Benchmark Description of a Stylized Three-Dimensional European Pressurized Reactor (EPR) Problem

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Abstract

This paper describes a whole-core, three-dimensional, code-to-code benchmark problem based on the European Pressurized Reactor (EPR) developed by AREVA NP. The core specifications were taken directly from the Final Safety Analysis Report (FSAR) submitted to the Nuclear Regulatory Commission (NRC) and the reactor core was modeled in a stylized manner while maintaining full heterogeneity at the pin and assembly level. Three different fresh core control rod configurations are presented in this paper – All Rods Out (ARO), Some Rods In (SRI), and All Rods In (ARI). Detailed Monte Carlo results are presented and include core eigenvalues, pin fission densities, and assembly averaged fission distributions. The benchmark results together with the provided macroscopic cross section libraries are useful for testing the numerical accuracy of transport solution methods for criticality analysis. The benchmark description includes the material atom densities and other relevant parameters for cross section studies.

Keywords: PWR, EPR, Benchmark

1. Introduction

Computer codes for solving the neutron transport equation are in constant development, and numerical validation of new methods and implementations requires robust and thorough benchmark problems. While some stylization is usually imposed, benchmarks need to be as explicit and as representative of real reactor problems as possible, particularly in reference to fuel pins, reactor dimensions, and operations. The most intensive and useful benchmark is a whole-core, three-dimensional model that includes heterogeneities at the pin and assembly levels.

Historically, a number of publicly available benchmark problems have been limited to proof-of-concept with analytical solutions to small models with only a few assemblies. Recent openly available studies have begun incorporating more intricate and complicated reactor designs in benchmark problems, but there is still a dearth of realistic reference models and solutions. In particular, comparisons with reactor measurement data are not publicly available. Specifically, problems without a significant amount of homogenization are necessary to properly validate and verify new methods.

This work builds upon the present but limited amount of whole-core, robust benchmark descriptions currently available. A fully heterogeneous, whole-core, three-dimensional benchmark of a stylized European Pressurized Reactor (EPR) is presented in this paper. Three configurations are developed; namely, All Rods Out (ARO), Some Rods In (SRI), and All Rods In (ARI). Using the material atom densities for these configurations, readers will be able to perform cross section investigations as well as generate their own macroscopic cross sections. Additionally, multigroup macroscopic material cross section libraries are provided for numerical validation of neutron transport methods.

Reactor parameters were provided by the Final Safety Analysis Report (FSAR) from AREVA (2013) submitted to the Nuclear Regulatory Commission (NRC). Libraries of 2-, 4-, 8-, and 47-group structures were generated in the lattice depletion transport code HELIOS (Simeonov 2003) for each unique assembly. For the purposes of this study and to preserve brevity in this paper, 8 and 47-group libraries are provided. Additionally, reference results were generated using the Monte Carlo code MCNP5 with the 8-group cross section library. Results include core eigenvalues, assembly region averaged fission densities, and assembly level fuel pin fission densities.

2. Core Specification

The EPR benchmark specification was constructed using the parameters and specifications outlined in the FSAR submitted to the NRC. The core specifications are similar to current generation PWRs in the fuel enrichment and composition, the core design, and the conditions for criticality. The EPR hosts 7 unique assemblies with various enrichments of UO₂ fuel and gadolinium-based integral fuel burnable absorbers.

2.1 Radial Layout

The EPR consists of 241 assemblies arranged in a checkerboard pattern. The assemblies are a typical 17x17 rod array with 265 fuel rods per assembly. Reactivity control is maintained almost entirely by boron in the coolant. Additional reactivity is also provided by the burnable poison rods. Control rods are not inserted in a fresh core. The core layout presented in Figure 1 was taken directly from the FSAR.

Figure 1. Radial core layout of the EPR.

The specific power, moderator temperature, and fuel temperature were all retrieved from the FSAR (AREVA 2013). The boron concentration for the core was chosen for a fresh core at hot zero power for a "theorized" multiplication factor of 0.99. Steady state parameters are presented in Table 1. Only average temperatures and densities were provided and subsequently used in the model. The results presented in this study used cross sections generated with equilibrium xenon and samarium, but cross sections are provided to the reader for both with and without equilibrium xenon and samarium.

It is important to note the assumption of average moderator temperatures throughout the core. PWR cores generally do not have a flat temperature distribution and there are other factors to consider such as void coefficient in developing a model. Enforcing an average temperature in this study allowed for the generation of a compact, portable set of cross sections easily accessible and applicable in other transport solution methods, while maintaining the important physics and relative simplicity.

TABLE 1. Steady State Parameters

Number of Fuel Assembly	241
Number of Unique Assemblies	7
Specific Power	35.53 W/g
Fuel Temperature	900 K
Moderator Temperature	585.4 K

Cladding Temperature	600 K
Assembly Width/Length	21.4 cm
Boron Concentration in Moderator	1600 ppm

To simplify the layout and decrease the computer runtime, $1/8^{\text{th}}$ symmetry was invoked in the cross section generation for assemblies and in the reference whole-core calculations by MCNP. Specular reflective boundary conditions were invoked for the west and east boundaries as well as the top, bottom, and radial boundaries in the lattice depletion calculations for cross section generation. For the MCNP calculation, specular reflective boundaries were applied on left and right of the $1/8^{\text{th}}$ model while a vacuum was imposed on the top and bottom. This is shown in Figure 2, where the assemblies are labeled by assembly type, and the moderator meshes are denoted by M. The model was also stylized by using square assemblies for moderator on the periphery beyond which non-reentrant boundary condition is assumed. In doing this, the model does not explicitly account for effects of the complex radial reflector region comprised of steel with water holes. This facilitates the use of Cartesian transport codes while retaining some of the reflector effect. Similar simplifications can be seen in Douglass and Rahnema (2010), Pounders and Rahnema (2011), and Zhang and Rahnema (2011).

Figure 2. Core model invoking $1/8^{\text{th}}$ symmetry with layers of moderator (M) around the core.

2.2 Axial Layout

Each of the 7 unique assemblies in the core is composed of five axial regions for each fuel rod: a bottom and top blanket region, a bottom and top cutback region, and a central region. Figure 3 illustrates the axial layout of each fuel pin in the EPR.

<u>Height</u>	
419.999 cm	Blanket
399.679 cm	Cutback
384.439 cm	Central
30.480 cm	Cutback
15.240 cm	Blanket
0.000 cm	

Figure 3. Generic axial layout for each fuel pin.

In order to resolve and illustrate the axial flux, the core was subdivided further into 19 axial regions in MCNP. The subdivision into 19 axial regions is illustrated below in Figure 4. The 19 axial regions were chosen to show axial fluxes in regions of similar length. Traditionally, 20 or 24 axial zones have been used to provide resolution. The 19 chosen for this study is the result of breaking up the central fuel region into 15 equal axial zones of similar length to the four cutback and blanket fuel regions. The choice of 15 zones was arbitrary but provides sufficient resolution.

<u>Height</u>	
419.999 cm	19 - Blanket
399.679 cm	18 - Cutback
384.439 cm	17 - Central
360.842 cm	16 - Central
337.245 cm	15 - Central
313.647 cm	14 - Central
290.050 cm	13 - Central
266.453 cm	12 - Central
242.855 cm	11 - Central
219.258 cm	10 - Central
195.661 cm	9 - Central
172.063 cm	8 - Central
148.466 cm	7 - Central
124.869 cm	6 - Central
101.271 cm	5 - Central
77.675 cm	4 - Central
54.077 cm	3 - Central
30.480 cm	2 - Cutback
15.240 cm	1 - Blanket
0.000 cm	

Figure 4. Axial regions for flux resolution.

2.3 Core Configurations

Three core configurations are described in this paper: All Rods Out (ARO), Some Rods In (SRI), All Rods In (ARI). The SRI configuration consists of all the control banks inserted fully in the core, while the ARI configuration consists of all the shutdown banks inserted in addition to the control banks. Figures 5 and 6 depict the SRI and ARI configurations respectively.

						M	M	M	M	M	M	M	M	M	M						
				M	M	M	M	M	M	M	M	M	M	M	M	M	M				
		M	M	M	M	M	A1	A1	A1	A1	A1	A1	A1	M	M	M	M	M			
		M	M	M	A1	A1	CC1	C1	C2	C2	C2	C1	CC1	A1	A1	M	M	M			
	M	M	M	A1	C1	CC2	C3	BC2	B2	CC3	B2	BC2	C3	CC2	C1	A1	M	M	M		
	M	M	M	A1	C1	C3	B1	B1	B1	A2	B2	A2	B1	B1	C3	C1	A1	M	M		
M	M	M	A1	CC2	B1	CC3	B2	C3	B2	CC3	B2	C3	B2	CC3	B1	CC2	A1	M	M	M	
M	M	A1	CC1	C3	B1	B2	A2	B2	A1	B2	A1	B2	A2	B2	B1	C3	CC1	A1	M	M	
M	M	A1	C1	CC2	B1	C3	B2	AC1	B2	A1	B2	AC1	B2	C3	B1	BC2	C1	A1	M	M	
M	M	A1	C2	B2	A2	B2	A1	B2	B1	B1	B2	A1	B2	A2	B2	C2	A1	M	M		
M	M	A1	C2	CC3	B2	CC3	B2	A1	B1	CC2	B1	A1	B2	CC3	B2	CC3	C2	A1	M	M	
M	M	A1	C2	B2	A2	B2	A1	B2	B1	B1	B1	B2	A1	B2	A2	B2	C2	A1	M	M	
M	M	A1	C1	BC2	B1	C3	B2	AC1	B2	A1	B2	AC1	B2	C3	B1	BC2	C1	A1	M	M	
M	M	A1	CC1	C3	B1	B2	A2	B2	A1	B2	A1	B2	A2	B2	B1	C3	CC1	A1	M	M	
M	M	M	A1	CC2	B1	CC3	B2	C3	B2	CC3	B2	C3	B2	CC3	B1	CC2	A1	M	M	M	
	M	M	A1	C1	C3	B1	B1	B1	A2	B2	A2	B1	B1	C3	C1	A1	M	M			
	M	M	M	A1	C1	CC2	C3	BC2	B2	CC3	B2	BC2	C3	CC2	C1	A1	M	M	M		
		M	M	M	A1	A1	CC1	C1	C2	C2	C2	C1	CC1	A1	A1	M	M	M			
		M	M	M	M	M	A1	A1	A1	A1	A1	A1	A1	M	M	M	M				
						M	M	M	M	M	M	M	M	M	M						
						M	M	M	M	M	M	M	M	M	M						

Figure 5. SRI configuration where non-shaded assemblies are control banks, and M represents the moderator around the core.

						M	M	M	M	M	M	M	M	M	M						
				M	M	M	M	M	M	M	M	M	M	M	M	M	M				
		M	M	M	M	M	A1	A1	A1	AC1	A1	A1	A1	M	M	M	M	M			
		M	M	M	A1	A1	CC1	C1	CC2	C2	CC2	C1	CC1	A1	A1	M	M	M			
	M	M	M	AC1	C1	CC2	C3	BC2	B2	CC3	B2	BC2	C3	CC2	C1	AC1	M	M	M		
	M	M	A1	C1	CC3	B1	BC1	B1	A2	B2	A2	B1	BC1	B1	CC3	C1	A1	M	M		
M	M	A1	CC2	B1	CC3	B2	CC3	B2	CC3	B2	CC3	B2	CC3	B1	CC2	A1	M	M	M		
M	M	A1	CC1	C3	BC1	B2	A2	B2	AC1	B2	AC1	B2	A2	B2	BC1	C3	CC1	A1	M	M	
M	M	A1	C1	BC2	B1	CC3	B2	AC1	B2	A1	B2	AC1	B2	CC3	B1	BC2	C1	A1	M	M	
M	M	A1	CC2	B2	A2	B2	AC1	B2	BC1	B1	BC1	B2	AC1	B2	A2	B2	CC2	A1	M	M	
M	M	AC1	C2	CC3	B2	CC3	B2	A1	B1	CC2	B1	A1	B2	CC3	B2	CC3	C2	AC1	M	M	
M	M	A1	CC2	B2	A2	B2	AC1	B2	BC1	B1	BC1	B2	AC1	B2	A2	B2	CC2	A1	M	M	
M	M	A1	C1	BC2	B1	CC3	B2	AC1	B2	A1	B2	AC1	B2	CC3	B1	BC2	C1	A1	M	M	
M	M	A1	CC1	C3	BC1	B2	A2	B2	AC1	B2	AC1	B2	A2	B2	BC1	C3	CC1	A1	M	M	
M	M	M	A1	CC2	B1	CC3	B2	CC3	B2	CC3	B2	CC3	B2	CC3	B1	CC2	A1	M	M	M	
	M	M	A1	C1	CC3	B1	BC1	B1	A2	B2	A2	B1	BC1	B1	CC3	C1	A1	M	M		
	M	M	M	AC1	C1	CC2	C3	BC2	B2	CC3	B2	BC2	C3	CC2	C1	AC1	M	M	M		
		M	M	M	A1	A1	CC1	C1	CC2	C2	CC2	C1	CC1	A1	A1	M	M	M			
		M	M	M	M	M	A1	A1	A1	AC1	A1	A1	A1	M	M	M	M				
						M	M	M	M	M	M	M	M	M	M						
						M	M	M	M	M	M	M	M	M	M						

Figure 6. ARI configuration where non-shaded assemblies are control banks and shutdown banks, and M represents the moderator around the core.

To facilitate reporting the results, Figure 7 specifies the indexing scheme used to label each assembly in the core.

Figure 7. Layout of EPR core with 1/8th symmetry and assembly indices labeled.

3. Assembly Specification

All 7 unique assemblies are modeled with the same detail - no spatial homogenization is implemented, and each pin cell is modeled to exact specifications. Pin cells consist of a central fuel pin surrounded by a gap, zirconium cladding, and moderator. Each assembly is a 17x17 square grid of pin cells with 24 guide tubes. The layout of a generic EPR assembly is shown in Figure 8.

Rod Type	# of Rods	Rod Description
265	Fuel Rod
23	Guide Tube
1	Guide Tube – This tube represents the four symmetric locations in the assembly that may contain incore instrumentation. There is a maximum of two instrumentation guide tubes per assembly.

Figure 8. General EPR Assembly (AREVA 2013).

The seven unique assemblies contain fuel pins with different fuel enrichments (U-235) and burnable absorbers (Gd_2O_3). Specifications and material compositions for all 7 unique assemblies are presented in Appendix A. Specific parameters for the fuel assemblies are presented in Table 2. Control rods are modeled explicitly as annular pins surrounded by the same zirconium cladding associated with the fuel rods. The control elements are an Ag-In-Cd composite, with specific material specifications given in Appendix A.

