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Plutonium Production Reactor Progression Problems: Magnox Neutronics Benchmarks

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OAK RIDGE NATIONAL LABORATORY
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Nuclear Nonproliferation Division
Nuclear Energy and Fuel Cycle Division

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ACRONYMS

ARI	all rods in
ARO	all rods out
BOC	beginning of cycle
CP	charge-pan
EOC	end of cycle
GWd/MTU	gigawatt-day per metric ton of uranium
MC	Monte Carlo
MWd/MTU	megawatt-day per metric ton of uranium
NNSA	National Nuclear Security Administration
ORNL	Oak Ridge National Laboratory
pcm	per cent mille (10^{-5})

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EXECUTIVE SUMMARY

The goal of this document is to provide a set of comprehensive benchmarking neutronics problems for gas-cooled, graphite-moderated reactors. The problems are designed to be representative problems that increase in complexity to test performance of various codes. For the simulation of the benchmarking problems, the Shift Monte Carlo code and MPACT deterministic code are chosen because of their state-of-the-art capabilities, which are optimized for various reactor designs. Because these codes have been developed primarily for light water reactor applications, their application to graphite-moderated, gas-cooled reactors has not been extensively explored. This report attempts to evaluate benchmarks for a Magnox-style reactor, one that is graphite-moderated and gas-cooled. Parameters that are calculated and presented in this benchmark include the eigenvalue, peaking factors, and isotope concentrations. Results show good agreement between Shift and MPACT, and demonstrate the capability of MPACT to model graphite-moderated systems well.

1. INTRODUCTION

High-fidelity tools have been developed to accommodate the next generation of modeling and simulation for advanced nuclear reactors. Several of these advanced reactor concepts use a graphite moderator, gas coolant, or a combination of both. Advanced modeling and simulation tools will require validation for these types of reactors, as well as others reactors with novel fuel designs, moderators, spectra, and geometry.

The goal of this document is threefold. The first goal is to create, model, and simulate a set of progression problems for graphite-moderated, gas-cooled reactors such that the results from any neutron transport code can be compared to these reference solutions. The second goal is to test the performance and capability of the MPACT code in comparison with a Monte Carlo code. As discussed later, MPACT was originally developed for light water reactors but can be leveraged for any reactor design. The third goal is to provide a set of benchmarks to which experimental measurements of spent fuel from Magnox reactors can be compared against in the future.

Previous series of progression problems have been developed for pressurized water reactor (PWR) and reference solutions provided [5]. An earlier iteration of 2D progression problems were compared with the Serpent Monte Carlo code [11, 12]. Development of full-core simulations has compared performance for larger-scale problems [1]. More information on the Magnox reactor design can also be found in Refs. [7, 1].

The set of progression problems contains six main geometries, each one progressively more complex than the previous problem. Progression problems include both two-dimensional (2D) and three-dimensional (3D) geometries. The set of geometries is intended to span from the simplest geometry, a fuel pin cell, to the most complex, a 3D (quarter) core. The set of six problem geometries is listed in Table 1.1.

The progression problems will come in the form of three numbers: X.X.X. The first number is the geometry indicator as listed in Table 1.1. The second number indicates whether the problem is a beginning of cycle (BOC) calculation (1) or a depletion calculation (2). The third number indicates the problem progression in terms of complexity. This number can indicate a variety of things, from a variation in temperatures to a change in the control rod insertion depth. Generally, the goal with each progression problem is to compare performance with each degree of complexity.

Table 1.1. Summary of naming convention for progression problems for geometry and solution method.

Problem	Geometry
1.X.X	2D Fuel Cell
2.X.X	2D Charge Pan
3.X.X	2D Quarter Core
4.X.X	3D Fuel Channel
5.X.X	3D Charge Pan
6.X.X	Mini-Core
X.1.X	BOC
X.2.X	Depletion

1.1 MODELING AND SIMULATION TOOLS

In the recent decades, advances in modeling and simulation tools have greatly increased the capability of neutron transport for reactor performance and safety analyses. Focus on the increased accuracy, flexibility, and solution convergence permits the study on an ever-increasing variety of designs for the next generation of reactors. The two codes were developed primarily for PWR cores through the Consortium for Advanced Light Water Reactor (CASL) energy simulation hub. Both the Shift Monte Carlo code and MPACT are capable of modeling complex geometries and are used to solve the benchmark problems in this report.

Throughout this report, the Shift and MPACT solutions were compared. Parameters to be compared include the neutron multiplication factor, i.e., eigenvalue (k_{eff}), isotopics, and power peaking factors. Owing to the nature of an MC (Shift) vs. deterministic (MPACT) code, listing of the uncertainty will be different. Shift will list the statistical uncertainty provided by the calculation, and MPACT will list the eigenvalue convergence criteria used in the input. For the 3D problems with complex geometries, not all values are provided for brevity.

This report documents the applicability of the capability of these codes to simulate Magnox reactors although they were originally developed to simulate LWRs. While Magnox and LWR are different designs, MPACT implementation in particular is alleviated by some similar design features. Key similarities include solid cylindrical fuel, square lattice, and thermal neutron spectra. Evident differences in a Magnox reactor include moderator type (graphite), coolant type (CO_2), lower operating temperature, metal fuel, and larger core size.

1.1.1 SHIFT

The Shift Monte Carlo (MC) code is a massively parallel transport package developed at Oak Ridge National Laboratory (ORNL) to enable high-performance neutronic analysis [15]. Shift is used as the MC solver in the Exnihilo code suite, which also contains the Denovo deterministic transport solver [3]. Shift leverages deterministic capabilities for variance reduction. Shift is a general purpose radiation transport solver that can solve eigenvalue and fixed source calculations with the options for neutron and photon transport. More recently, Shift couples to the ORIGEN module [4] for nuclide depletion calculations and has also been incorporated into the SCALE [17] code system. The Omnibus [8] front-end runner to the Exnihilo code suite is used to generate cell power tallies and isotope concentration tracking for depletion simulations.

These progression problems typically use 300 skipped cycles and 1200 active cycles. The number of particles per generation ranges from 2×10^4 to 5×10^5 to achieve at least a threshold of 10 and 20 pcm errors for the neutron multiplication factor for BOC and depletion problems, respectively.

1.1.2 MPACT

MPACT is a 3D full-core neutron transport code that uses the "2D/1D" method [2, 10]. This method uses the method of characteristics (MOC) to solve the radial (2D) solution. The coarse mesh finite difference acceleration is used in conjunction with the axial transport solver to various orders. MPACT was developed jointly by the University of Michigan and ORNL. MPACT requires group-specific cross section libraries, and a specific 69-group neutron flux library has been developed for Magnox reactors [9]. For depletion analyses, MPACT is also coupled to ORIGEN [4].

