 0.34\%$	$0.0276 \pm 10.87\%$ $0.023 \pm 8.70\%$	Trkov Pelloni	$0.99 \pm 10.9\%$ $1.19 \pm 8.7\%$
Aug197(n,g)/U235(n,f)	$\frac{(2.4156\text{-}3 \pm 0.24\%)}{(3.1629\text{-}2 \pm 0.17\%)} = 0.0764 \pm 0.29\%$	$0.1012 \pm 2.47\%$ $0.083 \pm 2.41\%$	Trkov Pelloni	**0.75** $\pm 2.49\%$ $0.92 \pm 2.43\%$
U233(n,f)/U235(n,f)	$\frac{(4.9218\text{-}2 \pm 0.17\%)}{(3.1629\text{-}2 \pm 0.17\%)} = 1.5561 \pm 0.24\%$	$1.578 \pm 1.71\%$	Alwin Pelloni	$0.99 \pm 1.73\%$
U238(n,f)/U235(n,f)	$\frac{(6.6575\text{-}3 \pm 0.23\%)}{(3.1629\text{-}2 \pm 0.17\%)} = 0.2105 \pm 0.29\%$	$0.2133 \pm 1.08\%$ $0.2133 \pm 1.08\%$ $0.2137 \pm 1.08\%$	Alwin Trkov Pelloni	$0.99 \pm 1.12\%$ $0.99 \pm 1.12\%$ $0.98 \pm 1.12\%$
Np237(n,f)/U235(n,f)	$\frac{(3.1129\text{-}2 \pm 0.18\%)}{(3.1629\text{-}2 \pm 0.17\%)} = 0.9842 \pm 0.25\%$	$0.9835 \pm 1.42\%$ $0.9835 \pm 1.42\%$ $0.962 \pm 1.66\%$	Alwin Trkov Pelloni	$1.00 \pm 1.44\%$ $1.00 \pm 1.44\%$ $1.02 \pm 1.68\%$
Pu239(n,f)/U235(n,f)	$\frac{(4.5415\text{-}2 \pm 0.17\%)}{(3.1629\text{-}2 \pm 0.17\%)} = 1.4359 \pm 0.24\%$	$1.4609 \pm 0.89\%$ $1.4609 \pm 0.89\%$ $1.448 \pm 2.00\%$	Alwin Trkov Pelloni	$0.98 \pm 0.92\%$ $0.98 \pm 0.92\%$ $0.99 \pm 2.01\%$

File: pmf001-SI-3.

Table C-5. Flattop-Pu (PMF006)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
U238(n,f)/U235(n,f)	$\frac{(8.2139\text{-}3 \pm 0.21\%)}{(4.6294\text{-}2 \pm 0.14\%)} = 0.1774 \pm 0.25\%$	$0.1772 \pm 1.13\%$ $0.1799 \pm 1.11\%$ $0.180 \pm 1.67\%$	Trkov Alwin Pelloni	$1.00 \pm 1.16\%$ $0.99 \pm 1.14\%$ $0.99 \pm 1.69\%$
Np237(n,f)/U235(n,f)	$\frac{(3.9856\text{-}2 \pm 0.16\%)}{(4.6294\text{-}2 \pm 0.14\%)} = 0.8609 \pm 0.21\%$	$0.8561 \pm 1.40\%$ $0.8561 \pm 1.40\%$ $0.84 \pm 1.19\%$	Alwin Trkov Pelloni	$1.01 \pm 1.42\%$ $1.01 \pm 1.42\%$ $1.02 \pm 1.21\%$

File: pmf006-SI-3.

Table C-6. Thor (PMF008)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
Th232(n,g)/U235(n,g)	(3.9448-3 ± 0.18%) / (4.5218-3 ± 0.22%) = 0.8724 ± 0.28%	1.20 ± 5.00%	Pelloni	**0.73** ± 5.01%
Th232(n,2n)/U238(n,ng)	(5.7107-4 ± 1.39%) / (7.9755-2 ± 0.15%) = 0.0072 ± 1.40%	1.04 ± 2.88%	Pelloni	**0.01** ± 3.20 %
Th232(n,f)/U235(n,f)	(2.0484-3 ± 0.23%) / (4.3001-2 ± 0.15%) = 0.0476 ± 0.27 %	0.26 ± 3.85%	Pelloni	**0.18** ± 3.86%
U238(n,2n)/U235(n,f)	(4.9601-4 ± 1.23%) / (4.3001-2 ± 0.15%) = 0.0115 ± 1.24%	0.053 ± 5.66%	Pelloni	**0.22** ± 5.79%
U238(n,g)/U235(n,f)	(2.8476-3 ± 0.22%) / (4.3001-2 ± 0.15%) = 0.0662 ± 0.27%	0.0830 ± 3.61%	Trkov Pelloni	**0.80** ± 3.62%
U238(n,f)/U235(n,f)	(8.2892-3 ± 0.21%) / (4.3001-2 ± 0.15%) = 0.1928 ± 0.26%	0.1962 ± 1.10% 0.195 ± 1.54%	Trkov Pelloni	0.98 ± 1.13% 0.99 ± 1.56%
Np237(n,f)/U235(n,f)	(3.9688-2 ± 0.16%) / (4.3001-2 ± 0.15%) = 0.9230 ± 0.22 %	0.9419 ± 1.17% 0.92 ± 2.17%	Trkov Pelloni	0.98 ± 1.19% 1.00 ± 2.18%