Table 2. Fuel Assembly Parameters

Number of Fuel Pins Per Assembly	265
Number of Guide Tubes	24
Fuel Pin Radius	0.4096 cm
Fuel Pin Clad Inner Radius	0.4180 cm
Fuel Pin Clad Outer Radius	0.4751 cm
Control Rod Inner Radius	0.2210 cm
Control Rod Outer Radius	0.3819 cm
Control Clad Inner Radius	0.3861 cm
Control Clad Outer Radius	0.4331 cm
Pin Pitch	1.2598 cm

4. Cross Section Generation

To facilitate the utilization of this benchmark with transport codes, multigroup cross sections were generated using HELIOS. Cross section libraries for 2-, 4-, 8-, and 47-group structures were created for each unique assembly. A two-dimensional slice of each assembly at each unique axial layer was modeled in HELIOS.

The calculations made in HELIOS generated cross sections for each unique fuel pin, cladding, and moderator in each assembly. All models took advantage of $1/8^{\text{th}}$ symmetry to simplify the calculation, and all models invoked specular reflection on each external boundary. For each model, the fuel pins were divided into 4 annular regions of equal area and the pins were surrounded by 8 equally spaced moderator meshes. The 4 annular regions in the fuel are needed to account for the self-shielding occurring near the surface of the fuel pin and the high absorption in the fuel pins with integrated burnable absorber. One annular region was used for the cladding and one annular region was used to represent the gap in between the fuel and cladding. The gap was modeled as a vacuum in the eigenvalue calculation, but it was treated as extremely sparse helium ($1E-10$ number density) in HELIOS.

Each HELIOS calculation generated a set of cross sections for each unique fuel pin depending on the assembly type. For example, fuel assembly C2 in Figure 9 contains 3 unique fuel pins: one with no burnable absorber (pin 1), and two with varying enrichments of gadolinium (pin 2 and pin 3). The result of the HELIOS calculation for assembly C2 was 3 sets of fuel cross sections (one for each fuel pin – 1, 2, and 3), one set of cladding cross sections, and one set of moderator cross sections. This was accomplished at equilibrium xenon and samarium by flux weighted condensation of cross sections in space and energy for each unique material. Table 3 below contains the group structures. The model used to generate cross sections for assembly C2 is shown below in Figure 9.

Figure 9. Fuel Assembly C2 HELIOS Model.

TABLE 3. Energy Group Bounds for Cross Section Generation

Lower Energy Bound (MeV)	8-Group	4-Group	2-Group
2.2313 x10 ⁻⁰⁰	1	1	1
8.2085x10 ⁻⁰¹	2		
9.1188 x10 ⁻⁰³	3		
1.3007 x10 ⁻⁰⁴	4	2	
3.9279 x10 ⁻⁰⁶	5		
6.2506 x10 ⁻⁰⁷	6	3	
1.4572 x10 ⁻⁰⁷	7	4	2
1.0000 x10 ⁻¹⁰	8		

Recall the purpose of this benchmark problem is to provide a framework for evaluating the accuracy of transport solution methods given a common set of cross section libraries. Evaluating cross section energy condensation and homogenization is outside the scope of this paper, but preliminary study of these effects have been performed and can be found in Lago and Rahnema (2015). The 8-group and 47-group cross section libraries are provided as a separate downloadable attachment to this paper.

5. Results

The solutions presented in this section were generated using MCNP5 (LANL 2005) and the multigroup cross sections discussed in section 4, with the boundary conditions specified in section 2.1.

The calculations were run on a 128-core computer cluster with 2 GHz Quad-Core AMD Opteron processors. A converged fission source was generated for each core configuration using 6000 total cycles, 2000 of which were inactive, with 250,000 neutron histories simulated in each cycle. Tallies were then generated using the converged source with 6000 total cycles and 250,000 neutron histories per cycle, and all the tallies passed MCNP statistical checks. Although no indications of false convergence were given, such issues in large reactor problems are possible when stochastic methods are used, as noted by Petrovic (2008).

Eigenvalues for all 3 core configurations using the 8- and 47-group structures are presented in Table 4. As mentioned in section 4 with Lago and Rahnema (2015), the fine-mesh group structures are preferred for this particular reactor benchmark problem.

TABLE 4. Eigenvalues and Standard Deviations

	ARO	SRI	ARI
8-group	0.98434 (0.00002)	0.96019 (0.00002)	0.91767 (0.00002)
47-group	0.98425 (0.00002)	0.96059 (0.00002)	0.91888 (0.00002)

The discrepancy between the results in Table 4 and the theorized value of 0.99 proposed in the FSAR warrants some discussion, but the differences are not unreasonable due to several key factors. The stylizations imposed in the model – specifically, not explicitly modeling the steel reflector region around the periphery of the core – already provide some reasoning for the difference but another cause in the deviations lies in the different transport methods used to generate solutions. While this study utilized HELIOS (collision-probability method) to generate cross sections and MCNP (Monte Carlo) to produce solutions, the theorized values in the FSAR were based off calculations using CASMO-3 (Edenius 1987) for cross section generation and

PRISM, a proprietary AREVA code, for core reactivity. As stated in the FSAR, the theorized values were generated using the nodal expansion method to solve the two-group diffusion theory representation of the reactor core. In addition to using different methods, the AREVA model also incorporates multiphysics variables (thermal hydraulics, material performance) which change the reactivity analysis and consequently the theorized values. Additionally, the uncertainties associated with cross section data factor into differences between theorized values and actual values calculated in a numerical simulation. These variables provide some understanding for the differences in the theorized values and the results in this study.

Pin fission density tally results are presented in Tables C1 through C6 (Appendix C) in the form of fuel node-averaged fission density distributions. Fuel nodes are considered to be axial layers of an assembly (or a coarse mesh), and an illustration of the division into fuel nodes is available in Fig. 4. Results are presented for all 3 configurations using the 8-group library. The associated relative percent uncertainties are found in Tables C1 through C6. Figure 7 can be used to identify which fuel assemblies in the core correspond to the appropriate indices in Tables C1 through C6.

The results presented in Tables C1 through C6 were produced using Eq. (1) for the normalized fuel node-averaged fission densities and Eq. (2) for the associated uncertainties:

$$F_i = \frac{4579 * \sum_k f_{k,i}}{8 * \sum_i \sum_k f_{k,i}}, \quad (1)$$

$$e_{F_i} = \sqrt{\left(\frac{\sqrt{\sum_k (e_{k,i} * f_{k,i})^2}}{\sum_k f_{k,i}} \right)^2 + \left(\frac{\sqrt{\sum_i \sum_k (e_{k,i} * f_{k,i})^2}}{\sum_i \sum_k f_{k,i}} \right)^2}. \quad (2)$$

In Eq. (1), the pin fission densities generated from the simulation, $f_{k,i}$, were normalized by summing all the pin fission densities over all the pins in each fuel node, and then dividing them by the total fission density in the core. Due to the invocation of 1/8th symmetry, the summation was multiplied by 8. The results were then normalized to the number of fuel nodes in the entire core, accounting for all assemblies and all axial levels (241 assemblies and 19 axial levels – 4579 total fuel nodes). In Eq. (2), the uncertainty $e_{k,i}$ was calculated for each fuel pin k in each node i .

Although the entire fuel pin fission density distribution was tallied, due to space limitations, results for a select set of assemblies at specific axial layers are presented. Normalized pin fission density results are presented in the ARO and ARI configurations for Assembly 1 at axial level 10 (center of the core), Assembly 4 at axial level 10 (diagonal to a controlled assembly), Assembly 8 at axial level 10 (controlled assembly), Assembly 16 at axial level 10 (between controlled assemblies), and Assembly 38 at axial level 10 (chosen for its location at the periphery). These locations were chosen because of their uniqueness in flux spectrum in energy and space. It is believed that select pin fission density results are sufficient for numerical validation of new methods. Eq. (3) was used to normalize the raw pin fission tallies – each individual fuel pin

segment tallied is divided by the total fission density in the core and multiplied by the total number of fuel pin tally segments ($1213435 = 241 \text{ assemblies} \times 265 \text{ pins per assembly} \times 19 \text{ axial levels}$). In Fig. C1-C10 (Appendix C), the bold values represent the normalized pin fission densities, while the values in gray show the associated percent uncertainties.

$$F_{k,i} = \frac{1213435 * f_{k,i}}{8 * \sum_i \sum_k f_{k,i}} \quad (3)$$

6. Conclusions

In this paper, a benchmark problem based on the stylized European Pressurized Reactor was developed and described for numerical validation of transport solution methods for criticality analysis. Multigroup cross section libraries were developed in the lattice depletion code HELIOS, and results were generated using a Monte Carlo model of the EPR with multiple configurations – All Rods Out, Some Rods In, and All Rods In. Due to the significant axial heterogeneity in the fuel and the large size of the reactor core, the EPR presents a practical benchmark for numerical validation of neutronic analysis tools.

The simplifications and stylizations imposed in the problem were made with the intent to retain the important physics relevant to the problem. The variety of the results, via the different core configurations and multigroup cross sections used, allow for a more thorough analysis of new methods for whole core calculations.

The simplifications in this model, particularly not explicitly modeling the steel reflector region, should be acknowledged and emphasized. While these simplifications are not practical for licensing or industrial applications, they make the benchmark description more accessible for use in a wide range of academic implementations.

In addition to the select results, the material compositions and information about the cross sections are found in the appendices.

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Appendix A

Material Compositions and Assembly Specifications

Figure A1. Radial and Axial Layout of Assembly A1.

Figure A2. Radial and Axial Layout of Assembly A2.

Figure A3. Radial and Axial Layout of Assembly B1.

Figure A4. Radial and Axial Layout of Assembly B2.

Figure A5. Radial and Axial Layout of Assembly C1.

Figure A6. Radial and Axial Layout of Assembly C2.

Figure A7. Radial and Axial Layout of Assembly C3.

Table A1. Control Rod Material Specifications

<i>AIC composition</i>	
Ag	80 %wt
In	15 %wt
Cd	5 %wt
AIC density	10.17 g/cm ³

APPENDIX B

CROSS SECTION LIBRARY FORMAT

Cross sections were generated for each unique cross-sectional area of each assembly. This resulted in ten different sets of cross sections for fuel, cladding, and moderator. The following format is used to present the cross sections:

$$\left\{ \sigma_{cg} \right\}_{g=1}^G, \left\{ \sigma_{fg} \right\}_{g=1}^G, \left\{ \nu_g \right\}_{g=1}^G, \left\{ \chi_g \right\}_{g=1}^G, \left\{ \left\{ \left\{ \sigma_{sn}^{g' \rightarrow g} \right\}_{g'=1}^G \right\}_{g=1}^G \right\}_{n=0}^N$$

The total number of energy groups is represented by G ; σ_{cg} is the capture cross section for group g ; σ_{fg} is the fission cross section for group g ; ν_g is the fission yield (neutrons per fission) in group g ; χ_g is the portion of the fission spectrum distribution corresponding to group g ; $\sigma_{sn}^{g' \rightarrow g}$ is the n^{th} Legendre moment for the group g' to g scattering cross section.

Cross sections are available in 8-group and 47-group structures as a separate, online download.

APPENDIX C

REFERENCE SOLUTIONS

Table C1. Averaged Normalized Fuel-Node Fission Density – 8-Group Library for ARO Configuration

Axial Level	Assembly Index									
	1	2	3	4	5	6	7	8	9	10
1	0.0569	0.2188	0.2094	0.1971	0.3738	0.1747	0.1689	0.3311	0.2971	0.1314
2	0.1550	0.5468	0.5195	0.4585	0.9414	0.4050	0.4191	0.7641	0.7356	0.2946
3	0.1695	0.5972	0.5598	0.9195	1.0068	0.8102	0.4405	1.5015	0.7605	0.3452
4	0.1903	0.6753	0.6321	1.0628	1.1506	0.9270	0.4940	1.7046	0.8433	0.3801
5	0.2128	0.7530	0.7053	1.1882	1.2826	1.0324	0.5496	1.8922	0.9330	0.4170
6	0.2342	0.8296	0.7759	1.3037	1.4134	1.1297	0.6026	2.0737	1.0225	0.4521
7	0.2548	0.9038	0.8429	1.4186	1.5397	1.2311	0.6542	2.2551	1.1115	0.4956
8	0.2771	0.9748	0.9172	1.5325	1.6618	1.3301	0.7074	2.4396	1.2029	0.5358
9	0.3004	1.0494	0.9873	1.6504	1.7885	1.4304	0.7643	2.6266	1.2934	0.5807
10	0.3218	1.1254	1.0634	1.7665	1.9210	1.5304	0.8215	2.8073	1.3915	0.6198
11	0.3449	1.2008	1.1372	1.8897	2.0619	1.6306	0.8788	2.9968	1.4942	0.6669
12	0.3692	1.2819	1.2189	2.0114	2.2007	1.7335	0.9392	3.1900	1.5955	0.7105
13	0.3919	1.3571	1.2936	2.2621	2.3429	1.8384	0.9977	3.5973	1.6967	0.7556
14	0.4131	1.4300	1.3656	2.3794	2.4834	1.9439	1.0596	3.8028	1.8035	0.8034
15	0.4323	1.5023	1.4338	2.4815	2.6161	2.0475	1.1222	3.9993	1.9154	0.8596
16	0.4529	1.5686	1.4983	2.5249	2.7369	2.1475	1.1778	4.1437	2.0387	0.9231
17	0.4738	1.6329	1.5581	1.4559	2.8308	2.1994	1.2333	2.4387	2.1750	0.9996
18	0.5025	1.7364	1.6744	0.6818	3.0713	1.2810	1.3601	1.1549	2.4509	0.9849
19	0.1984	0.7559	0.7329	2.1390	1.3318	0.6035	0.5939	3.3939	1.0821	0.4777
Axial Level	11	12	13	14	15	16	17	18	19	20
1	0.1397	0.2710	0.2566	0.2277	0.0991	0.1180	0.2344	0.2185	0.2008	0.1803
2	0.3659	0.6546	0.6683	0.5392	0.2548	0.2825	0.5209	0.5264	0.4794	0.4305
3	0.3434	0.6415	0.6176	0.5076	0.2309	0.2685	0.5994	0.5249	0.4706	0.4226
4	0.3676	0.6919	0.6538	0.5283	0.2368	0.2843	0.6443	0.5532	0.4908	0.4424
5	0.4036	0.7595	0.7139	0.5705	0.2547	0.3103	0.7035	0.5994	0.5310	0.4778
6	0.4409	0.8288	0.7802	0.6204	0.2772	0.3360	0.7676	0.6521	0.5753	0.5205
7	0.4775	0.9034	0.8474	0.6738	0.3020	0.3639	0.8319	0.7069	0.6235	0.5626
8	0.5165	0.9750	0.9137	0.7291	0.3278	0.3927	0.9002	0.7658	0.6730	0.6085
9	0.5552	1.0499	0.9785	0.7835	0.3537	0.4229	0.9685	0.8265	0.7254	0.6554
10	0.5970	1.1302	1.0477	0.8431	0.3798	0.4526	1.0306	0.8849	0.7782	0.7024
11	0.6400	1.2141	1.1184	0.9051	0.4087	0.4844	1.1004	0.9485	0.8345	0.7522