For all problems, a ray spacing of at least 0.03 is used. In several problems, a ray spacing of 0.01 is used to obtain better results. For the 3D progression problems, as stated later, the full height P3 equations are used to obtain better results. Additionally, MPACT uses a uniform axial

1.2 GEOMETRIES

Table 1.2 lists the relevant geometric parameters for the Magnox reactor core. The fuel used is close to natural uranium, and the cladding is Magnox (listed in Table 1.3). Unlike a traditional light water reactor (LWR), which has water as a coolant and a moderator, the Magnox fuel pin has a radial gas channel, and outside of the channel is the graphite reflector. The reactor design has three variable coolant channel radii, labeled A, B, and C. These problems only factor in neutronic calculations, thus the thermal hydraulic feedback is not calculated. However, the fuel channel radius greatly influences the moderating capability of the surrounding graphite.

The fuel channels in the Magnox design are organized into charge pans (analogous to LWR assemblies), which contain 16 (4 × 4) channels. At the center of a charge pan is a control rod channel for reactivity control, and it can be left empty for gas to flow. The charge pans are organized in a square pitch within the core. Each fuel element is just over one meter in length. All charge pans contain channels with either five or six fuel elements stacked axially with spacers (made of Magnox) in between the elements. Each relevant geometry will be discussed more in its own section.

Table 1.2. Geometrical parameters of gas-cooled, graphite-moderated reactor.

Geometry		Symbol	Value	Units	References
Radius					
	Fuel	r_{fuel}	1.46	cm	[7] p. 12
	Clad	r_{clad}	2.04	cm	[14] p. 4
	Coolant Channel Zone A	$r_{\text{cool,A}}$	5.2832	cm	[7] p. 22
	Coolant Channel Zone B	$r_{\text{cool,B}}$	5.0165	cm	[7] p. 22
	Coolant Channel Zone C	$r_{\text{cool,C}}$	4.5847	cm	[7] p. 22
	Control Rod Channel	$r_{\text{cr,chan}}$	4.1275	cm	From drawings
	Control Rod Channel	$r_{\text{cr,OD}}$	4.1275	cm	From drawings
Pitch	(Square)				
	Pin	p_{pin}	20.32	cm	[7] p. 12
	Charge-Pan	p_{pan}	81.28	cm	
Length					
	Fuel Element Active Length	$L_{\text{elem,act}}$	*cm*	101.6254	
	Fuel Element Total Length	$L_{\text{elem,tot}}$	*cm*	109.3724	
	Core Axial Upper Reflector	$L_{\text{refl,up}}$	*cm*	66.5	
	Core Axial Lower Reflector	$L_{\text{refl,lo}}$	*cm*	77.5	
	Channel Total Length	L_{chan}	*cm*	800.2344	

1.3 MATERIALS

The progression problems contain five primary materials throughout the problems, which are described in Table 1.3. Unless otherwise noted, the same material properties are used in all problems. Although temperatures may vary in the problems, these progression problems do not consider geometric or density changes due to temperature changes. Although the graphite density will decrease with irradiation, the graphite composition is not depleted or altered with burnup for this work.

Table 1.3. Compositions of materials used in progression problems.

Material		Composition		Value	Units	References
Fuel		Uranium Metal				[7] p. 12
			^{234}U	0.0057	wt%	[13] p. 331
			^{235}U	0.7204	wt%	[13] p. 331
			^{238}U	99.2739	wt%	[13] p. 331
Clad		Magnox-C Alloy				[13] p. 21
			^{Nat}Al	0.8	wt%	[18] p. 711
			^{Nat}Be	0.005	wt%	[18] p. 711
			^{Nat}Mg	99.195	wt%	[18] p. 711
Coolant		Carbon Dioxide				[7] p. 12
			^{Nat}C	27.2912	wt%	[13] p. 67
			^{Nat}O	72.7088	wt%	[13] p. 67
Moderator		Graphite				[7] p. 12
			^{Nat}C	100.0	wt%	[13] p. 70[a]
Control Rod						
	Sheath	Stainless Steel				[13]
	Absorber	3 wt% Boronated Steel				[13]

[a]The graphite in Ref. [13] has 1 ppm of boron; however, pure graphite is used instead.

Table 1.4. Densities.

Densities	Value	Units	References and Notes
Uranium Metal	18.9	g/cm^3	[6] p. 15 [16] p. 657
Magnox-C Alloy	1.74	g/cm^3	[16] p. 657
Carbon Dioxide	0.0081	g/cm^3	Estimated
Graphite	1.65	g/cm^3	[16] p. 173 p. 192 p. 657

1.4 OPERATING CONDITIONS

The progression problems use a consistent power based on the amount of the fuel in model, regardless of 2D or 3D configurations. The full core power of 182 MWt is used to calculate the powers of all progression problems [7]. The power levels for each problem are listed in Table 1.6. Note, problems 1–3 are 2D problems; therefore, linear power is used. For problems 4–6, the 3D geometries use absolute power.

Both single state-point eigenvalue (i.e., BOC) and depletion calculations are performed. The naming convention for BOC and depletion is described in Table 1.1. Table 1.5 lists the burnup steps for the depletion cases. Note that the end-of-cycle (EOC) burnup is low at 1330 MWd/MtU, which is orders of magnitudes lower than commercial light water reactor fuel at discharge. Table 1.6 shows the power values for each problem, all calculated from the total core power. Only fuel materials are depleted for all cases, and no decay time following irradiation is considered.

Table 1.5. Burnup points of comparison.

Step	Burnup [MWd/MTU]
0	0.0
1	25.0
2	50.0
3	100.0
4	200.0
5	300.0
6	400.0
7	500.0
8	600.0
9	700.0
10	800.0
11	900.0
12	1000.0
13	1100.0
14	1200.0
15	1300.0

Table 1.6. Power levels for various progression problems derived from total core power [7]

Parameter	Value	Units	Problem no.
Power Density	1.45	$\left[\frac{MW}{MtU}\right]$	—
Rod 2D	183.840	$\left[\frac{W}{cm}\right]$	1
Charge Pan 2D	2.941	$\left[\frac{kW}{cm}\right]$	2
Quarter Core 2D	77.948	$\left[\frac{kW}{cm}\right]$	3
Six-Element Channel 3D	112.069	[kW]	4
Charge Pan 3D	1.625	[MW]	5
Mini-Core 3D	6.874	[MW]	6
Core Power	182	[MW]	

2. PROBLEM 1: PIN-CELL 2D

Problem 1 demonstrates the capability to solve 2D Magnox pin-cell problems. Geometric dimensions are listed in Table 1.2, and the geometry is illustrated in Figure 1. Material densities are listed in Table 1.4. All external boundaries are fully reflected in this problem.