Files: pmf008-SI-3.

Table C-7. Jezebel-23 (UMF001)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
U238(n,f)/U235(n,f)	(6.2119-3 ± 0.26%) / (2.9564-2 ± 0.18%) = 0.2101 ± 0.32%	0.213 ± 1.08%	Pelloni	0.99 ± 1.13%
Np237(n,f)/U235(n,f)	(2.9378-2 ± 0.20%) / (2.9564-2 ± 0.18%) = 0.9937 ± 0.27%	0.997 ± 1.50% 0.977 ± 1.64%	Brown Pelloni	1.00 ± 1.52% 1.02 ± 1.66%

Files: u233mf001-SI-3.

Table C-8. Flattop-23 (UMF006)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
U238(n,f)/U235(n,f)	(8.2207-3 ± 0.21%) / (4.4129-2 ± 0.14%) = 0.1863 ± 0.25%	0.1916 ± 1.10% 0.191 ± 1.57%	Brown Pelloni	0.97 ± 1.13% 0.98 ± 1.59%
Np237(n,f)/U235(n,f)	(3.9974-2 ± 0.16%) / (4.4129-2 ± 0.14%) = 0.9058 ± 0.21%	0.9103 ± 1.43% 0.89 ± 1.12%	Brown Pelloni	1.00 ± 1.45% 1.02 ± 1.14%

File: u233mf006-SI-3.

Table C-9. Dirty Jezebel (PMF002)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
U238(n,f)/U235(n,f)	$\frac{(6.0147\text{-}3 \pm 0.25\%)}{(2.9364\text{-}2 \pm 0.17\%)} = 0.2048 \pm 0.30\%$	$0.206 \pm 1.46\%$	Pelloni	$0.99 \pm 1.49\%$
Np237(n,f)/U235(n,f)	$\frac{(2.8337\text{-}2 \pm 0.19\%)}{(2.9364\text{-}2 \pm 0.17\%)} = 0.9650 \pm 0.25\%$	$0.92 \pm 2.17\%$	Pelloni	$1.05 \pm 2.18\%$

File: pmf002-SI-3.

Appendix D

COG 11.3 Results Using ENDF/B-VIII.0 for Transport and IRDFF1.05 for Reaction Rates

Table D-1. Big-Ten (IMF007)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
In115(n,ng)/U235(n,f)	$\frac{(5.2567\text{-}5 \pm 1.91\%)}{(2.2630\text{-}3 \pm 0.75\%)}$ = 0.0232 ± 2.05%	0.0271 ± 2.21%	Pelloni	**0.86** ± 3.02%

File: IMF007-1s-SI-4.

Appendix E

COG 11.3 Results Using ENDF/B-VIII.0 for Transport and Reaction Rates Except ENDF/B-V Used for Co-59 Reaction Rates

Table E-1. Godiva (HMF001)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
Co59(n,g)/U235(n,f)	$\frac{(1.0251\text{-}4 \pm 0.74\%)}{(1.6358\text{-}2 \pm 0.25\%)} = 0.0063 \pm 0.78\%$	$0.0380 \pm 7.89\%$	Trkov Pelloni	**0.16** $\pm$ 7.93%

File: HMF001-1-SI-5.

Table E-2. Big-Ten (IMF007)

Spectral Index	COG11.3 Calculation	Experiment	Ref.	C/E
Co59(n,g)/U235(n,f)	$\frac{(2.2148\text{-}5 \pm 5.60\%)}{(2.2770\text{-}3 \pm 0.77\%)} = 0.0092 \pm 5.65\%$	$0.0095 \pm 2.11\%$	Trkov Pelloni	$0.97 \pm 6.03\%$

File: IMF007-1s-SI-5.