12	0.6819	1.2946	1.1918	0.9674	0.4352	0.5152	1.1702	1.0142	0.8935	0.8068
13	0.7259	1.3786	1.2662	1.0297	0.4631	0.5508	1.2464	1.0800	0.9504	0.8571
14	0.7724	1.4663	1.3446	1.1007	0.4944	0.5877	1.3240	1.1496	1.0130	0.9161
15	0.8239	1.5638	1.4381	1.1836	0.5324	0.6287	1.4160	1.2296	1.0896	0.9849
16	0.8817	1.6827	1.5531	1.2954	0.5860	0.6810	1.5351	1.3405	1.1947	1.0776
17	0.9821	1.8603	1.7563	1.4917	0.6857	0.7698	1.7022	1.5242	1.3739	1.2302
18	1.2156	2.2051	2.2111	1.8500	0.8876	0.9414	1.7181	1.7754	1.6242	1.4504
19	0.5053	0.9964	0.9240	0.8510	0.3739	0.4297	0.8407	0.8041	0.7392	0.6599
Axial Level	21	22	23	24	25	26	27	28	29	30
1	0.1397	0.1048	0.2035	0.1947	0.1767	0.1498	0.1140	0.0347	0.0862	0.1698
2	0.3659	0.2730	0.4928	0.4693	0.4663	0.4071	0.3183	0.0834	0.2357	0.4686
3	0.3434	0.2539	0.4821	0.4600	0.4442	0.4425	0.3808	0.1779	0.2605	0.5289
4	0.3676	0.2714	0.5191	0.4947	0.4787	0.4875	0.4323	0.2075	0.2960	0.5999
5	0.4036	0.2978	0.5686	0.5410	0.5270	0.5321	0.4755	0.2304	0.3293	0.6657
6	0.4409	0.3238	0.6176	0.5896	0.5771	0.5800	0.5201	0.2516	0.3607	0.7288
7	0.4775	0.3513	0.6726	0.6420	0.6259	0.6288	0.5638	0.2738	0.3913	0.7930
8	0.5165	0.3783	0.7286	0.6938	0.6743	0.6793	0.6072	0.2933	0.4216	0.8573
9	0.5552	0.4056	0.7825	0.7474	0.7228	0.7340	0.6548	0.3159	0.4518	0.9250
10	0.5970	0.4352	0.8446	0.8054	0.7754	0.7894	0.7039	0.3382	0.4852	0.9939
11	0.6400	0.4640	0.9024	0.8613	0.8296	0.8445	0.7534	0.3612	0.5162	1.0633
12	0.6819	0.4967	0.9616	0.9160	0.8827	0.9031	0.8042	0.3858	0.5528	1.1337
13	0.7259	0.5283	1.0227	0.9767	0.9357	0.9636	0.8603	0.4090	0.5873	1.2070
14	0.7724	0.5641	1.0912	1.0420	0.9956	1.0328	0.9136	0.4380	0.6247	1.2837
15	0.8239	0.6008	1.1641	1.1156	1.0608	1.1050	0.9721	0.4642	0.6590	1.3597
16	0.8817	0.6446	1.2535	1.1977	1.1425	1.1826	1.0332	0.4908	0.6934	1.4305
17	0.9821	0.7220	1.3849	1.3192	1.2654	1.2700	1.0751	0.4909	0.7218	1.4820
18	1.2156	0.8991	1.6463	1.5627	1.5355	1.3618	1.0341	0.2664	0.7578	1.5208
19	0.5053	0.3730	0.7397	0.7025	0.6281	0.5398	0.3976	0.1198	0.2971	0.5929
Axial Level	31	32	33	34	35	36	37	38		
1	0.1583	0.1319	0.0969	0.0605	0.0491	0.0964	0.0886	0.0665		
2	0.4476	0.3740	0.2319	0.1472	0.1202	0.2346	0.2171	0.1632		
3	0.5428	0.4582	0.4878	0.3189	0.2615	0.5130	0.4790	0.3645		
4	0.6256	0.5307	0.5737	0.3791	0.3137	0.6149	0.5782	0.4432		
5	0.6977	0.5907	0.6374	0.4208	0.3513	0.6945	0.6548	0.4994		
6	0.7668	0.6491	0.6972	0.4608	0.3857	0.7668	0.7221	0.5500		
7	0.8339	0.7064	0.7587	0.4983	0.4188	0.8341	0.7872	0.5978		
8	0.8998	0.7586	0.8205	0.5434	0.4519	0.9042	0.8507	0.6471		
9	0.9673	0.8174	0.8819	0.5810	0.4855	0.9726	0.9151	0.6973		

10	1.0402	0.8779	0.9438	0.6231	0.5200	1.0398	0.9785	0.7438		
11	1.1140	0.9402	1.0068	0.6647	0.5542	1.1077	1.0454	0.7935		
12	1.1918	1.0052	1.0731	0.7099	0.5943	1.1812	1.1145	0.8447		
13	1.2730	1.0713	1.2180	0.8040	0.6728	1.3258	1.2527	0.9556		
14	1.3485	1.1413	1.2854	0.8506	0.7088	1.3952	1.3192	1.0056		
15	1.4256	1.2028	1.3489	0.8920	0.7300	1.4444	1.3594	1.0355		
16	1.4854	1.2556	1.3468	0.8764	0.7060	1.3931	1.2986	0.9892		
17	1.5136	1.2730	0.7342	0.4625	0.3718	0.7298	0.6694	0.5075		
18	1.4301	1.1968	0.3301	0.2048	0.1658	0.3221	0.2925	0.2214		
19	0.5474	0.4550	1.1448	0.7559	0.6333	1.2533	1.1854	0.9021		

Table C2. Averaged Normalized Fuel-Node Fission Density % Uncertainty – 8-Group Library
for ARO Configuration

Axial Level	Assembly Index									
	1	2	3	4	5	6	7	8	9	10
1	0.1779	0.0875	0.0898	0.0921	0.0663	0.0983	0.0993	0.0705	0.0744	0.1133
2	0.1291	0.0622	0.0641	0.0633	0.0470	0.0677	0.0710	0.0487	0.0532	0.0794
3	0.0983	0.0475	0.0492	0.0451	0.0362	0.0482	0.0550	0.0350	0.0416	0.0592
4	0.0927	0.0446	0.0463	0.0419	0.0338	0.0451	0.0518	0.0328	0.0395	0.0564
5	0.0878	0.0423	0.0438	0.0397	0.0321	0.0428	0.0491	0.0312	0.0375	0.0539
6	0.0838	0.0403	0.0418	0.0379	0.0305	0.0409	0.0469	0.0298	0.0359	0.0517
7	0.0803	0.0386	0.0400	0.0363	0.0293	0.0392	0.0451	0.0285	0.0344	0.0494
8	0.0768	0.0372	0.0384	0.0349	0.0282	0.0377	0.0433	0.0275	0.0330	0.0475
9	0.0741	0.0358	0.0371	0.0337	0.0271	0.0363	0.0417	0.0265	0.0319	0.0457
10	0.0713	0.0346	0.0357	0.0325	0.0262	0.0351	0.0402	0.0256	0.0307	0.0442
11	0.0690	0.0335	0.0345	0.0315	0.0253	0.0340	0.0389	0.0248	0.0297	0.0426
12	0.0667	0.0324	0.0334	0.0305	0.0245	0.0330	0.0376	0.0240	0.0287	0.0413
13	0.0647	0.0315	0.0324	0.0288	0.0237	0.0321	0.0365	0.0226	0.0278	0.0400
14	0.0630	0.0307	0.0315	0.0281	0.0231	0.0312	0.0354	0.0220	0.0270	0.0388
15	0.0617	0.0300	0.0308	0.0275	0.0225	0.0304	0.0344	0.0215	0.0262	0.0375
16	0.0602	0.0293	0.0301	0.0273	0.0220	0.0297	0.0336	0.0211	0.0254	0.0362
17	0.0589	0.0287	0.0295	0.0356	0.0216	0.0293	0.0329	0.0273	0.0246	0.0349
18	0.0716	0.0349	0.0357	0.0432	0.0261	0.0381	0.0395	0.0330	0.0292	0.0434
19	0.0832	0.0411	0.0419	0.0296	0.0307	0.0462	0.0463	0.0233	0.0341	0.0518
Axial Level	11	12	13	14	15	16	17	18	19	20
1	0.1092	0.0778	0.0799	0.0848	0.1303	0.1189	0.0837	0.0867	0.0904	0.0955
2	0.0814	0.0563	0.0598	0.0621	0.0978	0.0864	0.0589	0.0629	0.0658	0.0695
3	0.0655	0.0451	0.0486	0.0508	0.0802	0.0701	0.0443	0.0502	0.0529	0.0558

4	0.0632	0.0434	0.0472	0.0497	0.0791	0.0682	0.0428	0.0488	0.0518	0.0546
5	0.0603	0.0415	0.0452	0.0478	0.0763	0.0653	0.0409	0.0469	0.0498	0.0525
6	0.0577	0.0397	0.0432	0.0459	0.0731	0.0627	0.0392	0.0449	0.0478	0.0503
7	0.0555	0.0381	0.0415	0.0440	0.0701	0.0602	0.0376	0.0432	0.0460	0.0484
8	0.0534	0.0366	0.0399	0.0423	0.0673	0.0580	0.0362	0.0415	0.0442	0.0465
9	0.0514	0.0353	0.0386	0.0408	0.0647	0.0559	0.0349	0.0400	0.0426	0.0448
10	0.0496	0.0340	0.0373	0.0394	0.0625	0.0540	0.0339	0.0386	0.0411	0.0433
11	0.0480	0.0328	0.0361	0.0380	0.0602	0.0522	0.0327	0.0373	0.0397	0.0418
12	0.0464	0.0318	0.0350	0.0368	0.0583	0.0507	0.0317	0.0361	0.0384	0.0404
13	0.0451	0.0308	0.0340	0.0356	0.0566	0.0490	0.0308	0.0350	0.0372	0.0392
14	0.0436	0.0299	0.0329	0.0345	0.0548	0.0474	0.0298	0.0339	0.0361	0.0379
15	0.0423	0.0289	0.0318	0.0332	0.0528	0.0458	0.0289	0.0328	0.0348	0.0366
16	0.0408	0.0279	0.0306	0.0318	0.0504	0.0441	0.0277	0.0314	0.0332	0.0349
17	0.0387	0.0266	0.0288	0.0296	0.0465	0.0414	0.0263	0.0295	0.0310	0.0328
18	0.0446	0.0307	0.0329	0.0336	0.0524	0.0473	0.0325	0.0342	0.0358	0.0379
19	0.0502	0.0355	0.0368	0.0384	0.0586	0.0545	0.0386	0.0395	0.0412	0.0436
Axial Level	21	22	23	24	25	26	27	28	29	30
1	0.1092	0.1263	0.0898	0.0918	0.0962	0.1045	0.1201	0.2238	0.1392	0.0983
2	0.0814	0.0941	0.0650	0.0665	0.0715	0.0765	0.0868	0.1508	0.1014	0.0714
3	0.0655	0.0761	0.0520	0.0533	0.0572	0.0585	0.0637	0.1044	0.0767	0.0536
4	0.0632	0.0735	0.0502	0.0514	0.0550	0.0557	0.0597	0.0969	0.0720	0.0502
5	0.0603	0.0702	0.0480	0.0491	0.0525	0.0533	0.0569	0.0919	0.0683	0.0477
6	0.0577	0.0673	0.0460	0.0470	0.0501	0.0511	0.0544	0.0879	0.0653	0.0456
7	0.0555	0.0646	0.0441	0.0451	0.0482	0.0491	0.0523	0.0843	0.0627	0.0437
8	0.0534	0.0622	0.0424	0.0434	0.0464	0.0472	0.0504	0.0814	0.0604	0.0421
9	0.0514	0.0602	0.0408	0.0418	0.0448	0.0454	0.0485	0.0785	0.0583	0.0405
10	0.0496	0.0581	0.0393	0.0402	0.0433	0.0438	0.0468	0.0757	0.0563	0.0390
11	0.0480	0.0562	0.0380	0.0389	0.0418	0.0424	0.0452	0.0733	0.0546	0.0378
12	0.0464	0.0544	0.0368	0.0377	0.0406	0.0410	0.0437	0.0710	0.0528	0.0366
13	0.0451	0.0527	0.0357	0.0366	0.0394	0.0396	0.0423	0.0690	0.0512	0.0354
14	0.0436	0.0510	0.0346	0.0354	0.0382	0.0383	0.0411	0.0666	0.0496	0.0344
15	0.0423	0.0494	0.0335	0.0342	0.0370	0.0370	0.0398	0.0648	0.0483	0.0334
16	0.0408	0.0478	0.0323	0.0330	0.0357	0.0358	0.0386	0.0629	0.0472	0.0326
17	0.0387	0.0451	0.0308	0.0315	0.0339	0.0345	0.0379	0.0629	0.0462	0.0320
18	0.0446	0.0518	0.0356	0.0365	0.0395	0.0419	0.0482	0.0846	0.0566	0.0397
19	0.0502	0.0584	0.0411	0.0422	0.0446	0.0481	0.0561	0.1052	0.0655	0.0459
Axial Level	31	32	33	34	35	36	37	38		
1	0.1017	0.1116	0.1312	0.1671	0.1857	0.1314	0.1372	0.1596		

