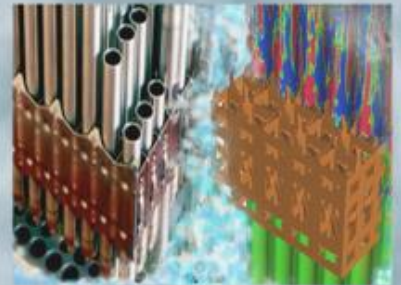
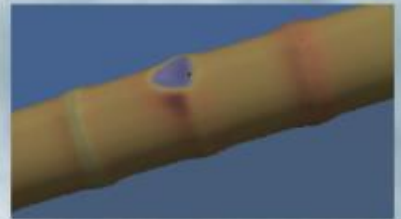
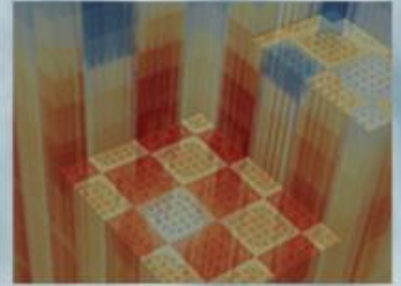


MPACT Library Verification by Comparison of Pincell Calculations to Monte Carlo Results

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REVISION LOG

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0	7/14/2015	All	Initial Release
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CONTENTS

CONTENTS.....	iii
FIGURES.....	iv
TABLES.....	v
ACRONYMS.....	vi
1. Introduction.....	1
2. Problem Geometry.....	1
3. MCNP Details.....	2
4. MPACT Details.....	3
5. MPACT Mesh Sensitivity.....	3
6. PWR Pincell Eigenvalue Results.....	5
7. Comparison of ENDF-B/VII.0 and VII.1 Libraries.....	7
8. PWR Reaction Rates.....	8
9. Conclusion.....	11
10. References.....	11
Appendix A – Complete Results.....	12
Appendix B – Number Densities.....	18

FIGURES

Figure 1: Pincell Geometry	1
Figure 2: Eigenvalue Differences	5
Figure 3: U-238 Reaction Rate Plots (MCNP)	10
Figure 4: U-238 Reaction Rate Differences (MPACT-MCNP)	10

TABLES

Table 1: Coolant Densities.....	1
Table 2: Pincell Dimensions	2
Table 3: Fuel to Coolant ratios.....	2
Table 4: MPACT Mesh Parameters	3
Table 5: Eigenvalues (polar=3).....	4
Table 6: Eigenvalues Comparisons (pcm) relative to converged (polar=3)	4
Table 7: PWR Eigenvalue Differences (pcm)	5
Table 8: Hot PWR Differences by Parameter Subgroup (pcm).....	6
Table 9: Cold PWR Differences by Parameter Subgroup (pcm)	6
Table 10: ENDF-B Eigenvalue Differences (pcm).....	7
Table 11: Reaction Rate Comparisons.....	8
Table 11: Reaction Rate Comparisons (continued)	9
Table A1: Complete Pincell Results	12

ACRONYMS

BWR	boiling water reactor
CASL	Consortium for Advanced Simulation of Light Water Reactors
CZP	Cold Zero Power
HFP	Hot Full Power
HZP	Hot Zero Power
LWR	light water reactor
PCM	percent mille (10^{-5})
PWR	pressurized water reactor
V&V	verification and validation
VERA	Virtual Environment for Reactor Applications

1. INTRODUCTION

This report summarizes the results of comparing MPACT to MCNP for a variety of PWR pincell problems. The purpose of this study is to determine how well the MPACT multigroup library agrees with continuous-energy Monte Carlo results.

The PWR cases consist of:

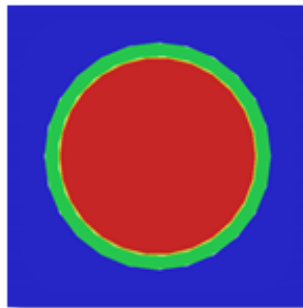
- Three U-235 enrichments (2.1%, 3.1%, and 4.1%)
- Four rod sizes corresponding to Watts Bar (WB) Unit 1 Cycle 1 (17x17), BEAVRS Cycle 1 (17x17), Surry Cycle 1 (15x15), and Krško (16x16)
- Three hot coolant densities corresponding to typical inlet, average, and outlet conditions
- Three hot fuel temperatures (600, 900, and 1200K)
- Cold cases at room temperature
- Three boron concentrations (0, 600, and 1300 ppm)

There are a total of 360 cases, 324 (3x4x3x3x3) hot cases and 36 (3x4x3) cold cases.

2. PROBLEM GEOMETRY

The PWR pincells were modeled as three concentric rings of fuel, helium gap, and zirconium, surrounded by a square region of coolant as shown in the following figure (not to scale):

Figure 1: Pincell Geometry



The moderator densities correspond to typical PWR conditions at core inlet, core average, and core outlet. The hot densities are calculated from subcooled steam tables at 2250 psia. The cold density is at room conditions.

Table 1: Coolant Densities

Reactor Condition	Nomenclature	Temperature (K)	Density (g/cc)
Cold	den0	293.6	1.0
Hot Inlet	den1	566.0	0.740816
Hot Average	den2	583.9	0.703158
Hot Outlet	den3	601.7	0.655986

The pincell geometries are shown in Table 2. These values are obtained from references [1-4].

Table 2: Pincell Dimensions

	WB 17x17	BEAVRS 17x17	Surry 15x15	Krško 16x16
Pin Pitch (cm)	1.26	1.26	1.43	1.2319
Fuel outer radius (cm)	0.4096	0.39218	0.4647	0.4096
Clad inner radius (cm)	0.4180	0.40005	0.4742	0.4180
Clad outer radius (cm)	0.4750	0.4572	0.5359	0.4750

All fuel had a stack density of 10.257 g/cc and the U-235 enrichments are 2.1, 3.1, and 4.1%.

The number densities for each material are given in the Appendix B. The same number densities are used in all the rod geometries.

In terms of fuel to moderator ratios, the BEAVRS rod is the “wettest” configuration and Krško is the “driest” configuration. The following table shows the ratio of the area of the fuel to the area of the coolant for the three pincell geometries.

Table 3: Fuel to Coolant ratios

	Area Fuel / Area Coolant
Krško 16x16	0.652
WB 17x17	0.600
Surry 15x15	0.594
BEAVRS 17x17	0.519

3. MCNP DETAILS

The version of MCNP used was MCNP 6.1.1b with ENDF/B VII.0 and VII.1 cross sections. All of the MCNP cases were run on the ORNL Fission-4 cluster.

With the exception of fuel temperatures, all of the hot temperatures were set to 600K. These temperatures are higher than normal PWR conditions, but allow the use of the cross section libraries distributed with MCNP. In the future, we could generate MCNP libraries at 560K, and re-run the calculations, but it should not have a large effect on code-to-code comparisons. The hot fuel temperatures used were 600K, 900K, or 1200K.

All of the cold temperatures were set to 293.6K, which corresponds to one of the temperatures on the MCNP libraries.

For the eigenvalue comparisons, MCNP was run with 50k neutrons per cycle, and 2000 active cycles, for a total of a total of 100M active particles per calculation. An additional 100 inactive cycles were also run to initialize the source distribution. The standard deviation on the eigenvalue for the eigenvalue cases is between 5-7 pcm.

For the reaction rate comparisons, MCNP was run with 1M neutrons per cycle and 2000 active cycles, for a total of 2 billion active particles. The standard deviation on the eigenvalue for the reaction rate cases is 1 pcm.

All of the material number densities were generated from the MPACT material processing, and then copied to MCNP to maintain consistency between the codes.

4. MPACT DETAILS

MPACT version 2.1.0 was used built from the current source on Dec 30, 2015.

The cross section library was "mpact47g_70s_v4.1m3_03192015.fmt". Subgroup cross sections were used in all the MPACT cases and all cross sections were P0 transport corrected (TCP0). All of the MPACT cases use the ENDF/B-VII.0 cross section data.