Appendix F.1

Sample COG11.3 Input File: HMF001-1-SI-2

```
HMF001-1-1: Godiva: Sphere Model with Detectors for Spectral Indices
basic
  neutron delayedn CM URRPT
criticality
  npart=100000 nbatch=5050 sdt=0.0001 nfirst=51 norm=1. nsource=1 0 0 0
mix nlib=ENDFB8R0 ptlib=PT.ENDFB8R0.ACE sablib=T.ENDFB8R0
  mat=1  bunches  al27 1.0                                      $ Al-27  @ 1 atom/b.cm
  mat=2  bunches   p31 1.0                                      $ P-31   @ 1 atom/b.cm
  mat=3  bunches  mn55 1.0                                      $ Mn-55  @ 1 atom/b.cm
  mat=4  bunches  fe56 1.0                                      $ Fe-56  @ 1 atom/b.cm
  mat=5  bunches  co59 1.0                                      $ Co-59  @ 1 atom/b.cm
  mat=6  bunches  cu63 1.0                                      $ Cu-63  @ 1 atom/b.cm
  mat=7  bunches  nb93 1.0                                      $ Nb-93  @ 1 atom/b.cm
  mat=8  bunches la139 1.0                                      $ La-139 @ 1 atom/b.cm
  mat=9  bunches ta181 1.0                                      $ Ta-181 @ 1 atom/b.cm
  mat=10 bunches au197 1.0                                      $ Au-197 @ 1 atom/b.cm
  mat=11 bunches  u233 1.0                                      $ U-233  @ 1 atom/b.cm
  mat=12 bunches  u235 1.0                                      $ U-235  @ 1 atom/b.cm
  mat=13 bunches  u238 1.0                                      $ U-238  @ 1 atom/b.cm
  mat=14 bunches np237 1.0                                      $ Np-237 @ 1 atom/b.cm
  mat=15 bunches pu239 1.0                                      $ Pu-239 @ 1 atom/b.cm
  mat=90 bunches  u234 4.9184-4 u235 4.4994-2 u238 2.4984-3  $ HEU
assign-m
  1 90 2 90
geometry
  sector 1 HEU       -1
  sector 2 HEU     1 -2
  boundary vacuum     2
volume
  material -9 -9 -9  9 -9 -9 -9  9 -9 18 18 18
surfaces
  1 sphere 0.25
  2 sphere 8.7407
detector
 number=#0000000 title="Godiva spectrum flux at center"
    reaction 1 0.065449847 drf-e neutron number-flux
 number=#0000001 title="Godiva spectrum averaged Al-27(n,ag) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  1 45
 number=#0000002 title="Godiva spectrum averaged Al-27(n,pg) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  1 82
 number=#0000003 title="Godiva spectrum averaged P-31(n,pg) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  2 82
 number=#0000004 title="Godiva spectrum averaged Mn-55(n,g) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  3 46
 number=#0000005 title="Godiva spectrum averaged Fe-56(n,pg) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  4 82
 number=#0000006 title="Godiva spectrum averaged Co-59(n,g) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate     5 46
 number=#0000007 title="Godiva spectrum averaged Cu-63(n,g) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  6 46
 number=#0000008 title="Godiva spectrum averaged Nb-93(n,g) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  7 46
 number=#0000009 title="Godiva spectrum averaged La-139(n,g) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  8 46
 number=#0000010 title="Godiva spectrum averaged Ta-181(n,g) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  9 46
 number=#0000011 title="Godiva spectrum averaged Au-197(n,g) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 10 46
 number=#0000012 title="Godiva spectrum averaged U-233(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 11 15
 number=#0000013 title="Godiva spectrum averaged U-235(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 12 15
 number=#0000014 title="Godiva spectrum averaged U-238(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 13 15
 number=#0000015 title="Godiva spectrum averaged Np-237(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 14 15
 number=#0000016 title="Godiva spectrum averaged Pu-239(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 15 15
end
```