2	0.0731	0.0800	0.0891	0.1124	0.1245	0.0885	0.0919	0.1069		
3	0.0532	0.0579	0.0619	0.0770	0.0853	0.0604	0.0623	0.0722		
4	0.0496	0.0538	0.0571	0.0707	0.0777	0.0551	0.0568	0.0654		
5	0.0469	0.0510	0.0541	0.0671	0.0735	0.0519	0.0533	0.0616		
6	0.0448	0.0487	0.0517	0.0642	0.0701	0.0493	0.0509	0.0587		
7	0.0430	0.0467	0.0497	0.0616	0.0674	0.0473	0.0487	0.0563		
8	0.0413	0.0450	0.0477	0.0591	0.0648	0.0455	0.0468	0.0542		
9	0.0399	0.0434	0.0460	0.0571	0.0626	0.0438	0.0452	0.0521		
10	0.0385	0.0419	0.0445	0.0551	0.0604	0.0424	0.0437	0.0505		
11	0.0372	0.0405	0.0431	0.0534	0.0585	0.0411	0.0423	0.0489		
12	0.0360	0.0391	0.0418	0.0517	0.0565	0.0398	0.0409	0.0474		
13	0.0348	0.0379	0.0392	0.0486	0.0532	0.0375	0.0386	0.0445		
14	0.0338	0.0368	0.0381	0.0472	0.0518	0.0366	0.0376	0.0434		
15	0.0329	0.0358	0.0372	0.0461	0.0510	0.0360	0.0370	0.0428		
16	0.0322	0.0350	0.0372	0.0465	0.0518	0.0366	0.0379	0.0438		
17	0.0319	0.0348	0.0500	0.0635	0.0708	0.0501	0.0524	0.0606		
18	0.0409	0.0448	0.0620	0.0793	0.0882	0.0627	0.0658	0.0763		
19	0.0478	0.0525	0.0404	0.0501	0.0547	0.0386	0.0397	0.0459		

Table C3. Averaged Normalized Fuel-Node Fission Density – 8-Group Library for SRI Configuration

Axial Level	Assembly Index									
	1	2	3	4	5	6	7	8	9	10
1	0.0421	0.2759	0.2756	0.2751	0.4855	0.1286	0.2220	0.4351	0.3610	0.1584
2	0.1227	0.6994	0.6906	0.6466	1.2262	0.3316	0.5680	1.0122	0.8925	0.3601
3	0.1581	0.7850	0.7609	1.3227	1.3282	0.6607	0.6309	2.0628	0.9343	0.4377
4	0.1862	0.9122	0.8808	1.5626	1.5419	0.7707	0.7406	2.4190	1.0632	0.4948
5	0.2115	1.0319	1.0010	1.7733	1.7479	0.8726	0.8394	2.7414	1.1983	0.5551
6	0.2340	1.1511	1.1067	1.9743	1.9413	0.9657	0.9320	3.0365	1.3246	0.6139
7	0.2562	1.2545	1.2002	2.1507	2.1199	1.0485	1.0164	3.3017	1.4424	0.6700
8	0.2758	1.3424	1.2811	2.3034	2.2721	1.1218	1.0897	3.5416	1.5442	0.7168
9	0.2931	1.4202	1.3567	2.4388	2.3995	1.1873	1.1523	3.7444	1.6356	0.7607
10	0.3086	1.4803	1.4228	2.5455	2.5037	1.2439	1.2058	3.9139	1.7153	0.7940
11	0.3200	1.5325	1.4747	2.6341	2.5900	1.2866	1.2454	4.0445	1.7708	0.8205
12	0.3278	1.5672	1.5063	2.6903	2.6502	1.3146	1.2747	4.1366	1.8123	0.8400
13	0.3325	1.5894	1.5284	2.7367	2.6904	1.3303	1.2882	4.2066	1.8343	0.8495
14	0.3350	1.5978	1.5322	2.7097	2.6927	1.3364	1.2906	4.1766	1.8360	0.8533
15	0.3346	1.5828	1.5223	2.6601	2.6699	1.3160	1.2813	4.1013	1.8331	0.8548
16	0.3299	1.5558	1.4962	2.5580	2.6277	1.2868	1.2587	3.9505	1.8187	0.8602

17	0.3207	1.5152	1.4784	1.4208	2.5688	0.7358	1.2153	2.2083	1.8273	0.8715
18	0.2803	1.5371	1.5350	0.6528	2.7013	0.4106	1.2451	1.0193	2.0009	0.8245
19	0.1384	0.6531	0.6591	2.7343	1.1562	1.3298	0.5268	4.2004	0.8720	0.3918
Axial Level	11	12	13	14	15	16	17	18	19	20
1	0.1060	0.3374	0.3232	0.2581	0.0607	0.1231	0.2596	0.2428	0.2007	0.1429
2	0.3071	0.8396	0.8519	0.6280	0.1727	0.3107	0.6026	0.5978	0.4894	0.3536
3	0.4008	0.8857	0.8148	0.6262	0.2148	0.3390	0.7594	0.6342	0.5098	0.3821
4	0.4733	1.0180	0.9007	0.6929	0.2420	0.3974	0.8861	0.7145	0.5636	0.4323
5	0.5370	1.1519	1.0134	0.7755	0.2708	0.4528	1.0053	0.8053	0.6314	0.4833
6	0.5946	1.2748	1.1207	0.8519	0.2994	0.5031	1.1196	0.8917	0.6992	0.5334
7	0.6479	1.3907	1.2212	0.9224	0.3266	0.5472	1.2266	0.9679	0.7601	0.5792
8	0.6929	1.4877	1.3122	0.9903	0.3519	0.5869	1.3152	1.0353	0.8122	0.6217
9	0.7353	1.5753	1.3934	1.0492	0.3718	0.6202	1.3961	1.0946	0.8607	0.6564
10	0.7673	1.6480	1.4602	1.0997	0.3875	0.6481	1.4658	1.1456	0.9007	0.6874
11	0.7950	1.7045	1.5103	1.1348	0.3987	0.6704	1.5153	1.1825	0.9297	0.7099
12	0.8126	1.7423	1.5500	1.1603	0.4077	0.6845	1.5485	1.2083	0.9497	0.7247
13	0.8192	1.7599	1.5704	1.1762	0.4154	0.6915	1.5656	1.2214	0.9589	0.7324
14	0.8208	1.7617	1.5805	1.1842	0.4161	0.6906	1.5687	1.2246	0.9635	0.7354
15	0.8135	1.7496	1.5807	1.1821	0.4182	0.6835	1.5596	1.2155	0.9592	0.7324
16	0.8016	1.7270	1.5801	1.1877	0.4205	0.6686	1.5352	1.2063	0.9564	0.7287
17	0.7718	1.7187	1.6402	1.2389	0.4288	0.6466	1.4976	1.2290	0.9893	0.7393
18	0.6731	1.8589	1.9640	1.4263	0.3943	0.6783	1.3641	1.3294	1.0880	0.7796
19	0.3342	0.8066	0.8035	0.6357	0.1992	0.2887	0.6353	0.5827	0.4790	0.3360
Axial Level	21	22	23	24	25	26	27	28	29	30
1	0.1060	0.0678	0.1974	0.1097	0.1207	0.0639	0.0797	0.0268	0.0919	0.1791
2	0.3071	0.1983	0.5018	0.2845	0.3290	0.1854	0.2297	0.0660	0.2671	0.5153
3	0.4008	0.2647	0.5516	0.3728	0.3418	0.2440	0.2940	0.1444	0.3261	0.6292
4	0.4733	0.3182	0.6559	0.4428	0.3946	0.2894	0.3525	0.1758	0.4028	0.7745
5	0.5370	0.3661	0.7515	0.5072	0.4485	0.3305	0.3982	0.2032	0.4734	0.9043
6	0.5946	0.4092	0.8406	0.5661	0.4997	0.3681	0.4440	0.2287	0.5315	1.0108
7	0.6479	0.4460	0.9190	0.6181	0.5458	0.4002	0.4822	0.2490	0.5826	1.1102
8	0.6929	0.4793	0.9869	0.6611	0.5861	0.4306	0.5173	0.2692	0.6258	1.1935
9	0.7353	0.5060	1.0416	0.6981	0.6227	0.4555	0.5496	0.2826	0.6637	1.2612
10	0.7673	0.5274	1.0877	0.7300	0.6533	0.4763	0.5749	0.2964	0.6930	1.3126
11	0.7950	0.5453	1.1222	0.7562	0.6765	0.4932	0.5939	0.3060	0.7157	1.3542
12	0.8126	0.5568	1.1448	0.7723	0.6880	0.5033	0.6060	0.3114	0.7254	1.3848
13	0.8192	0.5618	1.1570	0.7745	0.6976	0.5070	0.6064	0.3132	0.7292	1.3923
14	0.8208	0.5591	1.1512	0.7709	0.6979	0.5056	0.6051	0.3094	0.7249	1.3800

15	0.8135	0.5493	1.1311	0.7558	0.6920	0.4974	0.5997	0.2964	0.7049	1.3422
16	0.8016	0.5275	1.0910	0.7312	0.6786	0.4843	0.5801	0.2700	0.6652	1.2688
17	0.7718	0.4945	1.0382	0.6945	0.6699	0.4635	0.5438	0.1386	0.6044	1.1532
18	0.6731	0.4204	1.0708	0.6002	0.7367	0.3977	0.4855	0.0601	0.5526	1.0635
19	0.3342	0.2042	0.4500	0.3298	0.2866	0.1935	0.1807	0.3162	0.2033	0.3929
Axial Level	31	32	33	34	35	36	37	38		
1	0.1316	0.0538	0.0517	0.0397	0.0610	0.1120	0.0847	0.0453		
2	0.3870	0.1627	0.1299	0.1001	0.1516	0.2805	0.2124	0.1161		
3	0.5123	0.2342	0.3011	0.2333	0.3480	0.6446	0.4985	0.2791		
4	0.6340	0.2905	0.3784	0.2937	0.4436	0.8260	0.6433	0.3626		
5	0.7402	0.3383	0.4375	0.3379	0.5216	0.9716	0.7572	0.4302		
6	0.8341	0.3801	0.4862	0.3745	0.5858	1.0954	0.8534	0.4827		
7	0.9126	0.4139	0.5292	0.4081	0.6439	1.2027	0.9363	0.5275		
8	0.9781	0.4463	0.5697	0.4363	0.6934	1.2892	1.0067	0.5674		
9	1.0342	0.4728	0.5989	0.4608	0.7327	1.3672	1.0642	0.5989		
10	1.0794	0.4941	0.6242	0.4824	0.7597	1.4281	1.1065	0.6233		
11	1.1146	0.5095	0.6466	0.4986	0.7855	1.4706	1.1440	0.6419		
12	1.1333	0.5163	0.6614	0.5091	0.8025	1.4983	1.1663	0.6552		
13	1.1363	0.5193	0.6650	0.5125	0.7988	1.4947	1.1631	0.6574		
14	1.1257	0.5141	0.6500	0.5023	0.7736	1.4444	1.1270	0.6366		
15	1.0941	0.5003	0.6190	0.4793	0.7244	1.3476	1.0476	0.5921		
16	1.0329	0.4750	0.5472	0.4252	0.6275	1.1607	0.8930	0.4992		
17	0.9257	0.4236	0.2660	0.2072	0.3060	0.5628	0.4243	0.2311		
18	0.7841	0.3337	0.1132	0.0884	0.1308	0.2388	0.1789	0.0956		
19	0.2815	0.1549	0.6659	0.5136	0.8079	1.5089	1.1755	0.6640		

Table C4. Averaged Normalized Fuel-Node Fission Density % Uncertainty – 8-Group Library for SRI Configuration

Axial Level	Assembly Index									
	1	2	3	4	5	6	7	8	9	10
1	0.2008	0.0796	0.0799	0.0796	0.0594	0.1119	0.0884	0.0628	0.0689	0.1054
2	0.1411	0.0561	0.0567	0.0545	0.0421	0.0782	0.0623	0.0432	0.0493	0.0733
3	0.1003	0.0422	0.0431	0.0384	0.0321	0.0558	0.0468	0.0305	0.0382	0.0537
4	0.0925	0.0392	0.0400	0.0353	0.0298	0.0517	0.0432	0.0282	0.0358	0.0505
5	0.0865	0.0368	0.0375	0.0332	0.0280	0.0486	0.0406	0.0265	0.0337	0.0477
6	0.0825	0.0349	0.0357	0.0315	0.0266	0.0462	0.0385	0.0252	0.0321	0.0453
7	0.0788	0.0334	0.0343	0.0302	0.0255	0.0443	0.0369	0.0241	0.0308	0.0434
8	0.0760	0.0323	0.0332	0.0291	0.0246	0.0428	0.0357	0.0233	0.0298	0.0419

9	0.0736	0.0314	0.0323	0.0283	0.0239	0.0416	0.0347	0.0227	0.0289	0.0407
10	0.0719	0.0307	0.0315	0.0277	0.0234	0.0407	0.0339	0.0222	0.0282	0.0399
11	0.0705	0.0303	0.0310	0.0272	0.0231	0.0400	0.0334	0.0218	0.0278	0.0392
12	0.0696	0.0298	0.0306	0.0269	0.0227	0.0395	0.0329	0.0216	0.0275	0.0387
13	0.0694	0.0297	0.0304	0.0267	0.0226	0.0393	0.0328	0.0214	0.0273	0.0385
14	0.0690	0.0296	0.0304	0.0269	0.0226	0.0392	0.0327	0.0215	0.0273	0.0385
15	0.0689	0.0298	0.0305	0.0271	0.0227	0.0395	0.0329	0.0216	0.0273	0.0384
16	0.0693	0.0301	0.0307	0.0277	0.0229	0.0400	0.0332	0.0221	0.0274	0.0383
17	0.0705	0.0304	0.0309	0.0368	0.0231	0.0526	0.0337	0.0293	0.0274	0.0381
18	0.0931	0.0379	0.0381	0.0452	0.0284	0.0632	0.0420	0.0358	0.0329	0.0485
19	0.1114	0.0452	0.0451	0.0268	0.0336	0.0393	0.0501	0.0214	0.0387	0.0585
Axial Level	11	12	13	14	15	16	17	18	19	20
1	0.1226	0.0711	0.0728	0.0814	0.1626	0.1188	0.0811	0.0840	0.0924	0.1094
2	0.0869	0.0508	0.0541	0.0587	0.1161	0.0840	0.0559	0.0602	0.0665	0.0781
3	0.0613	0.0392	0.0432	0.0466	0.0841	0.0637	0.0402	0.0465	0.0519	0.0598
4	0.0565	0.0366	0.0410	0.0443	0.0791	0.0588	0.0372	0.0439	0.0493	0.0563
5	0.0530	0.0344	0.0387	0.0419	0.0749	0.0551	0.0350	0.0413	0.0466	0.0532
6	0.0504	0.0327	0.0368	0.0400	0.0713	0.0523	0.0332	0.0392	0.0443	0.0507
7	0.0482	0.0313	0.0352	0.0384	0.0682	0.0502	0.0317	0.0377	0.0425	0.0486
8	0.0466	0.0303	0.0340	0.0371	0.0658	0.0484	0.0306	0.0364	0.0411	0.0469
9	0.0453	0.0294	0.0330	0.0360	0.0639	0.0471	0.0297	0.0354	0.0400	0.0457
10	0.0443	0.0288	0.0323	0.0352	0.0627	0.0461	0.0290	0.0346	0.0391	0.0447
11	0.0436	0.0283	0.0317	0.0347	0.0617	0.0453	0.0285	0.0341	0.0385	0.0439
12	0.0431	0.0280	0.0313	0.0343	0.0611	0.0448	0.0282	0.0337	0.0380	0.0435
13	0.0429	0.0278	0.0311	0.0340	0.0605	0.0446	0.0280	0.0336	0.0378	0.0432
14	0.0429	0.0278	0.0310	0.0339	0.0605	0.0446	0.0280	0.0335	0.0378	0.0432
15	0.0431	0.0280	0.0310	0.0340	0.0603	0.0449	0.0281	0.0336	0.0378	0.0432
16	0.0434	0.0281	0.0310	0.0339	0.0601	0.0454	0.0283	0.0337	0.0379	0.0434
17	0.0442	0.0282	0.0305	0.0332	0.0596	0.0461	0.0287	0.0335	0.0373	0.0430
18	0.0588	0.0342	0.0356	0.0390	0.0770	0.0569	0.0372	0.0404	0.0446	0.0526
19	0.0697	0.0402	0.0403	0.0453	0.0907	0.0676	0.0453	0.0473	0.0522	0.0622
Axial Level	21	22	23	24	25	26	27	28	29	30
1	0.1226	0.1534	0.0930	0.1196	0.1188	0.1570	0.1465	0.2598	0.1373	0.0977
2	0.0869	0.1079	0.0656	0.0836	0.0868	0.1112	0.1041	0.1735	0.0972	0.0695
3	0.0613	0.0754	0.0497	0.0589	0.0664	0.0780	0.0740	0.1183	0.0700	0.0501
4	0.0565	0.0688	0.0455	0.0540	0.0618	0.0717	0.0675	0.1074	0.0629	0.0451
5	0.0530	0.0642	0.0425	0.0505	0.0580	0.0671	0.0635	0.1000	0.0581	0.0418
6	0.0504	0.0606	0.0402	0.0478	0.0549	0.0636	0.0601	0.0941	0.0548	0.0395