The mesh parameters used in MPACT were determined from a sensitivity study, as described in the next section. The following table shows the mesh parameters used in this study, as well as the "typical" parameters used for core calculations. In general, pincell calculations are more sensitive to the mesh and need a finer spatial resolution.

Table 4: MPACT Mesh Parameters

	Typical Value	Pincell Study
ray_spacing	0.05	0.01
polars_octant	2	3
azimuthals_octant	16	32

All cases use the Chebyshev-Yamamoto quadrature.

5. MPACT MESH SENSITIVITY

A sensitivity study was performed to select the mesh parameters used in MPACT. A typical pincell was selected (WB geometry, 600 ppm boron, average density, 1200K fuel temp) and run with different ray spacing, polar angles, and azimuthal angles. Parameters were chosen for all the cases based on the convergence of this typical pincell to the most converged answer.

Table 5: Eigenvalues (polar=3)

Azimuthal Angles per octant	Ray 0.1	Ray 0.05	Ray 0.01	Ray 0.005
4	1.23015	1.23351	1.23292	1.23282
8	1.23494	1.23574	1.23614	1.23634
16	1.23786	1.23775	1.23787	1.23806
24	1.23755	1.23807	1.23827	1.23829
32	1.23913	1.23866	1.23848	1.23848
64	1.23852	1.23893	1.23869	1.23867
128	1.23838	1.23883	1.23868	1.23871
256	1.23846	1.23878	1.23872	1.23868

Table 6: Eigenvalues Comparisons (pcm) relative to converged (polar=3)

Azimuthal Angles per octant	Ray 0.1	Ray 0.05	Ray 0.01	Ray 0.005
4	-853.1	-517.6	-576.8	-586.4
8	-373.9	-294.5	-254.1	-234.4
16	-82.1	-93.7	-81.0	-62.4
24	-113.8	-61.5	-41.2	-38.9
32	44.6	-2.7	-19.8	-20.3
64	-16.1	24.6	0.3	-1.4
128	-30.7	14.9	-0.6	3.0
256	-22.6	9.9	4.0	0.0

The polar=3 option is the most converged case you can obtain with the Chebyshev-Yamamoto quadrature set.

Based on these results, a mesh of 3 polar angles, 0.01 ray spacing, and 32 azimuthal angles was used in all of the MPACT cases to give good results converged to 20 pcm.

6. PWR PINCELL EIGENVALUE RESULTS

A summary of the PWR pincell eigenvalue results is shown in Table 7. Results are shown for all cases and for the hot and cold cases separately. All results are based on the MCNP and MPACT ENDF/B VII.0 libraries.

All results show the difference between the MCNP and MPACT eigenvalues in pcm.

$$\text{Diff} = (k_{\text{MPACT}} - k_{\text{MCNP}}) \times 10^5 \text{ pcm}$$

Table 7: PWR Eigenvalue Differences (pcm)

	Ave	Sdev	Min	Max	Count
All	19.6	88.4	-286.8	203.9	360
Hot	40.5	63.5	-124.3	203.9	324
Cold	-168.1	50.7	-286.8	-78.2	36

Overall, the PWR results are acceptable. The average of all 324 hot cases is 40.5 pcm with a standard deviation of 63.5 pcm. All of the hot cases are between -125 and +205 pcm. The cold cases show have an approximately -125 pcm bias compared to the hot cases.

The pincell results are shown as a histogram in Figure 2. The small peak on the left side of the graph corresponds to the cold results.

Figure 2: Eigenvalue Differences

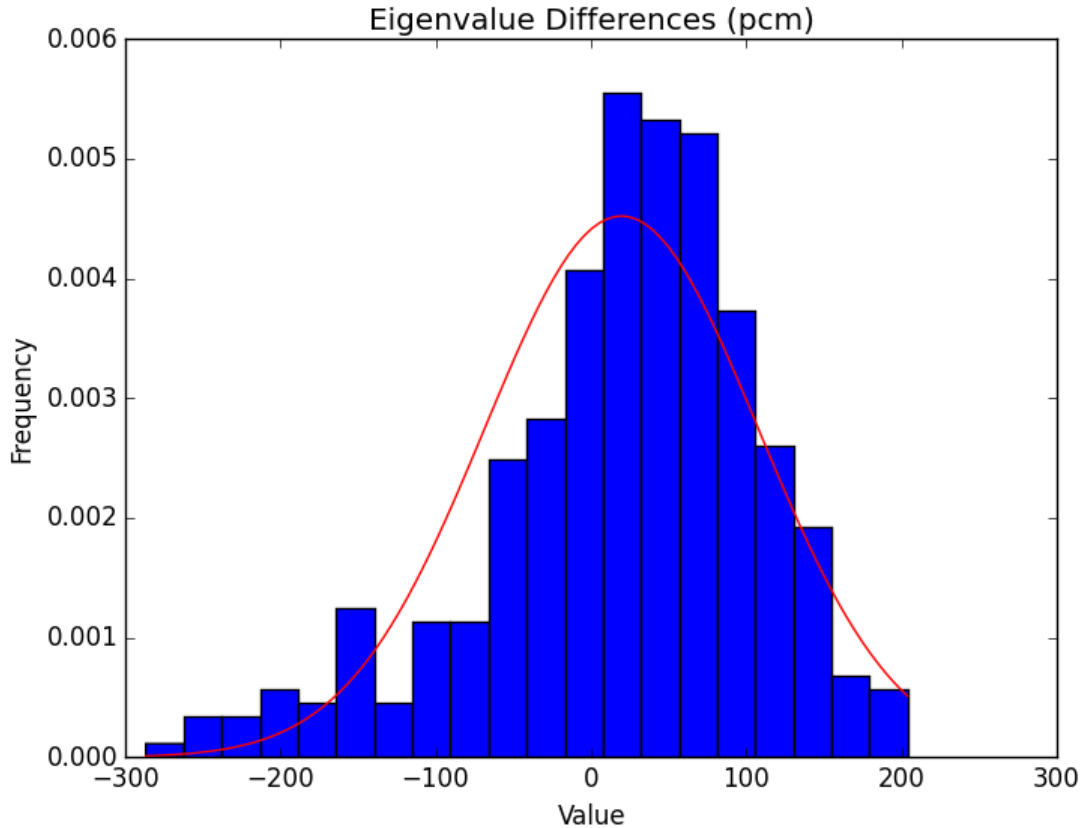


Table 8 shows the hot results averaged over individual parameter subgroups (type, enrichment, boron, moderator density, and fuel temperature). A “subgroup” is defined as all the cases that have a particular parameter. For example, out of 360 total cases, 108 cases have a boron concentration of 0ppm. Looking at the averages over subgroups allows us to identify “trends” in parameters.

Table 8: Hot PWR Differences by Parameter Subgroup (pcm)

		Ave	Sdev	Min	Max	Count
Type	beav	18.6	43.2	-82.5	108.3	81
Type	krsko	100.5	50.2	-13.9	203.9	81
Type	WB	56.6	48.4	-58.6	149.7	81
Type	surry	-13.8	46.8	-124.3	74.4	81
Enrich	21	54.2	57.4	-65.5	203.9	108
Enrich	31	44.2	63.0	-97.1	183.3	108
Enrich	41	23.0	66.3	-124.3	181.3	108
Boron	0	49.6	68.7	-124.3	203.9	108
Boron	600	37.8	62.9	-114.1	183.3	108
Boron	1300	34.0	58.0	-101.1	160.2	108
Density	den1	15.5	57.3	-124.3	140.4	108
Density	den2	37.5	60.0	-97.1	169.0	108
Density	den3	68.3	62.3	-76.4	203.9	108
Tfuel	600	75.3	52.4	-32.0	203.9	108
Tfuel	900	57.1	51.7	-56.0	183.4	108
Tfuel	1200	-11.0	50.8	-124.3	95.3	108

Using a criteria of 100 pcm between subgroup differences to define a trend, there are no trends in geometry, enrichment, boron, or moderator density. There does appear to be a small trend in fuel temperature (110 pcm).

Table 9 shows the cold results averaged over individual parameter subgroups. There are no trends in parameter subgroups, but there is a -200 pcm bias between hot and cold cases.