Appendix F.2

Sample COG11.3 Input File: HMF028-1-SI-2

```
HEU-MET-FAST-028-1:  17.840 kg Oy(93.24) sphere in 7.09" Nat-U (Flattop)
basic
  neutron delayedn CENTIMETERS URRPT
criticality
  npart=100000 nbatch=5050 sdt=0.0001 nfirst=51 norm=1. nsource=1 0 0 0
mix nlib=ENDFB8R0 ptlib=PT.ENDFB8R0.ACE sablib=T.ENDFB8R0  $ Atom Densities per Section 3.3, Table 2
  mat=91 bunches u234 4.8869-4 u235 4.4482-2 u238 2.7038-3 $ Oy(93.24) @ 18.62 g/cc
  mat=92 bunches u234 2.6438-6 u235 3.4610-4 u238 4.7721-2 $ Natural-U @ 19.00 g/cc
  mat=1  bunches   s32 1.0                                 $ S-32   @ 1 atom/b.cm
  mat=2  bunches  al27 1.0                                 $ Al-27  @ 1 atom/b.cm
  mat=3  bunches   p31 1.0                                 $ P-31   @ 1 atom/b.cm
  mat=4  bunches  fe56 1.0                                 $ Fe-56  @ 1 atom/b.cm
  mat=5  bunches  u233 1.0                                 $ U-233  @ 1 atom/b.cm
  mat=6  bunches  u235 1.0                                 $ U-235  @ 1 atom/b.cm
  mat=7  bunches  u238 1.0                                 $ U-238  @ 1 atom/b.cm
  mat=8  bunches np237 1.0                                 $ Np-237 @ 1 atom/b.cm
  mat=9  bunches pu239 1.0                                 $ Pu-239 @ 1 atom/b.cm
  mat=10 bunches am241 1.0                                 $ Am-241 @ 1 atom/b.cm
assign-m
  1 91 2 91 3 92
assign-mc
  1 orange 2 orange 3 black
geometry
  sector 1 Oy       -1
  sector 2 Oy     1 -2
  sector 3 Tu     2 -3
  boundary vacuum 3
picture cs material color
  -25   0  25 -25   0 -25   25   0 -25
volume material
  -25 -25 -25  25 -25 -25  -25  25 -25
   50  50  50
surfaces $ per Section 3.2
  1 sphere  0.25
  2 sphere  6.1156
  3 sphere 24.1242
detector
 number=#0000000 title="Flattop-25 spectrum averaged flux at center"
    reaction 1 0.065449847 drf-e neutron number-flux
 number=#0000001 title="Flattop-25 spectrum averaged S-32(n,pg) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  1 82
 number=#0000002 title="Flattop-25 spectrum averaged Al-27(n,ag) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  2 45
 number=#0000003 title="Flattop-25 spectrum averaged Al-27(n,pg) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  2 82
 number=#0000004 title="Flattop-25 spectrum averaged P-31(n,pg) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  3 82
 number=#0000005 title="Flattop-25 spectrum averaged Fe-56(n,pg) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  4 82
 number=#0000006 title="Flattop-25 spectrum averaged U-233(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  5 15
 number=#0000007 title="Flattop-25 spectrum averaged U-235(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  6 15
 number=#0000008 title="Flattop-25 spectrum averaged U-238(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  7 15
 number=#0000009 title="Flattop-25 spectrum averaged Np-237(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  8 15
 number=#0000010 title="Flattop-25 spectrum averaged Pu-239(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate  9 15
 number=#0000011 title="Flattop-25 spectrum averaged Am-241(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 10 15
end
```