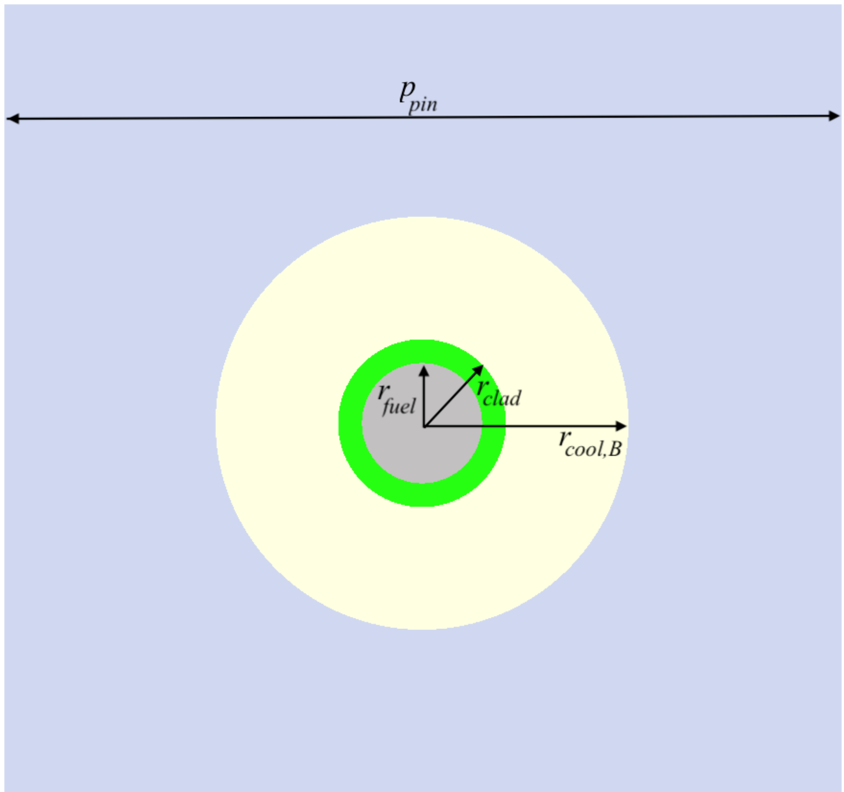


Figure 1. Magnox pin-cell geometry with Zone B coolant channel.

2.1 BEGINNING-OF-CYCLE PROBLEMS

2.1.1 Problem 1.1.1

2.1.1.1 Problem Description

For all regions, Problem 1.1.1 uses temperatures shown in Table 2.1. These temperature values are selected because continuous-energy incident neutron libraries exist at these temperatures for the reference solution. Comparing results at these temperatures attempts to eliminate errors due to on-the-fly Doppler broadening techniques.

Table 2.1. Temperatures for Problem 1.1.1.

Temperature	Value	Units
Fuel	900.0	K
Clad	600.0	K
Coolant	600.0	K
Moderator	600.0	K

2.1.1.2 Reference Solution

This first progression problem compares a Magnox pin cell at library temperatures. The neutron multiplication factors are shown in Table 2.2. They agree to 33 pcm. The uncertainties in parentheses refer to the absolute error of the highest precision digit(s) for each code or combined error in calculating the difference. The specific run parameters variables and wall time are shown in Table 2.3. MPACT converges to its solution with an order of magnitude less computational time.

Table 2.2. Neutron multiplication for the reference solution of Problem 1.1.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift k_{eff} (1σ)	MPACT k_{eff} (1σ)	Difference [pcm]
0	0.0	1.06271(7)	1.06304	33(7)

Table 2.3. Timing variables for the reference solution of Problem 1.1.1

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1500	1200	100000	1	48	2.23
MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1.0×10^{-06}	1.0×10^{-06}	0.01	1	1	0.05

2.1.2 Problem 1.1.2

2.1.2.1 Problem Description

The only difference between this problem and Problem 1.1.1 is the temperatures used. Temperatures used in this problem are typical of the operating conditions of a Magnox reactor. Both codes can use on-the-fly Doppler broadening to modify the cross-sections for the given temperatures. For all regions, Problem 1.1.2 uses average temperatures shown in Table 2.4.

Table 2.4. Temperatures for Problem 1.1.2.

Temperature	Value	Units	References & Notes
Fuel	698.15	K	[7] p. 22
Clad	533.59	K	Estimated
Coolant	511.15	K	Estimated
Moderator	523.15	K	[7] p. 22

2.1.2.2 Reference Solution

The goal of this problem is to utilize operating temperatures in a Magnox reactor and to compare the codes at these temperatures. The neutron multiplication factors are shown in Table 2.5 The codes agree to approximately 13 pcm. The specific run parameters variables and wall time are shown in Table 2.6. MPACT converges to its solution with an order of magnitude less computational time.

Table 2.5. Neutron multiplication for the reference solution of Problem 1.1.2.

Step	Burnup	Shift	MPACT	Difference
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	k_{eff} (1σ)	k_{eff} (1σ)	[pcm]
0	0.0	1.06769(7)	1.06782	13(7)

Table 2.6. Timing variables for the reference solution of Problem 1.1.2

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1500	1200	100000	1	48	2.17

MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1.0×10^{-06}	1.0×10^{-06}	0.01	1	1	0.05

2.2 DEPLETION

Burnup states used for comparison are listed in Table 1.5 and the total system specific power is listed in Table 1.6.

2.2.1 Problem 1.2.1

2.2.1.1 Problem Description

Temperatures used for this problem are listed in Table 2.4.

2.2.1.2 Reference Solution

The neutron multiplication factor agrees well between Shift and MPACT. The BOC difference is 46 pcm, and the EOC difference increases to 150 pcm. The burnups for the pin match identically, which is used for normalization.

The isotope concentrations in the pin cell are also compared. The percent difference for major actinides and fission products are shown in Figure 2. The percent differences are also tabulated in Tables 2.19-2.22. Some isotope differences are omitted as some minor fission products (^{84,86,87}Sr, ^{132,134,135}Ba, ^{85}Rb) have not been benchmarked for MPACT/VERA due to being low priority. Other than these isotopes, all the major actinides and fission products are within 3-4% for most of the burn cycle.