Table 9: Cold PWR Differences by Parameter Subgroup (pcm)

		Ave	Sdev	Min	Max	Count
Type	beav	-188.0	58.4	-286.8	-111.2	9
Type	krsko	-141.1	48.8	-225.8	-78.2	9
Type	WB	-163.1	48.5	-248.5	-101.6	9
Type	surry	-180.1	40.4	-251.0	-141.0	9
Enrich	21	-220.6	40.1	-286.8	-144.1	12
Enrich	31	-155.4	32.3	-208.9	-95.1	12
Enrich	41	-128.3	24.7	-157.0	-78.2	12
Boron	0	-136.4	38.6	-198.3	-78.2	12
Boron	600	-175.0	47.5	-261.6	-105.0	12
Boron	1300	-192.9	51.0	-286.8	-120.7	12

7. COMPARISON OF ENDF-B/VII.0 AND VII.1 LIBRARIES

The comparisons in the previous section were performed with the ENDF-B/VII.0 (E7.0) cross section library. To evaluate the newer ENDF-B/VII.1 (E7.1) library, all of the MCNP pincell cases were re-run with the E7.1 library, and the results were compared.

Table 10 shows the difference between the MCNP E7.1 and E7.0 cases. (No MPACT results are shown.)

$$\text{Diff} = (k_{\text{MCNP E7.1}} - k_{\text{MCNP E7.0}}) \times 10^5 \text{ pcm}$$

Table 10: ENDF-B Eigenvalue Differences (pcm)

	Ave	Sdev	Min	Max	Count
All	-17.9	12.2	-57.0	10.0	360
Hot	-15.6	10.5	-46.0	10.0	324
Cold	-38.1	7.3	-57.0	-20.0	36

The differences between the E7.1 and E7.0 libraries using MCNP are fairly small. The MCNP results agree with the general industry experience of a difference around 30 pcm for PWR applications between E7.1 and E7.0.

The pincell cases were also re-run with MPACT using the E7.1 library `mpact47g_71s_v4.1m3_03192015_fmt`, but large differences were encountered. These large differences are currently being investigated.

8. PWR REACTION RATES

In addition to the eigenvalue comparisons, a comparison of U-238 reaction rates was performed for one case in the 47g energy structure. The case is “pwr-600ppm-den2-900K”, but similar results are observed at 600K and 1200K.

Table 11: Reaction Rate Comparisons

Upper Bound Energy(eV)	Group	MCNP Reaction Rates (pcm)		MPACT Reaction Rates (pcm)		MPACT-MCNP (pcm)		MPACT-MCNP (%)	
		abs	nufis	abs	nufis	abs	nufis	abs	nufis
2.00E+07	1	237.88	824.68	82.35	839.93	-155.53*	15.26	*	1.85
6.07E+06	2	610.90	1830.18	613.39	1840.9	2.49	10.72	0.41	0.59
3.68E+06	3	1284.20	3338.36	1287.55	3346.87	3.35	8.51	0.26	0.25
2.23E+06	4	1224.89	2816.14	1243.16	2858.84	18.27	42.70	1.49	1.52
1.35E+06	5	328.65	165.22	330.76	163.16	2.11	-2.06	0.64	-1.25
8.21E+05	6	318.08	11.75	313.49	11.88	-4.59	0.14	-1.44	
4.98E+05	7	388.31	1.34	379.34	1.31	-8.97	-0.03	-2.31	
1.83E+05	8	377.69	0.42	363.92	0.39	-13.77	-0.03	-3.65	
6.74E+04	9	1359.99	0.53	1281.71	0.37	-78.28	-0.16	-5.76	
9.12E+03	10	1563.00	0.17	1554.78	0.17	-8.22	0.00	-0.53	
2.03E+03	11	4715.68	4.68	4627.17	4.57	-88.51	-0.11	-1.88	
1.30E+02	12	1778.84		1787.16		8.32		0.47	
7.89E+01	13	1054.93		1040.2		-14.73		-1.40	
4.79E+01	14	2275.37		2283.84		8.47		0.37	
2.90E+01	15	2938.77		2967.31		28.54		0.97	
1.37E+01	16	29.99		30.02		0.04		0.12	
1.21E+01	17	228.86		228.39		-0.47		-0.20	
8.3153	18	332.18		328.46		-3.72		-1.12	
7.3382	19	3131.01		3218.79		87.78		2.80	
6.4760	20	1178.97		1206.55		27.58		2.34	
5.7150	21	237.55		231.4		-6.15		-2.59	
5.0435	22	127.39		127.66		0.27		0.21	
4.4509	23	101.81		101.11		-0.70		-0.68	
3.9279	24	231.62		230.99		-0.63		-0.27	
2.3824	25	98.53		98.54		0.01		0.01	
1.8554	26	96.71		96.58		-0.13		-0.13	
1.4574	27	68.47		67.96		-0.51		-0.75	
1.2351	28	23.61		23.44		-0.17		-0.71	
1.1664	29	14.59		14.54		-0.05		-0.36	
1.1254	30	20.06		19.95		-0.11		-0.55	
1.0722	31	23.92		23.85		-0.07		-0.30	
1.0137	32	18.96		18.81		-0.15		-0.81	
0.9710	33	29.27		29.15		-0.12		-0.42	
0.9100	34	72.03		71.64		-0.39		-0.54	
0.7821	35	116.94		116.28		-0.66		-0.57	
0.6251	36	127.60		127.36		-0.24		-0.19	

Table 11: Reaction Rate Comparisons (continued)

Upper Bound	Group	MCNP Reaction Rates (pcm)		MPACT Reaction Rates (pcm)		MPACT-MCNP (pcm)		MPACT-MCNP (%)	
		abs	nufis	abs	nufis	abs	nufis	abs	nufis
0.5032	37	246.33		245.92		-0.41		-0.17	
0.3577	38	274.01		275.75		1.74		0.63	
0.2705	39	600.53		601.03		0.50		0.08	
0.1844	40	519.79		520.17		0.38		0.07	
0.1457	41	692.99		691.14		-1.85		-0.27	
0.1116	42	838.62		839.89		1.27		0.15	
0.08197	43	908.49		909.35		0.86		0.09	
0.05692	44	582.03		581.43		-0.60		-0.10	
0.04276	45	514.80		513.79		-1.01		-0.20	
0.03061	46	703.73		702.91		-0.82		-0.12	
0.01240	47	254.41		257.71		3.30		1.30	

* Group 1 results are biased by (n,2n) treatment. See discussion below.

All of the reaction rates are normalized so that the total absorptions is equal to 1 (10^5 pcm).

$$\sum_g \int \Sigma_{ag}(r) \phi_g(r) dV = 1.0$$

The reaction rates are only shown for the U-238 isotope. Additional reaction rates are available for all isotopes, but the U-238 resonances are the most interesting.

The absolute U-238 resonance errors greater than 50 pcm are highlighted in orange. The relative errors greater than 1% are highlighted in blue. Note that some resonances have a positive error, and some have a negative error, which tend to cancel out. The large cancellation of errors could help explain the biases in the eigenvalue results.

The reaction rate errors in group 1 are due to the (n,2n) treatment. The (n,2n) treatment is not accounted for in the MPACT reaction rate edits (i.e. absorption includes a negative (n,2n)), but it is accounted for in the MPACT depletion calculation where the absolute destruction rate is needed.

The goal should be to have resonance errors less than 1% in all of the important U-238 resonances. This accuracy is equal to current industry methods and should be easy to achieve using the advanced methods in CENTRM and with subgroup cross sections. The reaction rates errors in groups 9, 11, and 19 are especially troublesome.

Figures 3 and 4 show the U-238 reaction rates and reaction rate differences in graphical form.