Appendix F.3

Sample COG11.3 Input File: IMF001-1s-SI-2

```
IEU-MET-FAST-007-1: Big Ten [Rev. 2]
basic
  neutron delayedn CENTIMETERS URRPT
criticality
  npart=100000 nbatch=5050 sdt=0.0001 nfirst=51 norm=1.
  nsource=1  0 0 -10.54
mix nlib=ENDFB8R0 ptlib=PT.ENDFB8R0.ACE
  mat=1  bunches  u234 2.4761-5 u235 4.8461-3 u236 4.3348-5 u238 4.2695-2 $ U(10)
  mat=2  bunches  u234 5.4058-4 u235 4.9831-3 u236 1.3733-5 u238 4.3108-2 $ HEU & Nat-U
  mat=3  bunches  u234 2.6518-6 u235 3.4701-4               u238 4.7846-2 $ Nat-U
  mat=4  bunches  u234 2.8672-7 u235 1.0058-4 u236 1.1468-6 u238 4.7677-2 $ D38
  mat=9  bunches  u234 2.4761-5 u235 4.8461-3 u236 4.3348-5 u238 4.2695-2 $ U(10) for detector
region
  mat=11 bunches  li6  1.0                                                $ Li-6   @ 1 atom/b.cm
  mat=12 bunches  b10  1.0                                                $ B-10   @ 1 atom/b.cm
  mat=13 bunches  al27 1.0                                                $ Al-27  @ 1 atom/b.cm
  mat=14 bunches  sc45 1.0                                                $ Sc-45  @ 1 atom/b.cm
  mat=15 bunches  ti46 1.0                                                $ Ti-46  @ 1 atom/b.cm
  mat=16 bunches  ti47 1.0                                                $ Ti-47  @ 1 atom/b.cm
  mat=17 bunches  ti48 1.0                                                $ Ti-48  @ 1 atom/b.cm
  mat=18 bunches  fe54 1.0                                                $ Fe-54  @ 1 atom/b.cm
  mat=19 bunches  fe58 1.0                                                $ Fe-58  @ 1 atom/b.cm
  mat=20 bunches  co59 1.0                                                $ Co-59  @ 1 atom/b.cm
  mat=21 bunches  ni58 1.0                                                $ Ni-58  @ 1 atom/b.cm
  mat=22 bunches  cu63 1.0                                                $ Cu-63  @ 1 atom/b.cm
  mat=23 bunches in115 1.0                                                $ In-115 @ 1 atom/b.cm
  mat=24 bunches au197 1.0                                                $ Au-197 @ 1 atom/b.cm
  mat=25 bunches  u233 1.0                                                $ U-233  @ 1 atom/b.cm
  mat=26 bunches  u235 1.0                                                $ U-235  @ 1 atom/b.cm
  mat=27 bunches  u238 1.0                                                $ U-238  @ 1 atom/b.cm
  mat=28 bunches np237 1.0                                                $ Np-237 @ 1 atom/b.cm
  mat=29 bunches pu239 1.0                                                $ Pu-239 @ 1 atom/b.cm
assign-mc
  1 blue 2 pink 3 yellow 4 green 9 lime
geometry
  sector 1 U10      -1                  -8
  sector 1 U10       1 -2
  sector 1 U10          2 -3                9
  sector 9 U10          2 -3               -9                           $ Detector region
  sector 1 U10             3 -4
  sector 2 HEU-NatU     2  3  4    -6
  sector 3 Nat-U           4 -5  6
  sector 3 Nat-U     1  2          6 -7
  sector 4 D38       1  2     4  5  6  7 -8
  boundary vacuum                   8
picture cs material color
  -42   0  40 -42   0 -58  42  0 -58
volume material
  -42 -42 -58  42 -42 -58 -42 42 -58
   48  48  98
surfaces
  1 c z   2.25014   23.81250  39.05250 $ U10
  2 c z   3.10996    4.35102  23.81250 $ U10
  3 c z  12.54604  -22.39010   4.35102 $ U10
  4 c z   7.62     -41.73361 -22.39010 $ U10
  5 c z  26.67     -41.73361 -38.24644 $ Nat-U
  6 c z  26.67     -38.24644  17.16665 $ HEU+Nat-U
  7 c z  26.67      17.16665  23.81250 $ Nat-U
  8 c z  41.91     -57.46750  39.05250 $ D38
  9 s     0.25 tr 0 0 -10.53989        $ U10 central region for spectral indices calculations
detector
 number=#0000000 title="Big-Ten spectrum averaged flux at center"
    reaction 9 0.065449847 drf-e neutron number-flux
 number=#0000001 title="Big-Ten spectrum averaged Li-6(n,tag) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 11 43
 number=#0000002 title="Big-Ten spectrum averaged B-10(n,ag) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 12 45
 number=#0000003 title="Big-Ten spectrum averaged Al-27(n,ag) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 13 45
```

```
 number=#0000004 title="Big-Ten spectrum averaged Sc-45(n,pg) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 14 82
 number=#0000005 title="Big-Ten spectrum averaged Ti-46(n,pg) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 15 82
 number=#0000006 title="Big-Ten spectrum averaged Ti-47(n,pg) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 16 82
 number=#0000007 title="Big-Ten spectrum averaged Ti-48(n,pg) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 17 82
 number=#0000008 title="Big-Ten spectrum averaged Fe-54(n,pg) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 18 82
 number=#0000009 title="Big-Ten spectrum averaged Fe-58(n,g) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 19 46
 number=#0000010 title="Big-Ten spectrum averaged Co-59(n,g) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 20 46
 number=#0000011 title="Big-Ten spectrum averaged Ni-58(n,pg) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 21 82
 number=#0000012 title="Big-Ten spectrum averaged Cu-63(n,g) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 22 46
 number=#0000013 title="Big-Ten spectrum averaged In-115(n,ng) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 23 11
 number=#0000014 title="Big-Ten spectrum averaged Au-197(n,g) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 24 46
 number=#0000015 title="Big-Ten spectrum averaged U-233(n,f) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 25 15
 number=#0000016 title="Big-Ten spectrum averaged U-235(n,f) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 26 15
 number=#0000017 title="Big-Ten spectrum averaged U-238(n,f) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 27 15
 number=#0000018 title="Big-Ten spectrum averaged Np-237(n,f) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 28 15
 number=#0000019 title="Big-Ten spectrum averaged Pu-239(n,f) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 29 15
 number=#0000020 title="Big-Ten spectrum averaged U-238(n,g) reaction rate"
    reaction 9 0.065449847 drf-e neutron r-rate 27 46
end
```