Table 2.7. Neutron multiplication factor for the reference solution of Problem 1.2.1.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Shift k_{eff} (1σ)	MPACT k_{eff} (1σ)	Difference [pcm]
0	0.0	1.06741(16)	1.06787	46(16)
1	25.0	1.05237(16)	1.05282	45(16)
2	50.0	1.05198(16)	1.05258	60(16)
3	100.0	1.05283(16)	1.05373	91(16)
4	200.0	1.05683(16)	1.05749	66(16)
5	300.0	1.05999(17)	1.06096	97(16)
6	400.0	1.06242(16)	1.06381	139(16)
7	500.0	1.0648(17)	1.06609	129(17)
8	600.0	1.06662(17)	1.06779	117(16)
9	700.0	1.06787(17)	1.06920	133(17)
10	800.0	1.06887(17)	1.07027	140(17)
11	900.0	1.06991(17)	1.07105	114(17)
12	1000.0	1.07024(17)	1.07159	135(16)
13	1100.0	1.07013(17)	1.07191	178(16)
14	1200.0	1.07017(18)	1.07205	188(17)
15	1300.0	1.07054(17)	1.07203	150(17)

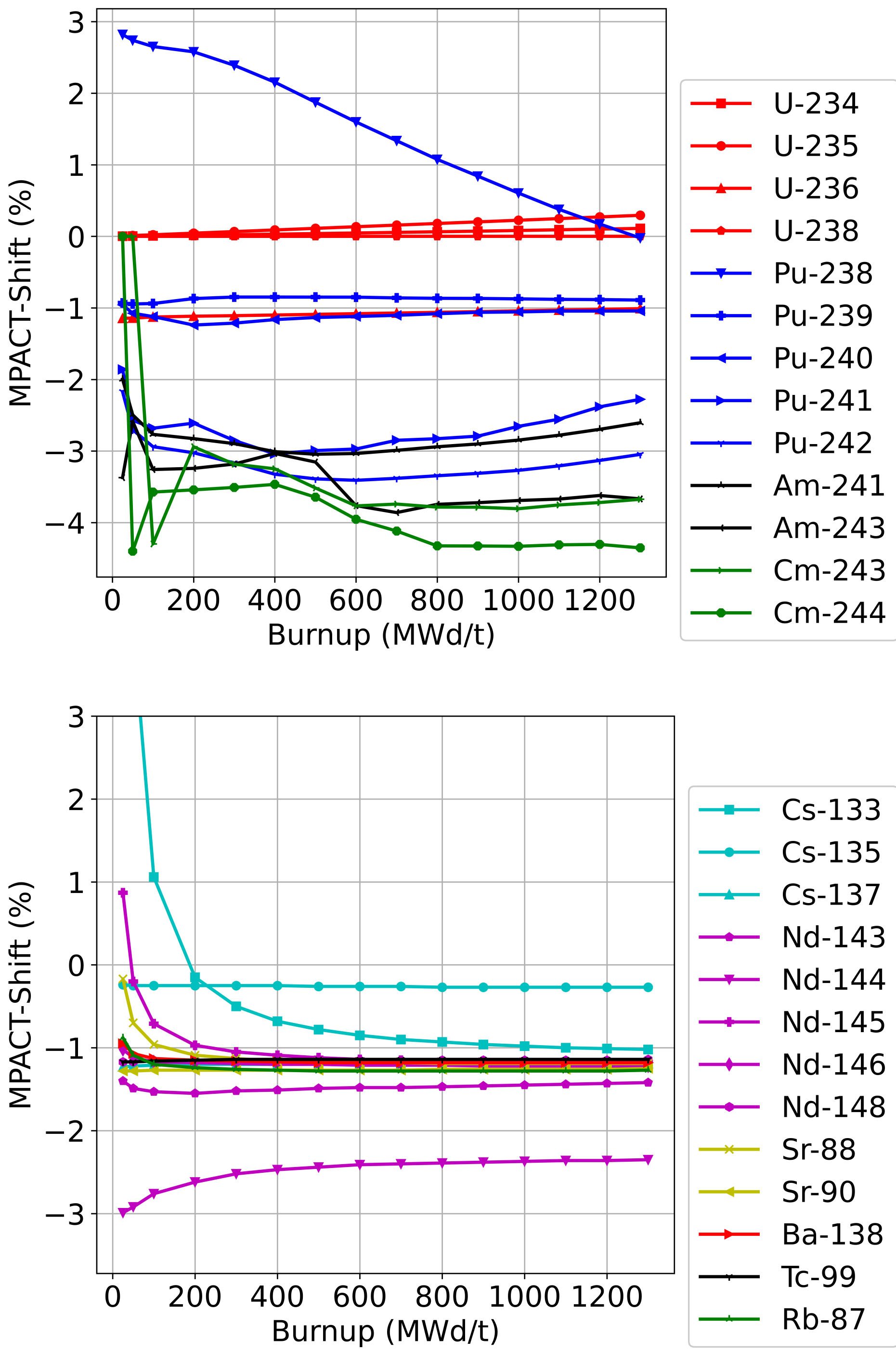


Figure 2. Percent difference in isotope concentrations between MPACT and Shift for actinides (top) and major fission products (bottom)

Table 2.8. Timing variables for the reference solution of Problem 1.2.1

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
15	1500	1200	20000	2	48	25.90
MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
15	1.0×10^{-06}	1.0×10^{-06}	0.03	1	1	0.44

Table 2.9. Uranium isotope concentrations for the reference solution of Problem 1.2.1.