Figure 3: U-238 Reaction Rate Plots (MCNP)

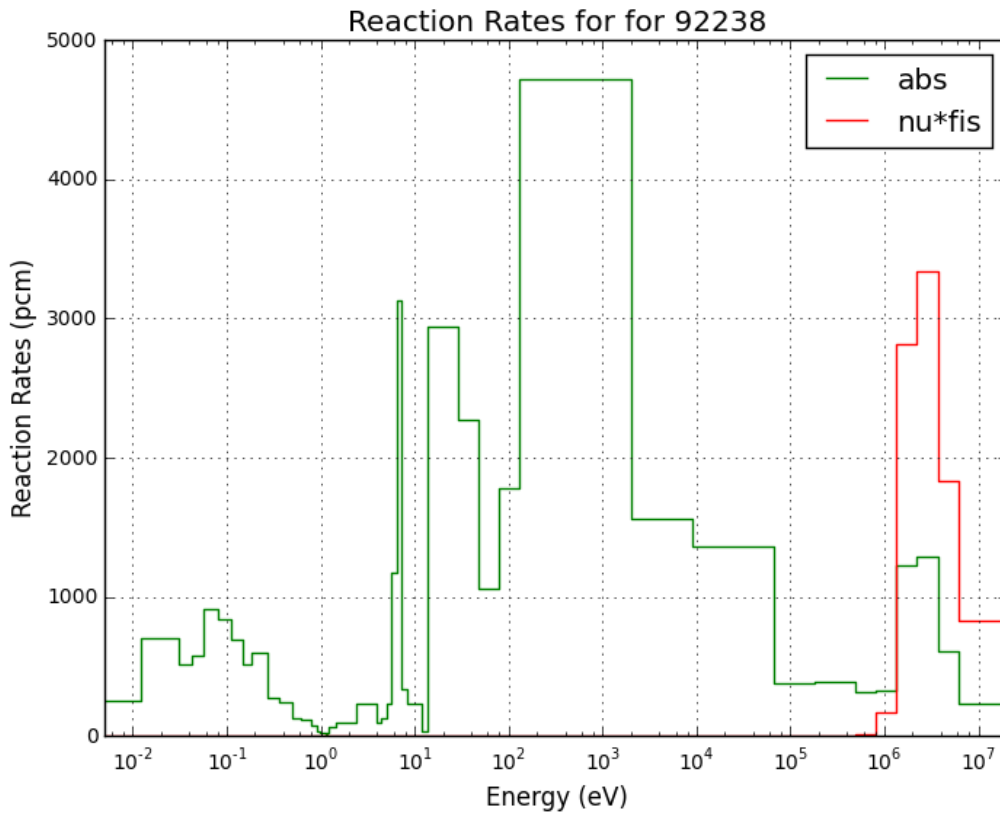
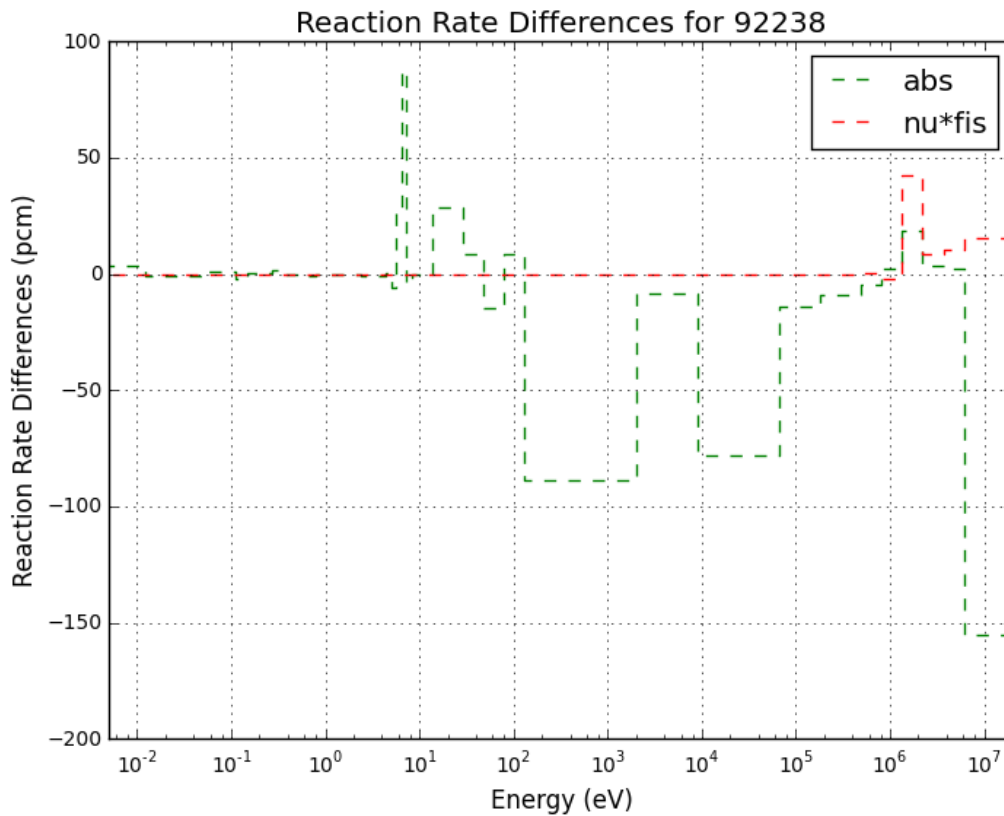


Figure 4: U-238 Reaction Rate Differences (MPACT-MCNP)



9. CONCLUSION

In this study, a large number of pincell eigenvalue comparisons were made between MPACT and MCNP to validate the MPACT multigroup library over the range of conditions experienced in a PWR. 360 pincell calculations were run covering a range of five geometries, three boron concentrations, three hot moderator densities three hot fuel temperatures, and one cold case. The average difference between the MPACT and MCNP eigenvalues is 19.6 pcm with a standard deviation of 88.4 pcm.

It was shown that there is a significant bias in the cold cases and the cold eigenvalues are approximately 200 pcm lower than the hot eigenvalues. No other significant biases were found with respect to geometry, enrichment, boron concentration, moderator density, or fuel temperatures.

In addition to the eigenvalue comparisons, group-by-group reaction rate comparisons were made for U-238 in a typical fuel rod. The reaction rate results show large errors in groups 9, 11, and 19, which correspond to large U-238 resonances. Two of these errors are positive and one error is negative, which leads to a cancellation of errors when looking at eigenvalue results.

10. REFERENCES

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- [3] “Benchmark for Evaluation and Validation of Reactor Simulations (BEAVRS) Benchmark Specification”, MIT, Release 1.1, October (2016), available from <http://crpg.mit.edu/pub/beavrs>
- [4] Krsko Updated Safety Analysis Report (USAR), Chapter 4, Revision 21.

APPENDIX A – COMPLETE RESULTS

The following tables shows the pincell eigenvalues for all 360 cases.

The naming convention of the cases is “geometry-enrichment-boron-moderator density-fuel temperature”.