Appendix F.4

Sample COG11.3 Input File: pmf001-SI-2

```
PU-MET-FAST-001: JEZEBEL (17.020 kg Pu(95.48)-1.02Ga @ 15.61 g/cc)
basic
  neutron delayedn CM URRPT
criticality
  npart=100000 nbatch=5050 sdt=0.0001 nfirst=51 norm=1.
  nsource=1 0. 0. 0.
mix nlib=ENDFB8R0 ptlib=PT.ENDFB8R0.ACE sablib=T.ENDFB8R0 $ Atom Densities per Table 3
  mat=1  bunches ga 1.3752-3 pu239 3.7047-2 pu240 1.7512-3 pu241 1.1674-4
  mat=2  bunches ga 1.3752-3 pu239 3.7047-2 pu240 1.7512-3 pu241 1.1674-4
  mat=11 bunches  mn55 1.0 $ Mn-55  @ 1 atom/b.cm
  mat=12 bunches  cu63 1.0 $ Cu-63  @ 1 atom/b.cm
  mat=13 bunches  nb93 1.0 $ Nb-93  @ 1 atom/b.cm
  mat=14 bunches au197 1.0 $ Au-197 @ 1 atom/b.cm
  mat=15 bunches  u233 1.0 $ U-233  @ 1 atom/b.cm
  mat=16 bunches  u235 1.0 $ U-235  @ 1 atom/b.cm
  mat=17 bunches  u238 1.0 $ U-238  @ 1 atom/b.cm
  mat=18 bunches np237 1.0 $ Np-237 @ 1 atom/b.cm
  mat=19 bunches pu239 1.0 $ Pu-239 @ 1 atom/b.cm
assign-mc
  1 blue 2 purple
geometry
  sector 1 alloy    -1
  sector 2 alloy  1 -2
  boundary vacuum 2
picture cs material
  -7 0 7 -7 0 -7 7 0 -7
volume
  -7 -7 -7 7 -7 -7 -7 7 -7
  14 14 14
surfaces
  1 sphere 0.25   $ Detector region
  2 sphere 6.3849 $ per Section 3.2
detector
 number=#0000000 title="Jezebel spectrum average flux at center"
    reaction 1 0.065449847 drf-e neutron number-flux
 number=#0000001 title="Jezebel spectrum averaged Mn-55(n,g) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 11 46
 number=#0000002 title="Jezebel spectrum averaged Cu-63(n,g) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 12 46
 number=#0000003 title="Jezebel spectrum averaged Nb-93(n,g) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 13 46
 number=#0000004 title="Jezebel spectrum averaged Au-197(n,g) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 14 46
 number=#0000005 title="Jezebel spectrum averaged U-233(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 15 15
 number=#0000006 title="Jezebel spectrum averaged U-235(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 16 15
 number=#0000007 title="Jezebel spectrum averaged U-238(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 17 15
 number=#0000008 title="Jezebel spectrum averaged Np-237(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 18 15
 number=#0000009 title="Jezebel spectrum averaged Pu-239(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 19 15
end
```

Appendix F.5

Sample COG11.3 Input File: pmf006-SI-2

```
PU-MET-FAST-006: 6.060 kg Pu(4.80)-1.10Ga @ 15.53 g/cc in 19.6088 cm Nat-U @ 19.0 g/cc
basic
neutron delayedn CM URRPT
criticality
  npart=100000 nbatch=5050 sdt=0.0001 nfirst=51 norm=1.
nsource=1 0. 0. 0.
mix nlib=ENDFB8R0 ptlib=PT.ENDFB8R0.ACE sablib=T.ENDFB8R0 $ Atom Densities per Table 5 in Section 3.3
  mat=1  bunches  pu239 3.6697-2 pu240 1.8700-3 pu241 1.1639-4 ga 1.4755-3
  mat=2  bunches  pu239 3.6697-2 pu240 1.8700-3 pu241 1.1639-4 ga 1.4755-3
  mat=3  bunches  u234 2.6438-6 u235 3.4610-4 u238 4.7721-2
  mat=11 bunches  u235 1.0                                                $ U-235  @ 1
atom/b.cm
  mat=12 bunches  u238 1.0                                                $ U-238  @ 1
atom/b.cm
  mat=13 bunches np237 1.0                                                $ Np-237 @ 1
atom/b.cm
geometry
sector 1 core     -1
sector 2 core   1 -2
sector 3 refl   2 -3
boundary vacuum 3
picture cs material
  -25 0 25 -25 0 -25 25 0 -25
volume
  -25 -25 -25 25 -25 -25 -25 25 -25
   50 50 50
surfaces
  1 sphere  0.25   $ Detector region
  2 sphere  4.5332 $ per Section 3.2
  3 sphere 24.1420 $ THK = 19.6088 cm
detector
 number=#0000000 title="Flattop-Pu spectrum averaged flux at center"
    reaction 1 0.065449847 drf-e neutron number-flux
 number=#0000001 title="Flattop-Pu spectrum averaged U-235(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 11 15
 number=#0000002 title="Flattop spectrum averaged U-238(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 12 15
 number=#0000003 title="Flattop spectrum averaged Np-237(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 13 15
end
```