Step	Burnup	^{234}U	^{235}U	^{236}U	^{238}U
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
			Shift		
0	0.0	2.5775×10^{-06}	3.4449×10^{-04}	0.0000×10^{-00}	4.7470×10^{-02}
1	25.0	2.5750×10^{-06}	3.4308×10^{-04}	2.2397×10^{-07}	4.7469×10^{-02}
2	50.0	2.5724×10^{-06}	3.4169×10^{-04}	4.4612×10^{-07}	4.7467×10^{-02}
3	100.0	2.5674×10^{-06}	3.3893×10^{-04}	8.8470×10^{-07}	4.7465×10^{-02}
4	200.0	2.5575×10^{-06}	3.3355×10^{-04}	1.7406×10^{-06}	4.7459×10^{-02}
5	300.0	2.5476×10^{-06}	3.2833×10^{-04}	2.5703×10^{-06}	4.7454×10^{-02}
6	400.0	2.5380×10^{-06}	3.2327×10^{-04}	3.3758×10^{-06}	4.7449×10^{-02}
7	500.0	2.5284×10^{-06}	3.1834×10^{-04}	4.1591×10^{-06}	4.7444×10^{-02}
8	600.0	2.5189×10^{-06}	3.1354×10^{-04}	4.9218×10^{-06}	4.7439×10^{-02}
9	700.0	2.5096×10^{-06}	3.0886×10^{-04}	5.6653×10^{-06}	4.7434×10^{-02}
10	800.0	2.5003×10^{-06}	3.0430×10^{-04}	6.3907×10^{-06}	4.7428×10^{-02}
11	900.0	2.4911×10^{-06}	2.9983×10^{-04}	7.0991×10^{-06}	4.7423×10^{-02}
12	1000.0	2.4820×10^{-06}	2.9547×10^{-04}	7.7914×10^{-06}	4.7418×10^{-02}
13	1100.0	2.4729×10^{-06}	2.9120×10^{-04}	8.4685×10^{-06}	4.7413×10^{-02}
14	1200.0	2.4639×10^{-06}	2.8702×10^{-04}	9.1314×10^{-06}	4.7408×10^{-02}
15	1300.0	2.4550×10^{-06}	2.8292×10^{-04}	9.7803×10^{-06}	4.7403×10^{-02}

Step	Burnup	^{234}U	^{235}U	^{236}U	^{238}U
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
			MPACT		
0	0.0	2.5775×10^{-06}	3.4449×10^{-04}	0.0000×10^{-00}	4.7470×10^{-02}
1	25.0	2.5750×10^{-06}	3.4310×10^{-04}	2.2073×10^{-07}	4.7469×10^{-02}
2	50.0	2.5726×10^{-06}	3.4172×10^{-04}	4.3968×10^{-07}	4.7467×10^{-02}
3	100.0	2.5677×10^{-06}	3.3900×10^{-04}	8.7205×10^{-07}	4.7465×10^{-02}
4	200.0	2.5581×10^{-06}	3.3369×10^{-04}	1.7159×10^{-06}	4.7460×10^{-02}
5	300.0	2.5486×10^{-06}	3.2855×10^{-04}	2.5340×10^{-06}	4.7454×10^{-02}
6	400.0	2.5392×10^{-06}	3.2355×10^{-04}	3.3283×10^{-06}	4.7449×10^{-02}
7	500.0	2.5300×10^{-06}	3.1869×10^{-04}	4.1009×10^{-06}	4.7444×10^{-02}
8	600.0	2.5208×10^{-06}	3.1395×10^{-04}	4.8533×10^{-06}	4.7439×10^{-02}
9	700.0	2.5118×10^{-06}	3.0934×10^{-04}	5.5869×10^{-06}	4.7434×10^{-02}
10	800.0	2.5028×10^{-06}	3.0483×10^{-04}	6.3029×10^{-06}	4.7429×10^{-02}
11	900.0	2.4939×10^{-06}	3.0042×10^{-04}	7.0022×10^{-06}	4.7424×10^{-02}
12	1000.0	2.4851×10^{-06}	2.9612×10^{-04}	7.6858×10^{-06}	4.7419×10^{-02}
13	1100.0	2.4764×10^{-06}	2.9190×10^{-04}	8.3546×10^{-06}	4.7414×10^{-02}
14	1200.0	2.4678×10^{-06}	2.8778×10^{-04}	9.0093×10^{-06}	4.7409×10^{-02}
15	1300.0	2.4592×10^{-06}	2.8373×10^{-04}	9.6506×10^{-06}	4.7405×10^{-02}

Table 2.10. Plutonium isotope concentrations for the reference solution of Problem 1.2.1.

Step	Burnup	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
				Shift		
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	7.8590×10^{-13}	1.0020×10^{-06}	2.0451×10^{-09}	5.2842×10^{-12}	3.8469×10^{-15}
2	50.0	5.7709×10^{-12}	2.2366×10^{-06}	9.2493×10^{-09}	4.9838×10^{-11}	7.3959×10^{-14}
3	100.0	3.3362×10^{-11}	4.6546×10^{-06}	3.8875×10^{-08}	4.2901×10^{-10}	1.3004×10^{-12}
4	200.0	1.6274×10^{-10}	9.2764×10^{-06}	1.5431×10^{-07}	3.4184×10^{-09}	2.0980×10^{-11}
5	300.0	3.9322×10^{-10}	1.3644×10^{-05}	3.3602×10^{-07}	1.1123×10^{-08}	1.0250×10^{-10}
6	400.0	7.2754×10^{-10}	1.7784×10^{-05}	5.7548×10^{-07}	2.5151×10^{-08}	3.0932×10^{-10}
7	500.0	1.1691×10^{-09}	2.1715×10^{-05}	8.6582×10^{-07}	4.6556×10^{-08}	7.1765×10^{-10}
8	600.0	1.7215×10^{-09}	2.5454×10^{-05}	1.2013×10^{-06}	7.6116×10^{-08}	1.4114×10^{-09}
9	700.0	2.3889×10^{-09}	2.9020×10^{-05}	1.5767×10^{-06}	1.1413×10^{-07}	2.4777×10^{-09}
10	800.0	3.1766×10^{-09}	3.2422×10^{-05}	1.9878×10^{-06}	1.6098×10^{-07}	4.0052×10^{-09}
11	900.0	4.0899×10^{-09}	3.5673×10^{-05}	2.4312×10^{-06}	2.1656×10^{-07}	6.0815×10^{-09}
12	1000.0	5.1367×10^{-09}	3.8786×10^{-05}	2.9041×10^{-06}	2.8043×10^{-07}	8.7907×10^{-09}
13	1100.0	6.3244×10^{-09}	4.1768×10^{-05}	3.4034×10^{-06}	3.5264×10^{-07}	1.2211×10^{-08}
14	1200.0	7.6608×10^{-09}	4.4627×10^{-05}	3.9274×10^{-06}	4.3244×10^{-07}	1.6419×10^{-08}
15	1300.0	9.1563×10^{-09}	4.7373×10^{-05}	4.4736×10^{-06}	5.2003×10^{-07}	2.1485×10^{-08}
				MPACT		
Step	Burnup	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	$\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	7.8189×10^{-13}	9.8194×10^{-07}	2.0167×10^{-09}	5.1210×10^{-12}	3.7974×10^{-15}
2	50.0	5.7371×10^{-12}	2.1914×10^{-06}	9.1223×10^{-09}	4.8041×10^{-11}	7.2832×10^{-14}
3	100.0	3.3140×10^{-11}	4.5601×10^{-06}	3.8351×10^{-08}	4.1348×10^{-10}	1.2798×10^{-12}
4	200.0	1.6155×10^{-10}	9.0920×10^{-06}	1.5213×10^{-07}	3.2994×10^{-09}	2.0658×10^{-11}
5	300.0	3.8965×10^{-10}	1.3373×10^{-05}	3.3146×10^{-07}	1.0714×10^{-08}	1.0088×10^{-10}
6	400.0	7.1934×10^{-10}	1.7425×10^{-05}	5.6808×10^{-07}	2.4191×10^{-08}	3.0423×10^{-10}
7	500.0	1.1529×10^{-09}	2.1271×10^{-05}	8.5507×10^{-07}	4.4822×10^{-08}	7.0601×10^{-10}
8	600.0	1.6934×10^{-09}	2.4927×10^{-05}	1.1866×10^{-06}	7.3335×10^{-08}	1.3895×10^{-09}
9	700.0	2.3443×10^{-09}	2.8409×10^{-05}	1.5579×10^{-06}	1.1016×10^{-07}	2.4423×10^{-09}
10	800.0	3.1101×10^{-09}	3.1731×10^{-05}	1.9647×10^{-06}	1.5549×10^{-07}	3.9531×10^{-09}
11	900.0	3.9963×10^{-09}	3.4903×10^{-05}	2.4034×10^{-06}	2.0934×10^{-07}	6.0099×10^{-09}
12	1000.0	5.0091×10^{-09}	3.7937×10^{-05}	2.8710×10^{-06}	2.7158×10^{-07}	8.6984×10^{-09}
13	1100.0	6.1559×10^{-09}	4.0842×10^{-05}	3.3650×10^{-06}	3.4198×10^{-07}	1.2101×10^{-08}
14	1200.0	7.4449×10^{-09}	4.3626×10^{-05}	3.8828×10^{-06}	4.2025×10^{-07}	1.6297×10^{-08}
15	1300.0	8.8855×10^{-09}	4.6297×10^{-05}	4.4227×10^{-06}	5.0604×10^{-07}	2.1360×10^{-08}