Table A1: Complete Pincell Results

Case	MCNP E7.0	MCNP E7.1	MPACT E7.0	MPACT-MCNP E7.0	MCNP 7.1- MCNP 7.0
beav-21-0000-den0-0293	1.30421	1.30378	1.30223	-198	-43
beav-21-0000-den1-0600	1.26198	1.26168	1.26255	57	-30
beav-21-0000-den1-0900	1.25228	1.25189	1.25266	38	-39
beav-21-0000-den1-1200	1.24398	1.24371	1.24379	-19	-27
beav-21-0000-den2-0600	1.25608	1.25571	1.25680	72	-37
beav-21-0000-den2-0900	1.24605	1.24576	1.24663	58	-29
beav-21-0000-den2-1200	1.23774	1.23733	1.23753	-21	-41
beav-21-0000-den3-0600	1.24722	1.24700	1.24826	104	-22
beav-21-0000-den3-0900	1.23697	1.23651	1.23773	76	-46
beav-21-0000-den3-1200	1.22809	1.22789	1.22833	24	-20
beav-21-0600-den0-0293	1.16171	1.16128	1.15909	-262	-43
beav-21-0600-den1-0600	1.15754	1.15722	1.15772	18	-32
beav-21-0600-den1-0900	1.14846	1.14824	1.14875	29	-22
beav-21-0600-den1-1200	1.14100	1.14062	1.14065	-35	-38
beav-21-0600-den2-0600	1.15697	1.15662	1.15734	37	-35
beav-21-0600-den2-0900	1.14760	1.14744	1.14808	48	-16
beav-21-0600-den2-1200	1.13984	1.13951	1.13974	-10	-33
beav-21-0600-den3-0600	1.15502	1.15473	1.15568	66	-29
beav-21-0600-den3-0900	1.14540	1.14512	1.14604	64	-28
beav-21-0600-den3-1200	1.13722	1.13704	1.13738	16	-18
beav-21-1300-den0-0293	1.03290	1.03252	1.03003	-287	-38
beav-21-1300-den1-0600	1.05744	1.05718	1.05744	0	-26
beav-21-1300-den1-0900	1.04914	1.04902	1.04935	21	-12
beav-21-1300-den1-1200	1.04224	1.04208	1.04199	-25	-16
beav-21-1300-den2-0600	1.06118	1.06085	1.06140	22	-33
beav-21-1300-den2-0900	1.05274	1.05253	1.05301	27	-21
beav-21-1300-den2-1200	1.04548	1.04533	1.04541	-7	-15
beav-21-1300-den3-0600	1.06483	1.06471	1.06541	58	-12
beav-21-1300-den3-0900	1.05591	1.05588	1.05664	73	-3
beav-21-1300-den3-1200	1.04860	1.04845	1.04871	11	-15
beav-31-0000-den0-0293	1.40933	1.40885	1.40798	-135	-48
beav-31-0000-den1-0600	1.35735	1.35697	1.35779	44	-38
beav-31-0000-den1-0900	1.34701	1.34666	1.34717	16	-35
beav-31-0000-den1-1200	1.33827	1.33808	1.33778	-49	-19
beav-31-0000-den2-0600	1.34943	1.34914	1.35014	71	-29
beav-31-0000-den2-0900	1.33878	1.33857	1.33925	47	-21
beav-31-0000-den2-1200	1.32995	1.32972	1.32963	-32	-23
beav-31-0000-den3-0600	1.33809	1.33800	1.33917	108	-9
beav-31-0000-den3-0900	1.32721	1.32703	1.32793	72	-18
beav-31-0000-den3-1200	1.31797	1.31788	1.31800	3	-9
beav-31-0600-den0-0293	1.28743	1.28686	1.28553	-190	-57
beav-31-0600-den1-0600	1.27041	1.27010	1.27064	23	-31
beav-31-0600-den1-0900	1.26069	1.26051	1.26083	14	-18
beav-31-0600-den1-1200	1.25259	1.25236	1.25208	-51	-23
beav-31-0600-den2-0600	1.26732	1.26710	1.26779	47	-22
beav-31-0600-den2-0900	1.25730	1.25712	1.25768	38	-18
beav-31-0600-den2-1200	1.24908	1.24882	1.24870	-38	-26
beav-31-0600-den3-0600	1.26207	1.26191	1.26290	83	-16
beav-31-0600-den3-0900	1.25178	1.25155	1.25242	64	-23
beav-31-0600-den3-1200	1.24322	1.24291	1.24312	-10	-31
beav-31-1300-den0-0293	1.17142	1.17102	1.16933	-209	-40
beav-31-1300-den1-0600	1.18350	1.18327	1.18362	12	-23
beav-31-1300-den1-0900	1.17445	1.17436	1.17459	14	-9
beav-31-1300-den1-1200	1.16692	1.16675	1.16650	-42	-17
beav-31-1300-den2-0600	1.18469	1.18447	1.18498	29	-22

beav-31-1300-den2-0900	1.17536	1.17519	1.17565	29	-17
beav-31-1300-den2-1200	1.16766	1.16739	1.16731	-35	-27
beav-31-1300-den3-0600	1.18483	1.18477	1.18553	70	-6
beav-31-1300-den3-0900	1.17527	1.17496	1.17582	55	-31
beav-31-1300-den3-1200	1.16727	1.16699	1.16715	-12	-28
beav-41-0000-den0-0293	1.46981	1.46940	1.46870	-111	-41
beav-41-0000-den1-0600	1.41153	1.41145	1.41210	57	-8
beav-41-0000-den1-0900	1.40117	1.40090	1.40114	-3	-27
beav-41-0000-den1-1200	1.39222	1.39211	1.39151	-71	-11
beav-41-0000-den2-0600	1.40286	1.40267	1.40336	50	-19
beav-41-0000-den2-0900	1.39194	1.39172	1.39213	19	-22
beav-41-0000-den2-1200	1.38284	1.38268	1.38228	-56	-16
beav-41-0000-den3-0600	1.39010	1.38994	1.39102	92	-16
beav-41-0000-den3-0900	1.37895	1.37876	1.37944	49	-19
beav-41-0000-den3-1200	1.36952	1.36949	1.36930	-22	-3
beav-41-0600-den0-0293	1.36351	1.36308	1.36207	-144	-43
beav-41-0600-den1-0600	1.33760	1.33740	1.33781	21	-20
beav-41-0600-den1-0900	1.32770	1.32734	1.32754	-16	-36
beav-41-0600-den1-1200	1.31930	1.31891	1.31847	-83	-39
beav-41-0600-den2-0600	1.33293	1.33265	1.33334	41	-28
beav-41-0600-den2-0900	1.32261	1.32247	1.32279	18	-14
beav-41-0600-den2-1200	1.31401	1.31381	1.31349	-52	-20
beav-41-0600-den3-0600	1.32568	1.32549	1.32640	72	-19
beav-41-0600-den3-0900	1.31509	1.31492	1.31548	39	-17
beav-41-0600-den3-1200	1.30609	1.30607	1.30587	-22	-2
beav-41-1300-den0-0293	1.25922	1.25885	1.25765	-157	-37
beav-41-1300-den1-0600	1.26160	1.26146	1.26167	7	-14
beav-41-1300-den1-0900	1.25204	1.25189	1.25212	8	-15
beav-41-1300-den1-1200	1.24428	1.24419	1.24363	-65	-9
beav-41-1300-den2-0600	1.26099	1.26063	1.26116	17	-36
beav-41-1300-den2-0900	1.25121	1.25102	1.25131	10	-19
beav-41-1300-den2-1200	1.24308	1.24309	1.24258	-50	1
beav-41-1300-den3-0600	1.25880	1.25859	1.25928	48	-21
beav-41-1300-den3-0900	1.24855	1.24854	1.24904	49	-1
beav-41-1300-den3-1200	1.24023	1.24018	1.24000	-23	-5
krsko-21-0000-den0-0293	1.29349	1.29304	1.29205	-144	-45
krsko-21-0000-den1-0600	1.23509	1.23488	1.23649	140	-21
krsko-21-0000-den1-0900	1.22442	1.22428	1.22557	115	-14
krsko-21-0000-den1-1200	1.21542	1.21522	1.21585	43	-20
krsko-21-0000-den2-0600	1.22689	1.22657	1.22842	153	-32
krsko-21-0000-den2-0900	1.21584	1.21564	1.21725	141	-20
krsko-21-0000-den2-1200	1.20662	1.20660	1.20731	69	-2
krsko-21-0000-den3-0600	1.21487	1.21483	1.21691	204	-4
krsko-21-0000-den3-0900	1.20357	1.20357	1.20540	183	0
krsko-21-0000-den3-1200	1.19424	1.19406	1.19519	95	-18
krsko-21-0600-den0-0293	1.17704	1.17659	1.17501	-203	-45
krsko-21-0600-den1-0600	1.15221	1.15194	1.15322	101	-27
krsko-21-0600-den1-0900	1.14203	1.14191	1.14314	111	-12
krsko-21-0600-den1-1200	1.13371	1.13365	1.13411	40	-6
krsko-21-0600-den2-0600	1.14834	1.14822	1.14977	143	-12
krsko-21-0600-den2-0900	1.13820	1.13809	1.13942	122	-11
krsko-21-0600-den2-1200	1.12956	1.12937	1.13017	61	-19
krsko-21-0600-den3-0600	1.14241	1.14219	1.14414	173	-22
krsko-21-0600-den3-0900	1.13175	1.13161	1.13344	169	-14
krsko-21-0600-den3-1200	1.12303	1.12282	1.12390	87	-21
krsko-21-1300-den0-0293	1.06725	1.06682	1.06499	-226	-43
krsko-21-1300-den1-0600	1.06998	1.06986	1.07082	84	-12
krsko-21-1300-den1-0900	1.06064	1.06048	1.06157	93	-16
krsko-21-1300-den1-1200	1.05283	1.05281	1.05325	42	-2
krsko-21-1300-den2-0600	1.07031	1.07014	1.07139	108	-17
krsko-21-1300-den2-0900	1.06059	1.06067	1.06186	127	8
krsko-21-1300-den2-1200	1.05268	1.05259	1.05330	62	-9
krsko-21-1300-den3-0600	1.06944	1.06943	1.07095	151	-1
krsko-21-1300-den3-0900	1.05945	1.05947	1.06105	160	2
krsko-21-1300-den3-1200	1.05125	1.05123	1.05219	94	-2
krsko-31-0000-den0-0293	1.38990	1.38958	1.38895	-95	-32
krsko-31-0000-den1-0600	1.32278	1.32251	1.32401	123	-27