Appendix F.6

Sample COG11.3 Input File: pmf008-SI-2

```
PU-MET-FAST-008: THOR (9.587 kg Pu(5.10)-1.01Ga 9 15.29 g/cc in 24.57 cm Th @ 11.58 g/cc)
basic
  neutron delayedn CM URRPT
criticality
  npart=100000 nbatch=5050 sdt=0.0001 nfirst=51 norm=1.
nsource=1 0. 0. 0.
mix nlib=ENDFB8R0 ptlib=PT.ENDFB8R0.ACE $ Atom Densities per Table 4 in Section 3.3
  mat=1 bunches pu239 3.6049-2 pu240 1.9562-3 pu241 1.1459-4 ga 1.3338-3
  mat=2 bunches pu239 3.6049-2 pu240 1.9562-3 pu241 1.1459-4 ga 1.3338-3
  mat=3 bunches th232 3.0054-2
  mat=10 bunches th232 1.0                                              $ Th-232 @ 1 atom/b.cm
  mat=11 bunches  u235 1.0                                              $ U-235  @ 1 atom/b.cm
  mat=12 bunches  u238 1.0                                              $ U-238  @ 1 atom/b.cm
  mat=13 bunches np237 1.0                                              $ Np-237 @ 1 atom/b.cm
geometry
  sector 1 core     -1
  sector 2 core   1 -2
  sector 3 refl   2 -3
  boundary vacuum 3
picture cs material
  -30 0 30 -30 0 -30 30 0 -30
volume
  -30 -30 -30 30 -30 -30 -30 30 -30
   60 60 60
surfaces
  1 sphere  0.25  $ Detector region
  2 sphere  5.310 $ per Section 3.2
  3 sphere 29.880 $ THK = 24.57 cm
detector
 number=#0000000 title="Thor spectrum average flux at center"
    reaction 1 0.065449847 drf-e neutron number-flux
 number=#0000001 title="Thor spectrum averaged Th-232(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 10 15
 number=#0000002 title="Thor spectrum averaged Th-232(n,2ng) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 10 12
 number=#0000003 title="Thor spectrum averaged Th-232(n,g) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 10 46
 number=#0000004 title="Thor spectrum averaged U-235(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 11 15
 number=#0000005 title="Thor spectrum averaged U-235(n,g) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 11 46
 number=#0000006 title="Thor spectrum averaged U-238(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 12 15
 number=#0000007 title="Thor spectrum averaged U-238(n,2ng) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 12 12
 number=#0000008 title="Thor spectrum averaged U-238(n,ng) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 12 11
 number=#0000009 title="Thor spectrum averaged U-238(n,g) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 12 46
 number=#0000010 title="Thor spectrum averaged Np-237(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 13 15
end
```

Appendix F.7

Sample COG11.3 Input File: u233mf001-SI-2

```
U233-MET-FAST-001: JEZEBEL-23 (16.535 kg U233 @ 18.424 g/cc)
basic
  neutron delayedn CM URRPT
criticality
  npart=100000 nbatch=5050 sdt=0.0001 nfirst=51 norm=1.
  nsource=1 0. 0. 0.
mix nlib=ENDFB8R0 ptlib=PT.ENDFB8R0.ACE sablib=T.ENDFB8R0 $ Atom Densities per Table 3
  mat=1  bunches u233 4.6712-2 u234 5.9026-4 u235 1.4281-5 u238 2.8561-4
  mat=2  bunches u233 4.6712-2 u234 5.9026-4 u235 1.4281-5 u238 2.8561-4
  mat=11 bunches  u235 1.0 $ U-235  @ 1 atom/b.cm
  mat=12 bunches  u238 1.0 $ U-238  @ 1 atom/b.cm
  mat=13 bunches np237 1.0 $ Np-237 @ 1 atom/b.cm
assign-mc
  1 blue 2 purple
geometry
  sector 1 u233     -1
  sector 2 u233   1 -2
  boundary vacuum 2
picture cs material
  -6 0 6 -6 0 -6 6 0 -6
volume
  -6 -6 -6 6 -6 -6 -6 6 -6
  12 12 12
surfaces
  1 sphere 0.25   $ Detector region
  2 sphere 5.9838 $ per Section 3.2
detector
 number=#0000000 title="Jezebel-23 spectrum averaged flux at center"
    reaction 1 0.065449847 drf-e neutron number-flux
 number=#0000001 title="Jezebel-23 spectrum averaged U-235(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 11 15
 number=#0000002 title="Jezebel-23 spectrum averaged U-238(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 12 15
 number=#0000003 title="Jezebel-23 spectrum averaged Np-237(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 13 15
end
```