7	0.0482	0.0581	0.0385	0.0457	0.0526	0.0609	0.0577	0.0903	0.0524	0.0378
8	0.0466	0.0560	0.0371	0.0442	0.0507	0.0587	0.0557	0.0869	0.0505	0.0364
9	0.0453	0.0545	0.0361	0.0430	0.0491	0.0571	0.0540	0.0847	0.0491	0.0354
10	0.0443	0.0534	0.0354	0.0421	0.0480	0.0559	0.0528	0.0829	0.0480	0.0347
11	0.0436	0.0526	0.0348	0.0414	0.0472	0.0549	0.0519	0.0814	0.0472	0.0342
12	0.0431	0.0520	0.0345	0.0409	0.0468	0.0543	0.0514	0.0806	0.0469	0.0338
13	0.0429	0.0518	0.0343	0.0408	0.0465	0.0542	0.0514	0.0805	0.0468	0.0337
14	0.0429	0.0518	0.0344	0.0410	0.0465	0.0542	0.0514	0.0810	0.0470	0.0339
15	0.0431	0.0524	0.0347	0.0414	0.0467	0.0547	0.0516	0.0827	0.0476	0.0343
16	0.0434	0.0534	0.0353	0.0420	0.0472	0.0554	0.0526	0.0866	0.0490	0.0353
17	0.0442	0.0552	0.0362	0.0432	0.0474	0.0567	0.0543	0.1199	0.0514	0.0370
18	0.0588	0.0743	0.0450	0.0575	0.0580	0.0759	0.0717	0.1514	0.0676	0.0484
19	0.0697	0.0891	0.0538	0.0697	0.0673	0.0910	0.0849	0.0802	0.0806	0.0576
Axial Level	31	32	33	34	35	36	37	38		
1	0.1139	0.1711	0.1832	0.2107	0.1702	0.1246	0.1434	0.1969		
2	0.0802	0.1186	0.1212	0.1392	0.1134	0.0825	0.0950	0.1292		
3	0.0559	0.0799	0.0803	0.0922	0.0754	0.0550	0.0625	0.0840		
4	0.0502	0.0716	0.0717	0.0820	0.0668	0.0485	0.0550	0.0737		
5	0.0465	0.0663	0.0667	0.0765	0.0617	0.0448	0.0507	0.0678		
6	0.0438	0.0627	0.0632	0.0726	0.0581	0.0422	0.0478	0.0640		
7	0.0419	0.0600	0.0606	0.0696	0.0554	0.0403	0.0456	0.0611		
8	0.0405	0.0578	0.0584	0.0673	0.0534	0.0389	0.0440	0.0590		
9	0.0393	0.0562	0.0570	0.0655	0.0520	0.0378	0.0428	0.0574		
10	0.0385	0.0550	0.0558	0.0641	0.0511	0.0370	0.0419	0.0562		
11	0.0379	0.0541	0.0548	0.0630	0.0502	0.0364	0.0413	0.0554		
12	0.0376	0.0537	0.0542	0.0623	0.0497	0.0361	0.0409	0.0549		
13	0.0375	0.0536	0.0541	0.0621	0.0498	0.0361	0.0409	0.0548		
14	0.0377	0.0539	0.0547	0.0627	0.0507	0.0367	0.0416	0.0557		
15	0.0383	0.0546	0.0560	0.0643	0.0523	0.0380	0.0431	0.0577		
16	0.0393	0.0560	0.0596	0.0682	0.0562	0.0410	0.0467	0.0629		
17	0.0416	0.0593	0.0847	0.0967	0.0798	0.0583	0.0671	0.0915		
18	0.0563	0.0829	0.1080	0.1233	0.1017	0.0744	0.0859	0.1183		
19	0.0679	0.1016	0.0540	0.0621	0.0495	0.0359	0.0407	0.0545		

Table C5. Averaged Normalized Fuel-Node Fission Density – 8-Group Library for ARI Configuration

Axial Level	Assembly Index									
	1	2	3	4	5	6	7	8	9	10
1	0.0269	0.1606	0.1060	0.1803	0.3012	0.0925	0.1502	0.1908	0.2751	0.1518
2	0.0804	0.4201	0.2798	0.4297	0.7688	0.2409	0.3826	0.4975	0.6934	0.3544
3	0.1132	0.5150	0.3891	0.9280	0.8805	0.5058	0.4377	1.0458	0.7804	0.4689
4	0.1422	0.6434	0.4856	1.1624	1.0877	0.6252	0.5402	1.2985	0.9575	0.5782
5	0.1691	0.7614	0.5737	1.3720	1.2862	0.7331	0.6367	1.5362	1.1282	0.6801
6	0.1901	0.8614	0.6508	1.5583	1.4599	0.8290	0.7234	1.7414	1.2770	0.7715
7	0.2093	0.9469	0.7167	1.7127	1.6081	0.9130	0.7979	1.9109	1.4079	0.8484
8	0.2221	1.0119	0.7703	1.8324	1.7220	0.9807	0.8555	2.0489	1.5092	0.9092
9	0.2311	1.0593	0.8086	1.9187	1.7950	1.0264	0.8978	2.1480	1.5761	0.9506
10	0.2370	1.0857	0.8281	1.9692	1.8420	1.0550	0.9179	2.2020	1.6123	0.9781
11	0.2375	1.0966	0.8309	1.9798	1.8517	1.0607	0.9186	2.2110	1.6221	0.9859
12	0.2348	1.0829	0.8152	1.9604	1.8180	1.0407	0.9065	2.1724	1.5953	0.9744
13	0.2277	1.0521	0.7850	1.8044	1.7515	0.8659	0.8748	2.0942	1.5311	0.9429
14	0.2146	0.9965	0.7396	1.6721	1.6496	0.7788	0.8248	1.9763	1.4416	0.8904
15	0.1974	0.9259	0.6778	1.5112	1.5181	0.6829	0.7605	1.8250	1.3250	0.8216
16	0.1776	0.8357	0.6060	1.3162	1.3642	0.3611	0.6828	1.6457	1.1952	0.7439
17	0.1530	0.7271	0.5260	0.6795	1.2015	0.1934	0.6015	1.4453	1.0623	0.6560
18	0.1208	0.6623	0.4201	0.2996	1.1637	1.0000	0.5821	0.7608	1.0482	0.5500
19	0.0563	0.2657	0.2217	1.8977	0.4768	0.9408	0.2384	0.4035	0.4311	0.2463
Axial Level	11	12	13	14	15	16	17	18	19	20
1	0.1017	0.2911	0.1791	0.2425	0.0675	0.1620	0.3307	0.2501	0.1310	0.1569
2	0.2957	0.7412	0.5214	0.6156	0.2002	0.4123	0.7773	0.6457	0.3442	0.4128
3	0.4007	0.8420	0.7119	0.7003	0.2761	0.4676	1.0373	0.7765	0.4772	0.5183
4	0.4982	1.0347	0.8868	0.8656	0.3484	0.5782	1.3007	0.9701	0.6009	0.6613
5	0.5854	1.2208	1.0465	1.0228	0.4131	0.6850	1.5458	1.1497	0.7165	0.7946
6	0.6627	1.3854	1.1932	1.1608	0.4714	0.7812	1.7552	1.3102	0.8180	0.9096
7	0.7276	1.5259	1.3121	1.2787	0.5201	0.8594	1.9374	1.4419	0.9020	1.0041
8	0.7831	1.6334	1.4072	1.3698	0.5563	0.9230	2.0813	1.5451	0.9655	1.0747
9	0.8208	1.7049	1.4734	1.4326	0.5850	0.9650	2.1778	1.6169	1.0093	1.1254
10	0.8418	1.7487	1.5104	1.4676	0.6015	0.9913	2.2311	1.6593	1.0331	1.1534
11	0.8447	1.7568	1.5199	1.4728	0.6055	0.9915	2.2404	1.6632	1.0408	1.1597
12	0.8279	1.7266	1.4914	1.4454	0.5979	0.9755	2.1999	1.6397	1.0218	1.1406
13	0.7974	1.6605	1.4345	1.3882	0.5771	0.9373	2.1111	1.5801	0.9864	1.0978
14	0.7538	1.5613	1.3521	1.3062	0.5422	0.8827	1.9844	1.4932	0.9285	1.0330

15	0.6966	1.4351	1.2469	1.2018	0.4976	0.8128	1.8285	1.3750	0.8530	0.9459
16	0.6284	1.2882	1.1193	1.0743	0.4425	0.7274	1.6369	1.2283	0.7581	0.8343
17	0.5517	1.1366	0.9789	0.9441	0.3802	0.6403	1.4242	1.0661	0.6508	0.7034
18	0.4523	1.1113	0.7955	0.9203	0.3030	0.6281	1.1816	0.9831	0.5183	0.6169
19	0.2149	0.4558	0.3780	0.3770	0.1416	0.2593	0.5282	0.3971	0.2712	0.2427
Axial Level	21	22	23	24	25	26	27	28	29	30
1	0.1017	0.0904	0.2545	0.1444	0.1564	0.0916	0.1077	0.0235	0.0891	0.1252
2	0.2957	0.2651	0.6583	0.3823	0.4421	0.2792	0.3279	0.0661	0.2640	0.3873
3	0.4007	0.3709	0.7671	0.5403	0.5081	0.4145	0.4772	0.1614	0.3474	0.5811
4	0.4982	0.4671	0.9675	0.6909	0.6485	0.5466	0.6402	0.2204	0.4536	0.7651
5	0.5854	0.5554	1.1563	0.8304	0.7807	0.6608	0.7821	0.2698	0.5454	0.9270
6	0.6627	0.6343	1.3185	0.9484	0.8973	0.7562	0.8971	0.3118	0.6253	1.0636
7	0.7276	0.6989	1.4543	1.0463	0.9930	0.8366	0.9912	0.3475	0.6932	1.1730
8	0.7831	0.7504	1.5570	1.1204	1.0651	0.8971	1.0620	0.3721	0.7430	1.2566
9	0.8208	0.7853	1.6249	1.1683	1.1180	0.9409	1.1170	0.3888	0.7796	1.3124
10	0.8418	0.8024	1.6633	1.1966	1.1468	0.9597	1.1434	0.3990	0.7999	1.3431
11	0.8447	0.8057	1.6654	1.1989	1.1522	0.9591	1.1491	0.3995	0.8056	1.3416
12	0.8279	0.7939	1.6336	1.1768	1.1298	0.9373	1.1272	0.3913	0.7937	1.3152
13	0.7974	0.7625	1.5659	1.1261	1.0841	0.9010	1.0838	0.3144	0.7628	1.2596
14	0.7538	0.7179	1.4678	1.0546	1.0144	0.8452	1.0182	0.2686	0.7175	1.1723
15	0.6966	0.6587	1.3377	0.9603	0.9215	0.7642	0.9271	0.2098	0.6536	1.0631
16	0.6284	0.5826	1.1858	0.8432	0.8096	0.6632	0.8029	0.0932	0.5714	0.9276
17	0.5517	0.4964	1.0152	0.7112	0.6831	0.5397	0.6382	0.0446	0.4704	0.7525
18	0.4523	0.3931	0.9635	0.5567	0.6549	0.3985	0.4784	0.3757	0.3919	0.5489
19	0.2149	0.1840	0.3892	0.2877	0.2382	0.1786	0.1594	0.3501	0.1366	0.2442
Axial Level	31	32	33	34	35	36	37	38		
1	0.1696	0.0870	0.0938	0.0692	0.0339	0.1090	0.1171	0.0792		
2	0.5133	0.2702	0.2390	0.1785	0.0963	0.2792	0.3016	0.2053		
3	0.7304	0.4099	0.5881	0.4445	0.2345	0.6986	0.7504	0.5128		
4	0.9744	0.5495	0.8010	0.6084	0.3158	0.9477	1.0215	0.7046		
5	1.1816	0.6670	0.9761	0.7438	0.3860	1.1524	1.2442	0.8597		
6	1.3575	0.7679	1.1250	0.8604	0.4422	1.3248	1.4314	0.9883		
7	1.5010	0.8474	1.2446	0.9512	0.4907	1.4686	1.5879	1.0962		
8	1.6122	0.9127	1.3349	1.0176	0.5274	1.5796	1.7044	1.1798		
9	1.6883	0.9557	1.3997	1.0661	0.5540	1.6539	1.7834	1.2343		
10	1.7292	0.9799	1.4330	1.0926	0.5701	1.6965	1.8307	1.2633		
11	1.7394	0.9847	1.4399	1.0908	0.5729	1.7063	1.8435	1.2766		
12	1.7106	0.9654	1.4130	1.0743	0.5662	1.6773	1.8086	1.2520		