Table 2.11. Americium isotope concentrations for the reference solution of Problem 1.2.1.

		Shift	
Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{241}Am $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{243}Am $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	2.8011×10^{-15}	6.4345×10^{-19}
2	50.0	5.3970×10^{-14}	2.6387×10^{-17}
3	100.0	9.5392×10^{-13}	9.7729×10^{-16}
4	200.0	1.5520×10^{-11}	3.2591×10^{-14}
5	300.0	7.6518×10^{-11}	2.4314×10^{-13}
6	400.0	2.3274×10^{-10}	9.8991×10^{-13}
7	500.0	5.4359×10^{-10}	2.9092×10^{-12}
8	600.0	1.0751×10^{-09}	6.9882×10^{-12}
9	700.0	1.8966×10^{-09}	1.4486×10^{-11}
10	800.0	3.0785×10^{-09}	2.7014×10^{-11}
11	900.0	4.6908×10^{-09}	4.6602×10^{-11}
12	1000.0	6.7995×10^{-09}	7.5558×10^{-11}
13	1100.0	9.4674×10^{-09}	1.1655×10^{-10}
14	1200.0	1.2752×10^{-08}	1.7248×10^{-10}
15	1300.0	1.6709×10^{-08}	2.4687×10^{-10}
		MPACT	
Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{241}Am $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{243}Am $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	2.7078×10^{-15}	6.1871×10^{-19}
2	50.0	5.2032×10^{-14}	2.5678×10^{-17}
3	100.0	9.1823×10^{-13}	9.4651×10^{-16}
4	200.0	1.4941×10^{-11}	3.1640×10^{-14}
5	300.0	7.3634×10^{-11}	2.3637×10^{-13}
6	400.0	2.2376×10^{-10}	9.6466×10^{-13}
7	500.0	5.2258×10^{-10}	2.8340×10^{-12}
8	600.0	1.0340×10^{-09}	6.7708×10^{-12}
9	700.0	1.8253×10^{-09}	1.4034×10^{-11}
10	800.0	2.9651×10^{-09}	2.6226×10^{-11}
11	900.0	4.5211×10^{-09}	4.5292×10^{-11}
12	1000.0	6.5587×10^{-09}	7.3519×10^{-11}
13	1100.0	9.1403×10^{-09}	1.1352×10^{-10}
14	1200.0	1.2325×10^{-08}	1.6822×10^{-10}
15	1300.0	1.6166×10^{-08}	2.4084×10^{-10}

Table 2.12. Curium isotope concentrations for the reference solution of Problem 1.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift ^{243}Cm $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	Shift ^{244}Cm $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
2	50.0	$0.0000 \times 10^{+00}$	1.9235×10^{-20}
3	100.0	5.5931×10^{-19}	1.4704×10^{-18}
4	200.0	3.7278×10^{-17}	9.8996×10^{-17}
5	300.0	4.0205×10^{-16}	1.0983×10^{-15}
6	400.0	2.0913×10^{-15}	5.9027×10^{-15}
7	500.0	7.3326×10^{-15}	2.1417×10^{-14}
8	600.0	2.0083×10^{-14}	6.0738×10^{-14}
9	700.0	4.6449×10^{-14}	1.4549×10^{-13}
10	800.0	9.5023×10^{-14}	3.0821×10^{-13}
11	900.0	1.7711×10^{-13}	5.9479×10^{-13}
12	1000.0	3.0691×10^{-13}	1.0669×10^{-12}
13	1100.0	5.0157×10^{-13}	1.8041×10^{-12}
14	1200.0	7.8122×10^{-13}	2.9067×10^{-12}
15	1300.0	1.1690×10^{-12}	4.4974×10^{-12}