Appendix F.8

Sample COG11.3 Input File: u233mf006-SI-2

```
U233-MET-FAST-006: 5.740 kg U233a @ 18.42 g/cc in 19.9136 cm Nat-U @ 19.00 g/cc
basic
neutron delayedn CM URRPT
criticality
npart=100000 nbatch=5050 sdt=0.0001 nfirst=51 norm=1.
nsource=1 0. 0. 0.
mix nlib=ENDFB8R0 ptlib=PT.ENDFB8R0.ACE sablib=T.ENDFB8R0 $ Atom Densities per Table 5 in Section 3.3
  mat=1 bunches u233 4.6710-2 u234 5.8772-4 u235 1.4158-5 u238 2.7959-4
  mat=2 bunches u233 4.6710-2 u234 5.8772-4 u235 1.4158-5 u238 2.7959-4
  mat=3 bunches u235 3.5050-4 u238 4.7719-2
  mat=11 bunches  u235 1.0                                                $ U-235  @ 1 atom/b.cm
  mat=12 bunches  u238 1.0                                                $ U-238  @ 1 atom/b.cm
  mat=13 bunches np237 1.0                                                $ Np-237 @ 1 atom/b.cm
geometry
sector 1 core     -1
sector 2 core   1 -2
sector 3 refl   2 -3
boundary vacuum 3
picture cs material
-25 0 25 -25 0 -25 25 0 -25
volume
-25 -25 -25 25 -25 -25 -25 25 -25
50 50 50
surfaces
1 sphere  0.25   $ Detector region
2 sphere  4.2058 $ per Section 3.2
3 sphere 24.1194 $ THK = 19.9136 cm
detector
 number=#0000000 title="Flattop-23 spectrum averaged flux at center"
    reaction 1 0.065449847 drf-e neutron number-flux
 number=#0000001 title="Flattop-23 spectrum averaged U-235(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 11 15
 number=#0000002 title="Flattop-23 spectrum averaged U-238(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 12 15
 number=#0000003 title="Flattop-23 spectrum averaged Np-237(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 13 15
end
```

Appendix F.9

Sample COG11.3 Input File: pmf002-SI-2

```
PU-MET-FAST-002: 19.460 kg Pu(20.1)-1.01Ga @ 15.73 g/cc bare sphere
basic
neutron delayedn CM URRPT
criticality
npart=100000 nbatch=5050 sdt=0.0001 nfirst=51 norm=1.
nsource=1 0. 0. 0.
mix nlib=ENDFB8R0 ptlib=PT.ENDFB8R0.ACE sablib=T.ENDFB8R0 $ Atom Densities per Table 3 in Section 3.3
  mat=1  bunches pu239 2.9934-2 pu240 7.8754-3 pu241 1.2146-3 ga 1.5672-4
  mat=2  bunches pu239 2.9934-2 pu240 7.8754-3 pu241 1.2146-3 ga 1.5672-4
  mat=11 bunches  u235 1.0                                              $ U-235  @ 1 atom/b.cm
  mat=12 bunches  u238 1.0                                              $ U-238  @ 1 atom/b.cm
  mat=13 bunches np237 1.0                                              $ Np-237 @ 1 atom/b.cm
geometry
sector 1 core     -1
sector 2 core   1 -2
boundary vacuum 2
picture cs material color
-7  0  7 -7  0 -7  7 0 -7
volume
-7 -7 -7  7 -7 -7 -7 7 -7
14 14 14
surfaces
1 sphere  0.25   $ Detector region
2 sphere  6.6596 $ per Section 3.2
detector
 number=#0000000 title="Dirty Jezebel spectrum flux at center"
    reaction 1 0.065449847 drf-e neutron number-flux
 number=#0000001 title="Dirty Jezebel spectrum averaged U-235(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 11 15
 number=#0000002 title="Dirty Jezebel spectrum averaged U-238(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 12 15
 number=#0000003 title="Dirty Jezebel spectrum averaged Np-237(n,f) reaction rate"
    reaction 1 0.065449847 drf-e neutron r-rate 13 15
end
```