krsko-31-0000-den1-0900	1.31145	1.31116	1.31240	95	-29
krsko-31-0000-den1-1200	1.30190	1.30190	1.30216	26	0
krsko-31-0000-den2-0600	1.31262	1.31253	1.31431	169	-9
krsko-31-0000-den2-0900	1.30118	1.30103	1.30245	127	-15
krsko-31-0000-den2-1200	1.29148	1.29146	1.29201	53	-2
krsko-31-0000-den3-0600	1.29892	1.29879	1.30074	182	-13
krsko-31-0000-den3-0900	1.28704	1.28687	1.28856	152	-17
krsko-31-0000-den3-1200	1.27706	1.27698	1.27785	79	-8
krsko-31-0600-den0-0293	1.29196	1.29149	1.29056	-140	-47
krsko-31-0600-den1-0600	1.25478	1.25461	1.25581	103	-17
krsko-31-0600-den1-0900	1.24406	1.24382	1.24491	85	-24
krsko-31-0600-den1-1200	1.23500	1.23489	1.23526	26	-11
krsko-31-0600-den2-0600	1.24878	1.24862	1.25013	135	-16
krsko-31-0600-den2-0900	1.23774	1.23761	1.23897	123	-13
krsko-31-0600-den2-1200	1.22863	1.22856	1.22910	47	-7
krsko-31-0600-den3-0600	1.23980	1.23974	1.24163	183	-6
krsko-31-0600-den3-0900	1.22863	1.22845	1.23012	149	-18
krsko-31-0600-den3-1200	1.21919	1.21913	1.21997	78	-6
krsko-31-1300-den0-0293	1.19546	1.19504	1.19388	-158	-42
krsko-31-1300-den1-0600	1.18483	1.18476	1.18582	99	-7
krsko-31-1300-den1-0900	1.17471	1.17472	1.17565	94	1
krsko-31-1300-den1-1200	1.16636	1.16635	1.16661	25	-1
krsko-31-1300-den2-0600	1.18260	1.18247	1.18388	128	-13
krsko-31-1300-den2-0900	1.17233	1.17239	1.17343	110	6
krsko-31-1300-den2-1200	1.16368	1.16363	1.16416	48	-5
krsko-31-1300-den3-0600	1.17857	1.17841	1.18016	159	-16
krsko-31-1300-den3-0900	1.16785	1.16785	1.16935	150	0
krsko-31-1300-den3-1200	1.15899	1.15890	1.15978	79	-9
krsko-41-0000-den0-0293	1.44496	1.44463	1.44418	-78	-33
krsko-41-0000-den1-0600	1.37288	1.37277	1.37401	113	-11
krsko-41-0000-den1-0900	1.36134	1.36106	1.36208	74	-28
krsko-41-0000-den1-1200	1.35160	1.35155	1.35164	4	-5
krsko-41-0000-den2-0600	1.36202	1.36200	1.36346	144	-2
krsko-41-0000-den2-0900	1.35026	1.35023	1.35129	103	-3
krsko-41-0000-den2-1200	1.34053	1.34037	1.34065	12	-16
krsko-41-0000-den3-0600	1.34705	1.34702	1.34886	181	-3
krsko-41-0000-den3-0900	1.33496	1.33499	1.33638	142	3
krsko-41-0000-den3-1200	1.32489	1.32497	1.32548	59	8
krsko-41-0600-den0-0293	1.36054	1.36016	1.35949	-105	-38
krsko-41-0600-den1-0600	1.31550	1.31532	1.31645	95	-18
krsko-41-0600-den1-0900	1.30455	1.30426	1.30513	58	-29
krsko-41-0600-den1-1200	1.29534	1.29523	1.29520	-14	-11
krsko-41-0600-den2-0600	1.30819	1.30803	1.30943	124	-16
krsko-41-0600-den2-0900	1.29686	1.29676	1.29786	100	-10
krsko-41-0600-den2-1200	1.28768	1.28744	1.28771	3	-24
krsko-41-0600-den3-0600	1.29766	1.29757	1.29926	160	-9
krsko-41-0600-den3-0900	1.28605	1.28613	1.28735	130	8
krsko-41-0600-den3-1200	1.27633	1.27635	1.27694	61	2
krsko-41-1300-den0-0293	1.27523	1.27499	1.27402	-121	-24
krsko-41-1300-den1-0600	1.25523	1.25511	1.25608	85	-12
krsko-41-1300-den1-0900	1.24477	1.24470	1.24541	64	-7
krsko-41-1300-den1-1200	1.23606	1.23591	1.23601	-5	-15
krsko-41-1300-den2-0600	1.25129	1.25120	1.25248	119	-9
krsko-41-1300-den2-0900	1.24060	1.24057	1.24154	94	-3
krsko-41-1300-den2-1200	1.23174	1.23170	1.23192	18	-4
krsko-41-1300-den3-0600	1.24530	1.24509	1.24665	135	-21
krsko-41-1300-den3-0900	1.23414	1.23407	1.23536	122	-7
krsko-41-1300-den3-1200	1.22485	1.22495	1.22545	60	10
wb-21-0000-den0-0293	1.29956	1.29916	1.29785	-171	-40
wb-21-0000-den1-0600	1.24716	1.24680	1.24812	96	-36
wb-21-0000-den1-0900	1.23683	1.23674	1.23761	78	-9
wb-21-0000-den1-1200	1.22818	1.22796	1.22823	5	-22
wb-21-0000-den2-0600	1.23977	1.23949	1.24088	111	-28
wb-21-0000-den2-0900	1.22913	1.22890	1.23010	97	-23
wb-21-0000-den2-1200	1.22015	1.22008	1.22049	34	-7
wb-21-0000-den3-0600	1.22892	1.22881	1.23042	150	-11
wb-21-0000-den3-0900	1.21794	1.21785	1.21930	136	-9