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	MPACT ^{243}Cm $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	MPACT ^{244}Cm $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	0.0000×10^{-00}	0.0000×10^{-00}
2	50.0	1.3290×10^{-21}	1.4601×10^{-20}
3	100.0	4.8732×10^{-19}	1.2624×10^{-18}
4	200.0	3.2610×10^{-17}	8.6225×10^{-17}
5	300.0	3.5223×10^{-16}	9.7499×10^{-16}
6	400.0	1.8403×10^{-15}	5.3348×10^{-15}
7	500.0	6.4619×10^{-15}	1.9675×10^{-14}
8	600.0	1.7732×10^{-14}	5.6618×10^{-14}
9	700.0	4.1069×10^{-14}	1.3739×10^{-13}
10	800.0	8.4066×10^{-14}	2.9438×10^{-13}
11	900.0	1.5666×10^{-13}	5.7377×10^{-13}
12	1000.0	2.7122×10^{-13}	1.0380×10^{-12}
13	1100.0	4.4254×10^{-13}	1.7684×10^{-12}
14	1200.0	6.8778×10^{-13}	2.8673×10^{-12}
15	1300.0	1.0264×10^{-12}	4.4602×10^{-12}

Table 2.13. Cesium isotope concentrations for the reference solution of Problem 1.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{133}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{135}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{137}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
			Shift	
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	4.5614×10^{-08}	4.8829×10^{-08}	7.8444×10^{-08}
2	50.0	1.2645×10^{-07}	9.9978×10^{-08}	1.5681×10^{-07}
3	100.0	2.9598×10^{-07}	2.0268×10^{-07}	3.1333×10^{-07}
4	200.0	6.3567×10^{-07}	4.0961×10^{-07}	6.2553×10^{-07}
5	300.0	9.7497×10^{-07}	6.1839×10^{-07}	9.3662×10^{-07}
6	400.0	1.3139×10^{-06}	8.2881×10^{-07}	1.2466×10^{-06}
7	500.0	1.6523×10^{-06}	1.0407×10^{-06}	1.5554×10^{-06}
8	600.0	1.9904×10^{-06}	1.2540×10^{-06}	1.8630×10^{-06}
9	700.0	2.3280×10^{-06}	1.4685×10^{-06}	2.1694×10^{-06}
10	800.0	2.6651×10^{-06}	1.6841×10^{-06}	2.4747×10^{-06}
11	900.0	3.0019×10^{-06}	1.9008×10^{-06}	2.7787×10^{-06}
12	1000.0	3.3382×10^{-06}	2.1185×10^{-06}	3.0816×10^{-06}
13	1100.0	3.6740×10^{-06}	2.3370×10^{-06}	3.3832×10^{-06}
14	1200.0	4.0094×10^{-06}	2.5564×10^{-06}	3.6837×10^{-06}
15	1300.0	4.3443×10^{-06}	2.7765×10^{-06}	3.9829×10^{-06}
			MPACT	
Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{133}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{135}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{137}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	5.0919×10^{-08}	4.8535×10^{-08}	7.7474×10^{-08}
2	50.0	1.3154×10^{-07}	9.9359×10^{-08}	1.5489×10^{-07}
3	100.0	2.9909×10^{-07}	2.0141×10^{-07}	3.0952×10^{-07}
4	200.0	6.3468×10^{-07}	4.0700×10^{-07}	6.1800×10^{-07}
5	300.0	9.7001×10^{-07}	6.1436×10^{-07}	9.2536×10^{-07}
6	400.0	1.3049×10^{-06}	8.2330×10^{-07}	1.2316×10^{-06}
7	500.0	1.6394×10^{-06}	1.0337×10^{-06}	1.5367×10^{-06}
8	600.0	1.9734×10^{-06}	1.2454×10^{-06}	1.8406×10^{-06}
9	700.0	2.3071×10^{-06}	1.4583×10^{-06}	2.1434×10^{-06}
10	800.0	2.6403×10^{-06}	1.6722×10^{-06}	2.4450×10^{-06}
11	900.0	2.9731×10^{-06}	1.8872×10^{-06}	2.7455×10^{-06}
12	1000.0	3.3055×10^{-06}	2.1031×10^{-06}	3.0448×10^{-06}
13	1100.0	3.6374×10^{-06}	2.3199×10^{-06}	3.3429×10^{-06}
14	1200.0	3.9690×10^{-06}	2.5375×10^{-06}	3.6398×10^{-06}
15	1300.0	4.3001×10^{-06}	2.7558×10^{-06}	3.9355×10^{-06}

Table 2.14. Neodymium isotope concentrations for the reference solution of Problem 1.2.1.