13	1.6499	0.9292	1.3602	1.0333	0.5118	1.6128	1.7383	1.1991		
14	1.5467	0.8739	1.2662	0.9645	0.4644	1.5106	1.6299	1.1163		
15	1.4049	0.7937	1.1442	0.8680	0.4029	1.3695	1.4688	1.0080		
16	1.2226	0.6862	0.9825	0.7444	0.3175	1.1747	1.2645	0.8680		
17	0.9802	0.5485	0.7728	0.5797	0.1420	0.9201	0.9871	0.6730		
18	0.7511	0.3923	0.3412	0.2522	0.0685	0.4054	0.4345	0.2919		
19	0.2550	0.1722	0.1368	0.1013	0.5446	0.1608	0.1718	0.1151		

Table C6. Averaged Normalized Fuel-Node Fission Density % Uncertainty – 8-Group Library
for ARI Configuration

Axial Level	Assembly Index									
	1	2	3	4	5	6	7	8	9	10
1	0.2608	0.1080	0.1277	0.1022	0.0781	0.1367	0.1116	0.0943	0.0818	0.1121
2	0.1806	0.0745	0.0876	0.0687	0.0546	0.0945	0.0779	0.0651	0.0575	0.0760
3	0.1231	0.0536	0.0601	0.0471	0.0405	0.0657	0.0577	0.0451	0.0430	0.0534
4	0.1100	0.0479	0.0537	0.0422	0.0364	0.0590	0.0519	0.0405	0.0388	0.0481
5	0.1008	0.0441	0.0494	0.0388	0.0335	0.0545	0.0478	0.0373	0.0358	0.0444
6	0.0947	0.0415	0.0464	0.0365	0.0315	0.0512	0.0449	0.0350	0.0336	0.0416
7	0.0905	0.0396	0.0443	0.0347	0.0300	0.0489	0.0428	0.0334	0.0320	0.0397
8	0.0878	0.0382	0.0427	0.0336	0.0290	0.0471	0.0412	0.0323	0.0309	0.0384
9	0.0861	0.0374	0.0416	0.0328	0.0284	0.0460	0.0403	0.0315	0.0303	0.0375
10	0.0851	0.0369	0.0412	0.0324	0.0280	0.0454	0.0399	0.0312	0.0299	0.0370
11	0.0848	0.0368	0.0412	0.0323	0.0280	0.0453	0.0399	0.0311	0.0298	0.0368
12	0.0854	0.0370	0.0415	0.0324	0.0282	0.0457	0.0401	0.0314	0.0301	0.0370
13	0.0866	0.0375	0.0423	0.0339	0.0288	0.0501	0.0409	0.0319	0.0307	0.0377
14	0.0893	0.0385	0.0436	0.0352	0.0296	0.0529	0.0420	0.0329	0.0316	0.0387
15	0.0931	0.0400	0.0455	0.0370	0.0309	0.0564	0.0438	0.0342	0.0330	0.0404
16	0.0984	0.0421	0.0481	0.0396	0.0325	0.0772	0.0462	0.0360	0.0347	0.0424
17	0.1059	0.0452	0.0517	0.0547	0.0346	0.0947	0.0492	0.0384	0.0369	0.0451
18	0.1474	0.0593	0.0716	0.0685	0.0444	0.0467	0.0632	0.0527	0.0468	0.0611
19	0.1814	0.0727	0.0883	0.0330	0.0538	0.0481	0.0768	0.0648	0.0566	0.0760
Axial Level	11	12	13	14	15	16	17	18	19	20
1	0.1298	0.0795	0.0973	0.0871	0.1602	0.1074	0.0747	0.0858	0.1139	0.1081
2	0.0911	0.0555	0.0682	0.0610	0.1111	0.0752	0.0507	0.0596	0.0781	0.0743
3	0.0631	0.0413	0.0471	0.0454	0.0763	0.0559	0.0354	0.0433	0.0536	0.0529
4	0.0566	0.0373	0.0422	0.0408	0.0679	0.0502	0.0317	0.0388	0.0478	0.0468
5	0.0522	0.0343	0.0388	0.0376	0.0624	0.0462	0.0291	0.0356	0.0437	0.0427
6	0.0491	0.0322	0.0364	0.0352	0.0584	0.0432	0.0273	0.0333	0.0409	0.0399

7	0.0468	0.0307	0.0347	0.0335	0.0556	0.0412	0.0260	0.0318	0.0390	0.0380
8	0.0452	0.0297	0.0335	0.0324	0.0538	0.0398	0.0251	0.0307	0.0377	0.0367
9	0.0441	0.0291	0.0327	0.0318	0.0525	0.0389	0.0245	0.0300	0.0369	0.0359
10	0.0436	0.0287	0.0323	0.0314	0.0517	0.0384	0.0242	0.0296	0.0364	0.0355
11	0.0435	0.0286	0.0322	0.0313	0.0515	0.0384	0.0241	0.0296	0.0363	0.0354
12	0.0439	0.0289	0.0326	0.0316	0.0519	0.0387	0.0244	0.0298	0.0366	0.0357
13	0.0447	0.0295	0.0332	0.0322	0.0528	0.0394	0.0249	0.0304	0.0373	0.0363
14	0.0460	0.0304	0.0342	0.0332	0.0544	0.0406	0.0257	0.0312	0.0384	0.0375
15	0.0478	0.0317	0.0356	0.0346	0.0569	0.0424	0.0267	0.0325	0.0401	0.0391
16	0.0504	0.0334	0.0376	0.0366	0.0603	0.0448	0.0282	0.0344	0.0425	0.0417
17	0.0537	0.0356	0.0402	0.0391	0.0650	0.0478	0.0303	0.0369	0.0459	0.0454
18	0.0737	0.0454	0.0552	0.0499	0.0905	0.0608	0.0411	0.0483	0.0638	0.0608
19	0.0893	0.0549	0.0669	0.0605	0.1105	0.0735	0.0512	0.0589	0.0790	0.0752
Axial Level	21	22	23	24	25	26	27	28	29	30
1	0.1298	0.1379	0.0850	0.1086	0.1083	0.1360	0.1307	0.2787	0.1448	0.1164
2	0.0911	0.0960	0.0589	0.0742	0.0770	0.0931	0.0896	0.1850	0.1003	0.0790
3	0.0631	0.0656	0.0433	0.0504	0.0560	0.0616	0.0596	0.1191	0.0696	0.0521
4	0.0566	0.0584	0.0386	0.0445	0.0495	0.0537	0.0514	0.1019	0.0609	0.0454
5	0.0522	0.0536	0.0353	0.0406	0.0452	0.0488	0.0466	0.0921	0.0555	0.0412
6	0.0491	0.0502	0.0331	0.0380	0.0421	0.0457	0.0435	0.0858	0.0519	0.0385
7	0.0468	0.0477	0.0315	0.0362	0.0401	0.0434	0.0413	0.0812	0.0493	0.0367
8	0.0452	0.0461	0.0304	0.0350	0.0387	0.0419	0.0400	0.0785	0.0476	0.0354
9	0.0441	0.0451	0.0298	0.0342	0.0377	0.0410	0.0390	0.0768	0.0465	0.0347
10	0.0436	0.0446	0.0294	0.0339	0.0373	0.0405	0.0385	0.0758	0.0458	0.0343
11	0.0435	0.0445	0.0294	0.0338	0.0372	0.0406	0.0384	0.0757	0.0457	0.0343
12	0.0439	0.0448	0.0297	0.0341	0.0376	0.0410	0.0388	0.0765	0.0461	0.0346
13	0.0447	0.0457	0.0303	0.0348	0.0384	0.0418	0.0395	0.0855	0.0470	0.0354
14	0.0460	0.0472	0.0313	0.0360	0.0396	0.0432	0.0408	0.0923	0.0484	0.0367
15	0.0478	0.0492	0.0328	0.0378	0.0416	0.0454	0.0428	0.1044	0.0507	0.0385
16	0.0504	0.0524	0.0349	0.0403	0.0443	0.0488	0.0459	0.1553	0.0543	0.0412
17	0.0537	0.0567	0.0377	0.0439	0.0483	0.0540	0.0515	0.2015	0.0598	0.0458
18	0.0737	0.0790	0.0487	0.0615	0.0632	0.0780	0.0742	0.0781	0.0824	0.0664
19	0.0893	0.0965	0.0595	0.0768	0.0759	0.0973	0.0930	0.0809	0.1012	0.0832
Axial Level	31	32	33	34	35	36	37	38		
1	0.1039	0.1396	0.1412	0.1660	0.2270	0.1310	0.1264	0.1551		
2	0.0716	0.0946	0.0921	0.1075	0.1503	0.0851	0.0819	0.1003		
3	0.0481	0.0621	0.0592	0.0687	0.0973	0.0543	0.0524	0.0639		
4	0.0417	0.0536	0.0508	0.0587	0.0838	0.0466	0.0449	0.0546		

5	0.0379	0.0487	0.0460	0.0531	0.0758	0.0423	0.0407	0.0494		
6	0.0353	0.0454	0.0428	0.0493	0.0708	0.0394	0.0380	0.0460		
7	0.0336	0.0432	0.0407	0.0470	0.0672	0.0375	0.0361	0.0437		
8	0.0324	0.0416	0.0394	0.0454	0.0649	0.0361	0.0348	0.0422		
9	0.0317	0.0407	0.0384	0.0443	0.0633	0.0353	0.0340	0.0412		
10	0.0313	0.0402	0.0379	0.0438	0.0623	0.0348	0.0336	0.0407		
11	0.0312	0.0401	0.0379	0.0438	0.0623	0.0348	0.0335	0.0405		
12	0.0315	0.0405	0.0383	0.0442	0.0626	0.0351	0.0338	0.0409		
13	0.0321	0.0413	0.0390	0.0450	0.0657	0.0357	0.0345	0.0418		
14	0.0331	0.0426	0.0404	0.0466	0.0691	0.0369	0.0356	0.0433		
15	0.0347	0.0446	0.0425	0.0492	0.0742	0.0388	0.0375	0.0456		
16	0.0372	0.0480	0.0458	0.0530	0.0836	0.0419	0.0404	0.0491		
17	0.0416	0.0537	0.0516	0.0601	0.1240	0.0473	0.0458	0.0557		
18	0.0592	0.0786	0.0771	0.0904	0.1601	0.0706	0.0683	0.0840		
19	0.0734	0.0992	0.1012	0.1186	0.0638	0.0932	0.0902	0.1109		

2.89	2.16	2.17	2.17	2.22	2.26	2.32	2.36	2.88
0.63	0.47	0.46	0.45	0.45	0.44	0.45	0.46	0.61
2.91	1.96	1.95	1.91	1.99	2.09	2.20	2.84	
0.67	0.49	0.47	0.47	0.46	0.46	0.48	0.62	
	1.72	1.71		1.74	1.82	2.88		
	0.50	0.49		0.49	0.50	0.65		
1.12	1.72	1.71	1.61	1.61				
0.70	0.51	0.50	0.51	0.53				
2.74	1.68	1.68	1.60	2.69				
0.71	0.52	0.51	0.54	0.71				
	1.63	1.62						
	0.53	0.54						
3.03	1.74	2.94						
0.73	0.56	0.71						
2.93	2.92							
0.80	0.76							
2.91								
1.35								

Figure C1. Normalized pin fission densities and percent relative uncertainties for 8-group results, Assembly 1, ARO configuration, axial level 10

2.14	2.16	2.17	2.17	2.22	2.26	2.32	2.36	2.39
0.63	0.47	0.46	0.45	0.45	0.44	0.45	0.46	0.61
1.90	1.96	1.95	1.91	1.99	2.09	2.20	2.30	
0.67	0.49	0.47	0.47	0.46	0.46	0.48	0.62	
	1.72	1.71		1.74	1.82	2.03		
	0.50	0.49		0.49	0.50	0.65		
1.65	1.72	1.71	1.61	1.61				
0.70	0.51	0.50	0.51	0.53				
1.63	1.68	1.68	1.60	1.64				
0.71	0.52	0.51	0.54	0.71				
	1.63	1.62						
	0.53	0.54						
1.69	1.74	1.70						
0.73	0.56	0.71						
1.81	1.79							
0.80	0.76							
1.84								
1.35								

Figure C2. Normalized pin fission densities and percent relative uncertainties for 8-group results, Assembly 1, ARI configuration, axial level 10

3.12	3.10	3.10	3.11	3.08	3.04	3.01	2.95	2.92
0.55	0.41	0.39	0.39	0.39	0.39	0.40	0.00	0.00
3.39	3.33	3.32	3.35	3.28	3.22	3.15	3.09	3.00
0.54	0.40	0.39	0.38	0.38	0.38	0.39	0.39	0.39
	3.50	3.52		3.54	3.46	3.31	3.17	3.04
	0.39	0.38		0.38	0.38	0.38	0.39	0.39
3.61	3.58	3.58	3.65	3.67		3.48	3.25	3.10
0.52	0.39	0.38	0.37	0.37		0.38	0.38	0.39
3.67	3.62	3.64	3.70	3.67	3.68	3.59	3.36	3.16
0.52	0.38	0.37	0.37	0.37	0.37	0.37	0.38	0.38
	3.74	3.75		3.73	3.71		3.46	3.21
	0.38	0.37		0.37	0.37		0.38	0.38
3.73	3.66	3.69	3.77	3.65	3.60	3.61	3.45	3.24
0.51	0.38	0.37	0.37	0.37	0.37	0.37	0.38	0.38
3.61	3.67	3.70	3.77	3.69	3.66	3.63	3.45	3.28
0.51	0.38	0.37	0.37	0.36	0.37	0.37	0.37	0.38
3.65	3.67	3.78		3.78	3.75		3.56	3.29
0.51	0.38	0.37		0.36	0.37		0.37	0.38
3.67	3.70	3.77	3.83	3.74	3.69	3.69	3.51	3.33
0.51	0.38	0.36	0.36	0.36	0.36	0.37	0.37	0.38
3.83	3.78	3.81	3.85	3.78	3.71	3.70	3.50	3.32
0.51	0.38	0.36	0.36	0.36	0.36	0.37	0.37	0.38
	3.89	3.89		3.86	3.82		3.60	3.32
	0.37	0.36		0.36	0.36		0.37	0.38
3.90	3.81	3.82	3.92	3.83	3.87	3.73	3.52	3.30
0.51	0.37	0.36	0.36	0.36	0.36	0.36	0.37	0.38
3.86	3.83	3.80	3.87	3.90		3.69	3.46	3.29
0.51	0.38	0.36	0.36	0.36		0.37	0.37	0.38
	3.84	3.82		3.82	3.74	3.53	3.40	3.29
	0.38	0.37		0.36	0.36	0.37	0.37	0.38
3.74	3.66	3.66	3.69	3.62	3.53	3.42	3.31	3.22
0.51	0.38	0.37	0.36	0.37	0.37	0.37	0.37	0.38
3.47	3.47	3.48	3.47	3.42	3.37	3.31	3.25	3.17
0.52	0.39	0.37	0.37	0.37	0.37	0.38	0.38	0.38