wb-21-0000-den3-1200	1.20878	1.20858	1.20941	63	-20
wb-21-0600-den0-0293	1.17352	1.17316	1.17130	-222	-36
wb-21-0600-den1-0600	1.15648	1.15629	1.15715	67	-19
wb-21-0600-den1-0900	1.14695	1.14677	1.14751	56	-18
wb-21-0600-den1-1200	1.13891	1.13861	1.13884	-7	-30
wb-21-0600-den2-0600	1.15401	1.15376	1.15482	81	-25
wb-21-0600-den2-0900	1.14415	1.14394	1.14489	74	-21
wb-21-0600-den2-1200	1.13583	1.13563	1.13600	17	-20
wb-21-0600-den3-0600	1.14935	1.14930	1.15062	127	-5
wb-21-0600-den3-0900	1.13930	1.13903	1.14033	103	-27
wb-21-0600-den3-1200	1.13054	1.13052	1.13113	59	-2
wb-21-1300-den0-0293	1.05660	1.05636	1.05411	-249	-24
wb-21-1300-den1-0600	1.06764	1.06769	1.06821	57	5
wb-21-1300-den1-0900	1.05892	1.05870	1.05942	50	-22
wb-21-1300-den1-1200	1.05152	1.05124	1.05147	-5	-28
wb-21-1300-den2-0600	1.06945	1.06920	1.07003	58	-25
wb-21-1300-den2-0900	1.06015	1.05991	1.06095	80	-24
wb-21-1300-den2-1200	1.05261	1.05247	1.05277	16	-14
wb-21-1300-den3-0600	1.07028	1.07002	1.07123	95	-26
wb-21-1300-den3-0900	1.06063	1.06051	1.06177	114	-12
wb-21-1300-den3-1200	1.05276	1.05264	1.05327	51	-12
wb-31-0000-den0-0293	1.39904	1.39861	1.39789	-115	-43
wb-31-0000-den1-0600	1.33750	1.33723	1.33834	84	-27
wb-31-0000-den1-0900	1.32662	1.32639	1.32713	51	-23
wb-31-0000-den1-1200	1.31744	1.31735	1.31723	-21	-9
wb-31-0000-den2-0600	1.32817	1.32803	1.32937	120	-14
wb-31-0000-den2-0900	1.31710	1.31690	1.31790	80	-20
wb-31-0000-den2-1200	1.30777	1.30749	1.30778	1	-28
wb-31-0000-den3-0600	1.31527	1.31514	1.31671	144	-13
wb-31-0000-den3-0900	1.30371	1.30361	1.30490	119	-10
wb-31-0000-den3-1200	1.29409	1.29406	1.29451	42	-3
wb-31-0600-den0-0293	1.29227	1.29189	1.29079	-148	-38
wb-31-0600-den1-0600	1.26268	1.26250	1.26342	74	-18
wb-31-0600-den1-0900	1.25243	1.25229	1.25295	52	-14
wb-31-0600-den1-1200	1.24383	1.24374	1.24366	-17	-9
wb-31-0600-den2-0600	1.25779	1.25777	1.25875	96	-2
wb-31-0600-den2-0900	1.24726	1.24701	1.24801	75	-25
wb-31-0600-den2-1200	1.23841	1.23836	1.23848	7	-5
wb-31-0600-den3-0600	1.25035	1.25020	1.25154	119	-15
wb-31-0600-den3-0900	1.23951	1.23932	1.24044	93	-19
wb-31-0600-den3-1200	1.23026	1.23013	1.23062	36	-13
wb-31-1300-den0-0293	1.18870	1.18835	1.18687	-183	-35
wb-31-1300-den1-0600	1.18676	1.18649	1.18727	51	-27
wb-31-1300-den1-0900	1.17708	1.17691	1.17755	47	-17
wb-31-1300-den1-1200	1.16915	1.16895	1.16888	-27	-20
wb-31-1300-den2-0600	1.18565	1.18557	1.18653	88	-8
wb-31-1300-den2-0900	1.17568	1.17578	1.17653	85	10
wb-31-1300-den2-1200	1.16748	1.16752	1.16762	14	4
wb-31-1300-den3-0600	1.18320	1.18309	1.18436	116	-11
wb-31-1300-den3-0900	1.17311	1.17280	1.17398	87	-31
wb-31-1300-den3-1200	1.16437	1.16437	1.16476	39	0
wb-41-0000-den0-0293	1.45605	1.45578	1.45503	-102	-27
wb-41-0000-den1-0600	1.38904	1.38892	1.38981	77	-12
wb-41-0000-den1-0900	1.37794	1.37773	1.37827	33	-21
wb-41-0000-den1-1200	1.36865	1.36843	1.36815	-50	-22
wb-41-0000-den2-0600	1.37888	1.37874	1.37989	101	-14
wb-41-0000-den2-0900	1.36749	1.36731	1.36810	61	-18
wb-41-0000-den2-1200	1.35795	1.35790	1.35777	-18	-5
wb-41-0000-den3-0600	1.36477	1.36467	1.36607	130	-10
wb-41-0000-den3-0900	1.35304	1.35289	1.35395	91	-15
wb-41-0000-den3-1200	1.34328	1.34329	1.34336	8	1
wb-41-0600-den0-0293	1.36374	1.36333	1.36242	-132	-41
wb-41-0600-den1-0600	1.32568	1.32561	1.32632	64	-7
wb-41-0600-den1-0900	1.31515	1.31504	1.31542	27	-11
wb-41-0600-den1-1200	1.30628	1.30613	1.30583	-45	-15
wb-41-0600-den2-0600	1.31947	1.31930	1.32021	74	-17
wb-41-0600-den2-0900	1.30865	1.30833	1.30904	39	-32

wb-41-0600-den2-1200	1.29954	1.29936	1.29923	-31	-18
wb-41-0600-den3-0600	1.31005	1.30997	1.31117	112	-8
wb-41-0600-den3-0900	1.29876	1.29869	1.29966	90	-7
wb-41-0600-den3-1200	1.28946	1.28954	1.28956	10	8
wb-41-1300-den0-0293	1.27143	1.27108	1.26997	-146	-35
wb-41-1300-den1-0600	1.25982	1.25968	1.26028	46	-14
wb-41-1300-den1-0900	1.24977	1.24964	1.25005	28	-13
wb-41-1300-den1-1200	1.24160	1.24134	1.24101	-59	-26
wb-41-1300-den2-0600	1.25707	1.25686	1.25779	72	-21
wb-41-1300-den2-0900	1.24676	1.24669	1.24728	52	-7
wb-41-1300-den2-1200	1.23831	1.23821	1.23801	-30	-10
wb-41-1300-den3-0600	1.25237	1.25224	1.25338	101	-13
wb-41-1300-den3-0900	1.24186	1.24162	1.24251	65	-24
wb-41-1300-den3-1200	1.23283	1.23286	1.23293	10	3
surry-21-0000-den0-0293	1.30499	1.30459	1.30301	-198	-40
surry-21-0000-den1-0600	1.25588	1.25566	1.25607	19	-22
surry-21-0000-den1-0900	1.24592	1.24573	1.24600	8	-19
surry-21-0000-den1-1200	1.23764	1.23741	1.23698	-66	-23
surry-21-0000-den2-0600	1.24865	1.24844	1.24905	40	-21
surry-21-0000-den2-0900	1.23843	1.23813	1.23871	28	-30
surry-21-0000-den2-1200	1.22995	1.22955	1.22947	-48	-40
surry-21-0000-den3-0600	1.23815	1.23797	1.23886	71	-18
surry-21-0000-den3-0900	1.22764	1.22743	1.22817	53	-21
surry-21-0000-den3-1200	1.21879	1.21863	1.21864	-15	-16
surry-21-0600-den0-0293	1.17518	1.17479	1.17281	-237	-39
surry-21-0600-den1-0600	1.16251	1.16225	1.16249	-2	-26
surry-21-0600-den1-0900	1.15335	1.15305	1.15326	-9	-30
surry-21-0600-den1-1200	1.14552	1.14537	1.14494	-58	-15
surry-21-0600-den2-0600	1.16027	1.16002	1.16050	23	-25
surry-21-0600-den2-0900	1.15084	1.15067	1.15098	14	-17
surry-21-0600-den2-1200	1.14286	1.14268	1.14242	-44	-18
surry-21-0600-den3-0600	1.15623	1.15603	1.15672	49	-20
surry-21-0600-den3-0900	1.14634	1.14628	1.14683	49	-6
surry-21-0600-den3-1200	1.13815	1.13796	1.13796	-19	-19
surry-21-1300-den0-0293	1.05552	1.05517	1.05301	-251	-35
surry-21-1300-den1-0600	1.07140	1.07129	1.07138	-2	-11
surry-21-1300-den1-0900	1.06301	1.06278	1.06296	-5	-23
surry-21-1300-den1-1200	1.05578	1.05569	1.05533	-45	-9
surry-21-1300-den2-0600	1.07344	1.07343	1.07359	15	-1
surry-21-1300-den2-0900	1.06459	1.06468	1.06489	30	9
surry-21-1300-den2-1200	1.05741	1.05712	1.05701	-40	-29
surry-21-1300-den3-0600	1.07492	1.07471	1.07529	37	-21
surry-21-1300-den3-0900	1.06580	1.06563	1.06620	40	-17
surry-21-1300-den3-1200	1.05810	1.05807	1.05801	-9	-3
surry-31-0000-den0-0293	1.40522	1.40495	1.40375	-147	-27
surry-31-0000-den1-0600	1.34670	1.34662	1.34701	31	-8
surry-31-0000-den1-0900	1.33642	1.33622	1.33627	-15	-20
surry-31-0000-den1-1200	1.32773	1.32757	1.32676	-97	-16
surry-31-0000-den2-0600	1.33788	1.33772	1.33825	37	-16
surry-31-0000-den2-0900	1.32722	1.32699	1.32724	2	-23
surry-31-0000-den2-1200	1.31820	1.31818	1.31751	-69	-2
surry-31-0000-den3-0600	1.32509	1.32495	1.32583	74	-14
surry-31-0000-den3-0900	1.31401	1.31395	1.31448	47	-6
surry-31-0000-den3-1200	1.30492	1.30474	1.30446	-46	-18
surry-31-0600-den0-0293	1.29453	1.29433	1.29287	-166	-20
surry-31-0600-den1-0600	1.26961	1.26941	1.26957	-4	-20
surry-31-0600-den1-0900	1.25973	1.25962	1.25955	-18	-11
surry-31-0600-den1-1200	1.25147	1.25126	1.25062	-85	-21
surry-31-0600-den2-0600	1.26502	1.26482	1.26524	22	-20
surry-31-0600-den2-0900	1.25496	1.25474	1.25493	-3	-22
surry-31-0600-den2-1200	1.24649	1.24631	1.24578	-71	-18
surry-31-0600-den3-0600	1.25794	1.25780	1.25843	49	-14
surry-31-0600-den3-0900	1.24751	1.24735	1.24776	25	-16
surry-31-0600-den3-1200	1.23871	1.23868	1.23830	-41	-3
surry-31-1300-den0-0293	1.18777	1.18738	1.18598	-179	-39
surry-31-1300-den1-0600	1.19116	1.19101	1.19116	0	-15
surry-31-1300-den1-0900	1.18208	1.18186	1.18187	-21	-22