Figure C3. Normalized pin fission densities and percent relative uncertainties for 8-group results, Assembly 4, ARO configuration, axial level 10

3.62	3.61	3.61	3.58	3.50	3.44	3.36	3.25	3.14
0.54	0.40	0.39	0.39	0.39	0.39	0.40	0.00	0.00
3.97	3.88	3.85	3.87	3.79	3.65	3.54	3.42	3.28
0.53	0.39	0.38	0.38	0.38	0.38	0.39	0.39	0.40
	4.10	4.09		4.07	3.93	3.73	3.52	3.38
	0.39	0.37		0.37	0.38	0.38	0.39	0.39
4.24	4.15	4.16	4.24	4.24		3.95	3.67	3.48
0.52	0.38	0.37	0.37	0.37		0.38	0.38	0.39
4.32	4.20	4.21	4.32	4.23	4.20	4.08	3.80	3.54
0.51	0.38	0.36	0.36	0.36	0.37	0.37	0.38	0.39
	4.32	4.34		4.32	4.25		3.90	3.62
	0.37	0.36		0.36	0.36		0.38	0.38
4.34	4.26	4.30	4.35	4.25	4.17	4.12	3.87	3.61
0.51	0.38	0.36	0.36	0.36	0.36	0.37	0.37	0.38
4.23	4.21	4.31	4.38	4.25	4.18	4.15	3.91	3.64
0.51	0.37	0.36	0.36	0.36	0.36	0.37	0.37	0.38
4.18	4.23	4.35		4.37	4.28		3.99	3.66
0.50	0.37	0.36		0.36	0.36		0.37	0.38
4.23	4.26	4.31	4.41	4.31	4.22	4.19	3.94	3.68
0.50	0.37	0.36	0.36	0.36	0.36	0.37	0.37	0.38
4.43	4.36	4.37	4.45	4.30	4.23	4.20	3.95	3.71
0.50	0.37	0.36	0.36	0.36	0.36	0.36	0.37	0.38
	4.48	4.45		4.41	4.36		4.00	3.68
	0.37	0.36		0.36	0.36		0.37	0.38
4.44	4.39	4.38	4.47	4.37	4.36	4.21	3.91	3.66
0.50	0.37	0.36	0.36	0.36	0.36	0.36	0.37	0.38
4.43	4.31	4.34	4.42	4.39		4.13	3.83	3.63
0.50	0.37	0.36	0.36	0.36		0.37	0.37	0.38
	4.31	4.30		4.28	4.15	3.91	3.72	3.55
	0.37	0.36		0.36	0.37	0.37	0.38	0.38
4.16	4.09	4.07	4.11	4.01	3.86	3.74	3.62	3.48
0.52	0.38	0.37	0.37	0.37	0.37	0.38	0.38	0.39
3.87	3.86	3.84	3.83	3.78	3.70	3.61	3.49	3.37
0.52	0.39	0.38	0.37	0.37	0.38	0.38	0.39	0.39

Figure C4. Normalized pin fission densities and percent relative uncertainties for 8-group results, Assembly 4, ARI configuration, axial level 10

2.09	2.15	2.22	2.25	2.28	2.30	2.29	2.30	2.30	2.27	2.28	2.24	2.23	2.17	2.11	2.05	2.00
0.47	0.46	0.46	0.46	0.46	0.45	0.45	0.45	0.45	0.46	0.46	0.46	0.46	0.46	0.47	0.48	0.48
2.21	2.28	2.36	2.41	2.44	2.52	2.48	2.46	2.50	2.43	2.43	2.46	2.38	2.33	2.26	2.16	2.09
0.46	0.45	0.45	0.45	0.44	0.44	0.44	0.44	0.44	0.44	0.45	0.45	0.45	0.45	0.46	0.46	0.47
2.29	2.38	2.48	2.61	2.65		2.66	2.65		2.62	2.61		2.57	2.52	2.40	2.28	2.17
0.45	0.44	0.44	0.44	0.43		0.43	0.43		0.43	0.43		0.44	0.44	0.45	0.46	0.46
2.40	2.50	2.66		2.76	2.80	2.72	2.70	2.74	2.67	2.65	2.70	2.70		2.54	2.38	2.25
0.45	0.44	0.43		0.43	0.42	0.43	0.43	0.43	0.43	0.43	0.43	0.43		0.44	0.45	0.46
2.46	2.61	2.77	2.83	2.81	2.89	2.81	2.78	2.82	2.77	2.73	2.77	2.74	2.73	2.66	2.48	2.31
0.44	0.43	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.43	0.44	0.44	0.45
2.54	2.71		2.89	2.92		2.91	2.91		2.87	2.86		2.83	2.78		2.59	2.39
0.43	0.43		0.42	0.41		0.41	0.42		0.42	0.42		0.42	0.42		0.44	0.45
2.58	2.73	2.86	2.89	2.91	2.97	2.87	2.86	2.90	2.87	2.86	2.90	2.82	2.78	2.74	2.59	2.42
0.43	0.42	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.42	0.42	0.42	0.42	0.43	0.44
2.64	2.77	2.95	2.93	2.96	3.00	2.91	2.85	2.85	2.86	2.89	2.94	2.87	2.81	2.80	2.63	2.46
0.42	0.42	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.42	0.42	0.43	0.44
2.71	2.88		3.03	3.06		3.01	2.92	2.89	2.88	2.98		2.98	2.93		2.73	2.54
0.42	0.41		0.41	0.40		0.41	0.41	0.40	0.41	0.41		0.41	0.41		0.42	0.43
2.74	2.88	3.05	3.04	3.05	3.11	3.04	2.97	2.97	2.95	2.96	3.05	2.97	2.92	2.91	2.73	2.58
0.41	0.41	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.41	0.41	0.42	0.42	0.43
2.78	2.92	3.09	3.09	3.13	3.18	3.11	3.08	3.10	3.04	3.04	3.10	3.02	2.97	2.96	2.76	2.59
0.41	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.41	0.41	0.42	0.43
2.83	3.01		3.22	3.22		3.19	3.19		3.15	3.16		3.15	3.10		2.85	2.66
0.41	0.40		0.39	0.39		0.39	0.40		0.40	0.40		0.40	0.40		0.42	0.42
2.86	3.00	3.19	3.25	3.23	3.26	3.18	3.17	3.23	3.13	3.13	3.20	3.15	3.14	3.05	2.86	2.68
0.41	0.40	0.40	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.40	0.40	0.40	0.40	0.41	0.41	0.42
2.86	2.99	3.16		3.29	3.29	3.19	3.17	3.23	3.16	3.13	3.21	3.18		3.02	2.82	2.72
0.40	0.40	0.39		0.39	0.39	0.39	0.39	0.39	0.39	0.40	0.40	0.40		0.41	0.41	0.42
2.89	2.97	3.08	3.21	3.26		3.23	3.19		3.17	3.17		3.15	3.08	2.92	2.81	2.71
0.40	0.40	0.40	0.39	0.39		0.39	0.39		0.40	0.40		0.40	0.40	0.41	0.41	0.42
2.89	2.95	3.01	3.07	3.11	3.18	3.13	3.09	3.12	3.05	3.04	3.07	3.00	2.93	2.83	2.77	2.69
0.40	0.40	0.40	0.40	0.39	0.39	0.39	0.39	0.40	0.40	0.40	0.40	0.40	0.40	0.41	0.41	0.41
2.89	2.90	2.92	2.95	2.97	2.99	2.96	2.96	2.97	2.93	2.91	2.89	2.88	2.82	2.78	2.75	2.71
0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.41	0.41	0.41	0.41	0.41

Figure C5. Normalized pin fission densities and percent relative uncertainties for 8-group results, Assembly 8, ARO configuration, axial level 10

2.79	2.77	2.69	2.63	2.57	2.51	2.49	2.49	2.46	2.47	2.45	2.47	2.51	2.56	2.57	2.59	2.61
0.46	0.46	0.47	0.47	0.48	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.48	0.48	0.48	0.48
2.76	2.71	2.58	2.46	2.37	2.22	2.26	2.23	2.16	2.23	2.23	2.15	2.28	2.37	2.45	2.55	2.62
0.46	0.47	0.48	0.49	0.50	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.50	0.50	0.49	0.48	0.48
2.71	2.59	2.39	2.16	2.03		2.00	2.00		1.97	1.97		1.96	2.09	2.31	2.42	2.55
0.47	0.48	0.49	0.51	0.52		0.53	0.53		0.53	0.53		0.53	0.52	0.51	0.49	0.48
2.68	2.48	2.16		1.88	1.88	2.02	2.01	1.90	1.99	1.98	1.82	1.83		2.07	2.36	2.50
0.47	0.49	0.51		0.54	0.54	0.53	0.53	0.54	0.54	0.54	0.55	0.55		0.52	0.50	0.49
2.64	2.41	2.07	1.90	1.91	1.85	1.97	1.96	1.87	1.97	1.94	1.80	1.85	1.79	1.93	2.23	2.43
0.47	0.49	0.52	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.55	0.55	0.55	0.53	0.51	0.49
2.61	2.28		1.90	1.89		1.88	1.86		1.87	1.85		1.80	1.81		2.12	2.38
0.48	0.50		0.54	0.54		0.54	0.54		0.55	0.55		0.56	0.55		0.52	0.50
2.61	2.35	2.07	2.05	2.01	1.91	1.99	2.01	1.93	1.99	1.95	1.81	1.92	1.91	1.92	2.18	2.38
0.48	0.50	0.52	0.53	0.53	0.54	0.53	0.53	0.54	0.54	0.54	0.55	0.54	0.54	0.54	0.52	0.50
2.65	2.37	2.08	2.07	2.00	1.93	2.06	2.11	2.10	2.09	1.99	1.83	1.91	1.94	1.92	2.19	2.39
0.47	0.49	0.52	0.53	0.53	0.54	0.53	0.52	0.52	0.53	0.54	0.55	0.54	0.54	0.54	0.51	0.50
2.65	2.33		2.00	1.95		1.98	2.12	2.15	2.10	1.92		1.83	1.84		2.09	2.38
0.47	0.49		0.52	0.53		0.53	0.52	0.52	0.53	0.54		0.55	0.55		0.52	0.50
2.69	2.43	2.13	2.13	2.05	1.94	2.07	2.11	2.13	2.09	1.99	1.86	1.93	1.95	1.93	2.18	2.37
0.47	0.49	0.51	0.52	0.53	0.53	0.53	0.52	0.52	0.53	0.53	0.54	0.54	0.54	0.54	0.52	0.50
2.74	2.45	2.14	2.12	2.08	1.94	2.04	2.05	1.96	2.01	1.95	1.87	1.91	1.94	1.94	2.18	2.38
0.47	0.48	0.51	0.52	0.52	0.53	0.53	0.53	0.53	0.53	0.54	0.55	0.54	0.54	0.54	0.52	0.50
2.79	2.42		2.01	1.98		1.94	1.95		1.90	1.87		1.80	1.82		2.12	2.40
0.46	0.48		0.53	0.53		0.54	0.54		0.54	0.55		0.55	0.55		0.52	0.50
2.89	2.61	2.22	2.02	2.03	1.97	2.06	2.04	1.93	2.00	1.96	1.82	1.85	1.81	1.94	2.24	2.46
0.45	0.47	0.50	0.52	0.52	0.53	0.53	0.52	0.53	0.53	0.53	0.54	0.54	0.55	0.53	0.51	0.49
3.01	2.78	2.43		2.03	2.02	2.12	2.12	1.97	2.05	2.03	1.87	1.85		2.06	2.33	2.50
0.44	0.46	0.49		0.52	0.53	0.52	0.52	0.53	0.52	0.53	0.54	0.54		0.52	0.50	0.49
3.14	2.96	2.71	2.41	2.22		2.15	2.10		2.08	2.05		2.00	2.11	2.29	2.45	2.55
0.44	0.45	0.46	0.48	0.50		0.51	0.51		0.52	0.52		0.53	0.52	0.50	0.49	0.48
3.26	3.11	2.95	2.78	2.61	2.45	2.48	2.40	2.29	2.33	2.31	2.24	2.31	2.42	2.49	2.58	2.61
0.43	0.44	0.44	0.46	0.47	0.48	0.49	0.49	0.50	0.50	0.50	0.51	0.50	0.49	0.49	0.48	0.48
3.37	3.26	3.13	3.00	2.86	2.77	2.73	2.66	2.61	2.57	2.56	2.52	2.55	2.59	2.61	2.65	2.65
0.42	0.43	0.43	0.44	0.46	0.46	0.47	0.47	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.47	0.47

Figure C6. Normalized pin fission densities and percent relative uncertainties for 8-group results, Assembly 8, ARI configuration, axial level 10

0.90	0.87	0.88	0.88	0.89	0.88	0.89	0.89	0.90
0.89	0.65	0.63	0.63	0.62	0.62	0.62	0.62	0.61
0.94	0.90	0.90	0.91	0.92	0.92	0.92	0.92	0.92
0.88	0.65	0.64	0.62	0.62	0.62	0.61	0.61	0.61
	0.91	0.89		0.92	0.96	0.94	0.95	0.95
	0.66	0.65		0.63	0.62	0.61	0.60	0.60
0.84	0.84	0.81	0.20	0.87		0.98	0.97	0.99
0.91	0.67	0.65	0.45	0.63		0.61	0.60	0.60
0.34	0.81	0.83	0.84	0.87	0.89	0.96	0.99	1.02
0.69	0.66	0.65	0.65	0.64	0.63	0.61	0.59	0.58
	0.84	0.88		0.85	0.20		1.02	1.04
	0.68	0.64		0.64	0.44		0.59	0.58
0.79	0.77	0.84	0.90	0.87	0.88	0.98	1.02	1.06
0.94	0.69	0.65	0.63	0.63	0.63	0.61	0.59	0.58
0.67	0.19	0.79	0.87	0.85	0.91	1.02	1.04	1.08
0.96	0.47	0.65	0.64	0.64	0.61	0.60	0.58	0.57
0.69	0.68	0.81		0.35	0.93		1.08	1.08
0.97	0.71	0.66		0.47	0.62		0.58	0.56
0.68	0.19	0.80	0.89	0.87	0.92	1.03	1.06	1.08
0.96	0.46	0.65	0.63	0.63	0.61	0.59	0.58	0.57
0.83	0.81	0.88	0.93	0.91	0.89	1.00	1.06	1.10
0.93	0.67	0.63	0.62	0.62	0.62	0.60	0.58	0.56
	0.89	0.93		0.90	0.21		1.08	1.10
	0.66	0.63		0.62	0.43		0.58	0.56
0.37	0.87	0.91	0.91	0.93	0.96	1.04	1.07	1.10
0.67	0.64	0.62	0.63	0.61	0.61	0.59	0.58	0.57
0.95	0.95	0.89	0.21	0.97		1.07	1.06	1.08
0.87	0.63	0.62	0.43	0.61		0.58	0.57	0.57
	1.02	1.00		1.03	1.06	1.06	1.06	1.05
	0.62	0.61		0.59	0.58	0.58	0.57	0.57
1.04	1.02	1.01	1.03	1.04	1.04	1.05	1.05	1.04
0.83	0.61	0.59	0.59	0.59	0.58	0.58	0.57	0.58
1.01	1.01	1.00	1.02	1.01	1.01	1.02	1.03	1.03
0.83	0.61	0.59	0.58	0.58	0.58	0.58	0.57	0.57

Figure C7. Normalized pin fission densities and percent relative uncertainties for 8-group results, Assembly 16, ARO configuration, axial level 10

0.96	1.93	1.93	1.94	1.95	2.00	2.03	2.05	2.07
0.63	0.47	0.45	0.45	0.44	0.44	0.44	0.43	0.43
1.04	2.05	2.04	2.09	2.07	2.10	2.12	2.13	2.14
0.62	0.46	0.44	0.44	0.44	0.43	0.43	0.42	0.42
	2.10	2.04		2.12	2.22	2.21	2.21	2.23
	0.46	0.45		0.44	0.43	0.42	0.42	0.42
0.98	1.97	1.90	0.46	2.05		2.28	2.26	2.32
0.63	0.46	0.45	0.31	0.45		0.42	0.42	0.41
0.40	1.90	1.97	1.96	2.02	2.07	2.24	2.31	2.39
0.47	0.46	0.45	0.45	0.44	0.44	0.42	0.41	0.41
	1.98	2.08		1.99	0.47		2.37	2.43
	0.46	0.45		0.44	0.30		0.41	0.40
0.91	1.81	1.97	2.09	2.04	2.02	2.27	2.39	2.46
0.65	0.47	0.45	0.44	0.44	0.44	0.42	0.41	0.40
0.78	0.43	1.82	2.03	1.97	2.14	2.34	2.42	2.47
0.68	0.33	0.46	0.45	0.44	0.43	0.42	0.41	0.40
0.79	1.55	1.87		0.82	2.12		2.47	2.51
0.68	0.50	0.46		0.33	0.43		0.41	0.40
0.77	0.44	1.84	2.03	1.96	2.13	2.34	2.42	2.48
0.68	0.32	0.46	0.45	0.44	0.43	0.42	0.41	0.40
0.93	1.81	1.97	2.10	2.04	2.02	2.28	2.38	2.45
0.65	0.47	0.45	0.44	0.44	0.44	0.42	0.41	0.40
	1.98	2.07		1.98	0.48		2.40	2.46
	0.46	0.45		0.44	0.30		0.41	0.40
0.40	1.91	1.99	1.96	2.04	2.09	2.29	2.34	2.39
0.47	0.46	0.45	0.45	0.44	0.44	0.42	0.41	0.40
1.00	1.99	1.91	0.46	2.05		2.30	2.30	2.34
0.63	0.46	0.45	0.31	0.44		0.42	0.41	0.41
	2.11	2.07		2.14	2.24	2.24	2.24	2.25
	0.45	0.44		0.44	0.43	0.42	0.42	0.41
1.06	2.08	2.06	2.10	2.12	2.15	2.16	2.19	2.17
0.62	0.46	0.44	0.44	0.43	0.43	0.42	0.42	0.42
0.98	1.95	1.97	1.97	2.01	2.03	2.07	2.09	2.11
0.63	0.46	0.45	0.44	0.44	0.44	0.43	0.43	0.42

Figure C8. Normalized pin fission densities and percent relative uncertainties for 8-group results, Assembly 16, ARI configuration, axial level 10

0.69	0.67	0.66	0.64	0.63	0.61	0.59	0.58	0.56	0.53	0.50	0.47	0.46	0.43	0.42	0.42	0.46
0.90	0.92	0.93	0.93	0.95	0.95	0.97	0.98	1.02	1.04	1.06	1.09	1.11	1.15	1.16	1.17	1.16
0.61	0.61	0.60	0.58	0.59	0.57	0.55	0.51	0.52	0.48	0.47	0.44	0.42	0.41	0.39	0.40	0.44
0.91	0.91	0.92	0.93	0.95	0.96	0.98	0.99	1.02	1.04	1.06	1.08	1.11	1.14	1.14	1.15	1.14
0.60	0.59	0.60	0.60	0.59		0.55	0.53		0.48	0.47		0.43	0.42	0.41	0.42	0.46
0.91	0.91	0.91	0.93	0.93		0.97	0.98		1.02	1.04		1.09	1.12	1.13	1.13	1.11
0.62	0.62	0.63		0.61	0.60	0.56	0.54	0.53	0.50	0.48	0.48	0.46		0.44	0.44	0.49
0.88	0.88	0.90		0.92	0.93	0.94	0.96	0.98	1.00	1.02	1.04	1.05		1.09	1.08	1.07
0.66	0.67	0.67	0.66	0.65	0.63	0.60	0.58	0.56	0.54	0.51	0.51	0.48	0.48	0.48	0.48	0.54
0.85	0.86	0.87	0.87	0.88	0.89	0.90	0.93	0.94	0.95	0.99	1.00	1.02	1.04	1.04	1.04	1.02
0.72	0.71		0.71	0.69		0.64	0.63		0.58	0.56		0.53	0.52		0.53	0.59
0.83	0.84		0.84	0.86		0.89	0.89		0.94	0.94		0.97	1.01		1.00	0.97
0.75	0.75	0.76	0.73	0.72	0.71	0.67	0.66	0.63	0.60	0.59	0.57	0.55	0.54	0.55	0.57	0.65
0.80	0.81	0.81	0.81	0.83	0.84	0.85	0.87	0.88	0.91	0.92	0.94	0.95	0.96	0.97	0.95	0.92
0.81	0.80	0.81	0.79	0.77	0.76	0.72	0.69	0.66	0.64	0.63	0.61	0.58	0.57	0.58	0.61	0.70
0.77	0.78	0.78	0.80	0.79	0.81	0.82	0.84	0.86	0.87	0.88	0.91	0.92	0.93	0.94	0.93	0.90
0.84	0.87		0.83	0.82		0.78	0.74	0.69	0.68	0.67		0.64	0.63		0.65	0.75
0.75	0.76		0.77	0.78		0.79	0.81	0.83	0.84	0.86		0.89	0.90		0.90	0.88
0.89	0.90	0.91	0.87	0.86	0.87	0.82	0.78	0.76	0.72	0.70	0.70	0.67	0.67	0.68	0.71	0.81
0.73	0.73	0.74	0.74	0.75	0.77	0.77	0.78	0.81	0.81	0.83	0.84	0.87	0.87	0.87	0.86	0.84
0.95	0.94	0.96	0.93	0.91	0.91	0.87	0.83	0.81	0.78	0.75	0.74	0.71	0.71	0.74	0.76	0.88
0.71	0.71	0.72	0.73	0.73	0.74	0.75	0.76	0.78	0.79	0.81	0.82	0.83	0.83	0.84	0.83	0.81
1.00	1.00		0.99	0.99		0.93	0.90		0.85	0.82		0.78	0.79		0.83	0.94
0.70	0.70		0.70	0.71		0.73	0.74		0.76	0.78		0.81	0.81		0.80	0.78
1.03	1.03	1.05	1.04	1.02	0.99	0.96	0.93	0.91	0.87	0.85	0.85	0.82	0.82	0.83	0.85	0.99
0.68	0.68	0.69	0.69	0.70	0.71	0.72	0.72	0.74	0.75	0.76	0.77	0.78	0.79	0.80	0.77	0.75
1.03	1.03	1.07		1.06	1.03	0.99	0.97	0.95	0.90	0.89	0.88	0.87		0.84	0.87	1.02
0.68	0.67	0.68		0.68	0.69	0.70	0.71	0.72	0.74	0.74	0.75	0.76		0.78	0.77	0.75
1.04	1.05	1.06	1.08	1.07		1.03	1.00		0.95	0.92		0.88	0.86	0.84	0.89	1.03
0.66	0.67	0.68	0.68	0.68		0.69	0.70		0.72	0.74		0.75	0.76	0.77	0.76	0.74
1.04	1.04	1.04	1.05	1.05	1.06	1.01	0.98	0.99	0.93	0.91	0.91	0.86	0.83	0.82	0.87	1.01
0.67	0.67	0.67	0.67	0.68	0.69	0.69	0.70	0.70	0.72	0.72	0.74	0.75	0.76	0.77	0.77	0.74
1.01	1.01	1.02	1.03	1.02	1.03	0.99	0.98	0.96	0.94	0.91	0.87	0.85	0.83	0.81	0.83	0.93
0.66	0.68	0.68	0.67	0.68	0.68	0.68	0.69	0.70	0.71	0.72	0.73	0.74	0.76	0.77	0.76	0.75

Figure C9. Normalized pin fission densities and percent relative uncertainties for 8-group results, Assembly 38, ARO configuration, axial level 10

1.34	1.34	1.31	1.26	1.24	1.18	1.14	1.09	1.04	1.01	0.96	0.90	0.86	0.81	0.78	0.78	0.82
0.69	0.69	0.70	0.71	0.71	0.73	0.74	0.76	0.78	0.80	0.81	0.84	0.86	0.88	0.91	0.91	0.91
1.20	1.19	1.17	1.14	1.13	1.10	1.04	1.00	0.97	0.91	0.87	0.83	0.78	0.74	0.71	0.74	0.82
0.69	0.70	0.71	0.71	0.73	0.74	0.75	0.76	0.78	0.80	0.82	0.84	0.87	0.89	0.91	0.90	0.90
1.17	1.16	1.14	1.16	1.14		1.04	1.00		0.90	0.86		0.80	0.76	0.73	0.74	0.83
0.68	0.69	0.70	0.71	0.72		0.74	0.75		0.79	0.82		0.85	0.88	0.90	0.89	0.88
1.21	1.20	1.20		1.18	1.13	1.07	1.01	0.98	0.91	0.88	0.85	0.83		0.78	0.79	0.89
0.67	0.68	0.68		0.70	0.71	0.72	0.74	0.76	0.77	0.79	0.82	0.83		0.87	0.86	0.85
1.26	1.26	1.28	1.27	1.20	1.18	1.12	1.06	1.03	0.97	0.94	0.90	0.86	0.84	0.84	0.85	0.95
0.66	0.66	0.66	0.67	0.68	0.69	0.71	0.72	0.74	0.76	0.77	0.79	0.80	0.82	0.84	0.83	0.81
1.36	1.35		1.32	1.28		1.20	1.15		1.04	1.01		0.93	0.89		0.93	1.04
0.63	0.64		0.65	0.66		0.68	0.70		0.74	0.75		0.78	0.80		0.80	0.78
1.42	1.42	1.43	1.37	1.33	1.29	1.23	1.18	1.15	1.08	1.03	1.02	0.96	0.94	0.97	0.99	1.11
0.62	0.62	0.63	0.64	0.64	0.65	0.67	0.68	0.70	0.72	0.73	0.74	0.75	0.77	0.78	0.77	0.76
1.51	1.50	1.52	1.46	1.41	1.37	1.29	1.23	1.18	1.13	1.10	1.08	1.02	1.00	1.02	1.05	1.19
0.59	0.60	0.61	0.62	0.63	0.64	0.65	0.67	0.68	0.69	0.70	0.72	0.73	0.75	0.75	0.74	0.73
1.58	1.62		1.55	1.49		1.38	1.29	1.23	1.18	1.17		1.10	1.08		1.13	1.29
0.58	0.59		0.60	0.61		0.63	0.64	0.66	0.68	0.69		0.72	0.72		0.73	0.70
1.64	1.66	1.66	1.60	1.54	1.53	1.42	1.36	1.31	1.24	1.21	1.19	1.13	1.11	1.16	1.20	1.37
0.57	0.57	0.58	0.58	0.60	0.61	0.62	0.63	0.65	0.66	0.67	0.68	0.70	0.71	0.71	0.70	0.69
1.72	1.73	1.73	1.66	1.62	1.58	1.52	1.45	1.40	1.33	1.26	1.25	1.19	1.18	1.22	1.26	1.46
0.56	0.56	0.57	0.57	0.58	0.59	0.60	0.62	0.63	0.64	0.66	0.67	0.68	0.69	0.69	0.68	0.66
1.79	1.81		1.76	1.70		1.60	1.53		1.41	1.36		1.27	1.26		1.35	1.55
0.55	0.55		0.56	0.57		0.60	0.61		0.63	0.64		0.67	0.68		0.67	0.65
1.81	1.83	1.85	1.84	1.74	1.69	1.61	1.55	1.51	1.42	1.37	1.37	1.31	1.31	1.33	1.37	1.58
0.54	0.55	0.55	0.56	0.56	0.57	0.58	0.60	0.61	0.62	0.64	0.65	0.66	0.66	0.66	0.65	0.63
1.85	1.84	1.85		1.79	1.71	1.63	1.55	1.54	1.43	1.40	1.39	1.36		1.34	1.41	1.63
0.53	0.54	0.55		0.56	0.57	0.58	0.59	0.61	0.61	0.62	0.64	0.65		0.66	0.64	0.63
1.85	1.84	1.79	1.82	1.77		1.65	1.57		1.46	1.42		1.35	1.32	1.32	1.39	1.64
0.53	0.54	0.55	0.56	0.56		0.58	0.59		0.62	0.63		0.65	0.65	0.65	0.64	0.62
1.83	1.78	1.72	1.71	1.68	1.65	1.56	1.52	1.47	1.40	1.34	1.33	1.28	1.25	1.27	1.35	1.58
0.54	0.54	0.55	0.55	0.56	0.58	0.59	0.60	0.61	0.62	0.63	0.64	0.65	0.66	0.66	0.65	0.63
1.77	1.71	1.65	1.62	1.56	1.51	1.44	1.39	1.35	1.31	1.26	1.22	1.20	1.19	1.22	1.28	1.46
0.54	0.55	0.56	0.57	0.58	0.59	0.60	0.61	0.62	0.63	0.65	0.66	0.66	0.66	0.66	0.65	0.65

Figure C10. Normalized pin fission densities and percent relative uncertainties for 8-group results, Assembly 38, ARI configuration, axial level 10