surry-31-1300-den1-1200	1.17433	1.17417	1.17355	-78	-16
surry-31-1300-den2-0600	1.19067	1.19062	1.19084	17	-5
surry-31-1300-den2-0900	1.18122	1.18117	1.18126	4	-5
surry-31-1300-den2-1200	1.17326	1.17319	1.17269	-57	-7
surry-31-1300-den3-0600	1.18875	1.18863	1.18920	45	-12
surry-31-1300-den3-0900	1.17899	1.17889	1.17923	24	-10
surry-31-1300-den3-1200	1.17088	1.17057	1.17035	-53	-31
surry-41-0000-den0-0293	1.46277	1.46241	1.46136	-141	-36
surry-41-0000-den1-0600	1.39892	1.39867	1.39888	-4	-25
surry-41-0000-den1-0900	1.38826	1.38798	1.38782	-44	-28
surry-41-0000-den1-1200	1.37934	1.37924	1.37810	-124	-10
surry-41-0000-den2-0600	1.38897	1.38889	1.38916	19	-8
surry-41-0000-den2-0900	1.37801	1.37787	1.37783	-18	-14
surry-41-0000-den2-1200	1.36887	1.36877	1.36790	-97	-10
surry-41-0000-den3-0600	1.37521	1.37506	1.37556	35	-15
surry-41-0000-den3-0900	1.36382	1.36372	1.36390	8	-10
surry-41-0000-den3-1200	1.35428	1.35429	1.35368	-60	1
surry-41-0600-den0-0293	1.36647	1.36606	1.36496	-151	-41
surry-41-0600-den1-0600	1.33306	1.33290	1.33298	-8	-16
surry-41-0600-den1-0900	1.32300	1.32288	1.32255	-45	-12
surry-41-0600-den1-1200	1.31448	1.31427	1.31334	-114	-21
surry-41-0600-den2-0600	1.32723	1.32705	1.32719	-4	-18
surry-41-0600-den2-0900	1.31670	1.31659	1.31648	-22	-11
surry-41-0600-den2-1200	1.30797	1.30791	1.30705	-92	-6
surry-41-0600-den3-0600	1.31806	1.31816	1.31855	49	10
surry-41-0600-den3-0900	1.30754	1.30727	1.30748	-6	-27
surry-41-0600-den3-1200	1.29851	1.29823	1.29775	-76	-28
surry-41-1300-den0-0293	1.27087	1.27052	1.26936	-151	-35
surry-41-1300-den1-0600	1.26501	1.26484	1.26469	-32	-17
surry-41-1300-den1-0900	1.25547	1.25502	1.25491	-56	-45
surry-41-1300-den1-1200	1.24725	1.24716	1.24624	-101	-9
surry-41-1300-den2-0600	1.26269	1.26248	1.26263	-6	-21
surry-41-1300-den2-0900	1.25274	1.25260	1.25256	-18	-14
surry-41-1300-den2-1200	1.24453	1.24450	1.24365	-88	-3
surry-41-1300-den3-0600	1.25842	1.25837	1.25873	31	-5
surry-41-1300-den3-0900	1.24829	1.24807	1.24829	0	-22
surry-41-1300-den3-1200	1.23984	1.23966	1.23908	-76	-18
Ave				20	-18
StDev				88	12
Maximum				204	10
Minimum				-287	-57

APPENDIX B – NUMBER DENSITIES

The number densities for each material are given below (atoms/cc * 10²⁴).

Fuel (2.1% enrichment)

92234	4.019258513190756E-06
92235	4.864992501186317E-04
92236	2.228399660642638E-06
92238	2.238749037607419E-02
8016	4.576032003944108E-02

Fuel (3.1% enrichment)

92234	6.129696313485968E-06
92235	7.181546463859156E-04
92236	3.289492367984266E-06
92238	2.215528646178965E-02
8016	4.576549470430984E-02

Fuel (4.1% enrichment)

92234	8.298843086779618E-06
92235	9.498029937490817E-04
92236	4.350552787967713E-06
92238	2.192303162546796E-02
8016	4.577067225771165E-02

Gap

2004	2.648020953979913E-05
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Clad (natural Zr)

40090	2.228100088688169E-02
40091	4.858928598362912E-03
40092	7.426969216182290E-03
40094	7.526569805645464E-03
40096	1.212565660696912E-03

Coolant (4 densities and 3 boron concentrations)
Boron 0 ppm

1001	6.689001271791226E-02	
8016	3.344500635895613E-02	/ den0 0 ppm
1001	4.955319166163290E-02	
8016	2.477659583081645E-02	/ den1 0 ppm
1001	4.703424756270175E-02	
8016	2.351712378135087E-02	/ den2 0 ppm
1001	4.387891188277240E-02	
8016	2.193945594138620E-02	/ den3 0 ppm

Boron 600 ppm

1001	6.684987871028152E-02	
8016	3.342493935514076E-02	
5010	6.651027465151196E-06	
5011	2.677122110344777E-05	/ den0 600 ppm
1001	4.952345974663591E-02	
8016	2.476172987331796E-02	
5010	4.927187562623448E-06	
5011	1.983254893297177E-05	/ den1 600 ppm
1001	4.700602701416413E-02	
8016	2.350301350708206E-02	
5010	4.676723170340784E-06	
5011	1.882439828865813E-05	/ den2 600 ppm
1001	4.385258453564273E-02	
8016	2.192629226782137E-02	
5010	4.362980902754672E-06	
5011	1.756154624676629E-05	/ den3 600 ppm

Boron 13000 ppm

1001	6.680305570137898E-02	
8016	3.340152785068949E-02	
5010	1.441055950782759E-05	
5011	5.800431239080351E-05	/ den0 1300ppm
1001	4.948877251247277E-02	
8016	2.474438625623639E-02	
5010	1.067557305235081E-05	
5011	4.297052268810550E-05	/ den1 1300 ppm
1001	4.697310304087024E-02	
8016	2.348655152043512E-02	
5010	1.013290020240503E-05	
5011	4.078619629209261E-05	/ den2 1300 ppm
1001	4.382186929732479E-02	
8016	2.191093464866240E-02	
5010	9.453125289301790E-06	
5011	3.805001686799363E-05	/ den3 1300 ppm