				Shift		
Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{143}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{144}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{145}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{146}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{148}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	2.0333×10^{-08}	1.4520×10^{-09}	4.8749×10^{-08}	3.8290×10^{-08}	2.1624×10^{-08}
2	50.0	7.1914×10^{-08}	5.7729×10^{-09}	9.8409×10^{-08}	7.6615×10^{-08}	4.3272×10^{-08}
3	100.0	2.0669×10^{-07}	2.2636×10^{-08}	1.9734×10^{-07}	1.5313×10^{-07}	8.6558×10^{-08}
4	200.0	4.9683×10^{-07}	8.6269×10^{-08}	3.9378×10^{-07}	3.0566×10^{-07}	1.7302×10^{-07}
5	300.0	7.8494×10^{-07}	1.8452×10^{-07}	5.8846×10^{-07}	4.5763×10^{-07}	2.5935×10^{-07}
6	400.0	1.0688×10^{-06}	3.1190×10^{-07}	7.8152×10^{-07}	6.0909×10^{-07}	3.4554×10^{-07}
7	500.0	1.3485×10^{-06}	4.6382×10^{-07}	9.7307×10^{-07}	7.6011×10^{-07}	4.3162×10^{-07}
8	600.0	1.6242×10^{-06}	6.3641×10^{-07}	1.1632×10^{-06}	9.1073×10^{-07}	5.1758×10^{-07}
9	700.0	1.8963×10^{-06}	8.2641×10^{-07}	1.3520×10^{-06}	1.0610×10^{-06}	6.0345×10^{-07}
10	800.0	2.1649×10^{-06}	1.0311×10^{-06}	1.5396×10^{-06}	1.2109×10^{-06}	6.8921×10^{-07}
11	900.0	2.4300×10^{-06}	1.2482×10^{-06}	1.7259×10^{-06}	1.3606×10^{-06}	7.7488×10^{-07}
12	1000.0	2.6919×10^{-06}	1.4757×10^{-06}	1.9111×10^{-06}	1.5100×10^{-06}	8.6047×10^{-07}
13	1100.0	2.9507×10^{-06}	1.7121×10^{-06}	2.0953×10^{-06}	1.6592×10^{-06}	9.4598×10^{-07}
14	1200.0	3.2064×10^{-06}	1.9560×10^{-06}	2.2784×10^{-06}	1.8081×10^{-06}	1.0314×10^{-06}
15	1300.0	3.4592×10^{-06}	2.2062×10^{-06}	2.4605×10^{-06}	1.9569×10^{-06}	1.1168×10^{-06}
				MPACT		
Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{143}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{144}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{145}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{146}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{148}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	2.0051×10^{-08}	1.4088×10^{-09}	4.9172×10^{-08}	3.7892×10^{-08}	2.1366×10^{-08}
2	50.0	7.0852×10^{-08}	5.6062×10^{-09}	9.8214×10^{-08}	7.5741×10^{-08}	4.2755×10^{-08}
3	100.0	2.0354×10^{-07}	2.2020×10^{-08}	1.9593×10^{-07}	1.5131×10^{-07}	8.5528×10^{-08}
4	200.0	4.8914×10^{-07}	8.4059×10^{-08}	3.8998×10^{-07}	3.0198×10^{-07}	1.7098×10^{-07}
5	300.0	7.7301×10^{-07}	1.7997×10^{-07}	5.8228×10^{-07}	4.5207×10^{-07}	2.5630×10^{-07}
6	400.0	1.0526×10^{-06}	3.0440×10^{-07}	7.7298×10^{-07}	6.0164×10^{-07}	3.4148×10^{-07}
7	500.0	1.3282×10^{-06}	4.5285×10^{-07}	9.6219×10^{-07}	7.5076×10^{-07}	4.2654×10^{-07}
8	600.0	1.6000×10^{-06}	6.2152×10^{-07}	1.1500×10^{-06}	8.9948×10^{-07}	5.1149×10^{-07}
9	700.0	1.8681×10^{-06}	8.0726×10^{-07}	1.3365×10^{-06}	1.0479×10^{-06}	5.9635×10^{-07}
10	800.0	2.1327×10^{-06}	1.0074×10^{-06}	1.5218×10^{-06}	1.1959×10^{-06}	6.8111×10^{-07}
11	900.0	2.3940×10^{-06}	1.2196×10^{-06}	1.7060×10^{-06}	1.3437×10^{-06}	7.6579×10^{-07}
12	1000.0	2.6522×10^{-06}	1.4421×10^{-06}	1.8890×10^{-06}	1.4911×10^{-06}	8.5038×10^{-07}
13	1100.0	2.9072×10^{-06}	1.6733×10^{-06}	2.0710×10^{-06}	1.6384×10^{-06}	9.3489×10^{-07}
14	1200.0	3.1593×10^{-06}	1.9119×10^{-06}	2.2520×10^{-06}	1.7855×10^{-06}	1.0193×10^{-06}
15	1300.0	3.4084×10^{-06}	2.1566×10^{-06}	2.4320×10^{-06}	1.9323×10^{-06}	1.1037×10^{-06}

Table 2.15. Strontium isotope concentrations for the reference solution of Problem 1.2.1.

Step	Burnup [MWd/MtU]	^{84}Sr [atoms/b-cm]	^{86}Sr [atoms/b-cm]	^{87}Sr [atoms/b-cm]	^{88}Sr [atoms/b-cm]	^{90}Sr [atoms/b-cm]
				Shift		
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	2.9632×10^{-19}	3.2991×10^{-14}	1.6835×10^{-14}	4.3634×10^{-08}	7.1265×10^{-08}
2	50.0	1.1645×10^{-18}	1.5560×10^{-13}	3.6459×10^{-14}	8.7491×10^{-08}	1.4204×10^{-07}
3	100.0	4.5198×10^{-18}	7.5028×10^{-13}	8.4102×10^{-14}	1.7451×10^{-07}	2.8221×10^{-07}
4	200.0	1.7166×10^{-17}	3.4961×10^{-12}	2.1111×10^{-13}	3.4596×10^{-07}	5.5738×10^{-07}
5	300.0	3.7493×10^{-17}	8.3374×10^{-12}	3.7699×10^{-13}	5.1423×10^{-07}	8.2610×10^{-07}
6	400.0	6.5289×10^{-17}	1.5236×10^{-11}	5.7832×10^{-13}	6.7959×10^{-07}	1.0888×10^{-06}
7	500.0	1.0054×10^{-16}	2.4135×10^{-11}	8.1235×10^{-13}	8.4226×10^{-07}	1.3460×10^{-06}
8	600.0	1.4302×10^{-16}	3.4987×10^{-11}	1.0766×10^{-12}	1.0025×10^{-06}	1.5980×10^{-06}
9	700.0	1.9275×10^{-16}	4.7763×10^{-11}	1.3689×10^{-12}	1.1603×10^{-06}	1.8450×10^{-06}
10	800.0	2.4960×10^{-16}	6.2413×10^{-11}	1.6874×10^{-12}	1.3160×10^{-06}	2.0874×10^{-06}
11	900.0	3.1394×10^{-16}	7.8915×10^{-11}	2.0306×10^{-12}	1.4697×10^{-06}	2.3253×10^{-06}
12	1000.0	3.8583×10^{-16}	9.7250×10^{-11}	2.3970×10^{-12}	1.6215×10^{-06}	2.5591×10^{-06}
13	1100.0	4.6470×10^{-16}	1.1743×10^{-10}	2.7852×10^{-12}	1.7714×10^{-06}	2.7888×10^{-06}
14	1200.0	5.5169×10^{-16}	1.3935×10^{-10}	3.1943×10^{-12}	1.9196×10^{-06}	3.0146×10^{-06}
15	1300.0	6.4530×10^{-16}	1.6306×10^{-10}	3.6229×10^{-12}	2.0662×10^{-06}	3.2367×10^{-06}
				MPACT		
Step	Burnup [MWd/MtU]	^{84}Sr [atoms/b-cm]	^{86}Sr [atoms/b-cm]	^{87}Sr [atoms/b-cm]	^{88}Sr [atoms/b-cm]	^{90}Sr [atoms/b-cm]
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	1.5878×10^{-18}	2.2275×10^{-14}	1.7027×10^{-14}	4.3574×10^{-08}	7.0375×10^{-08}
2	50.0	3.3119×10^{-18}	7.9740×10^{-14}	3.7451×10^{-14}	8.6905×10^{-08}	1.4027×10^{-07}
3	100.0	7.1491×10^{-18}	2.7124×10^{-13}	8.8555×10^{-14}	1.7289×10^{-07}	2.7872×10^{-07}
4	200.0	1.6287×10^{-17}	8.8742×10^{-13}	2.2979×10^{-13}	3.4230×10^{-07}	5.5051×10^{-07}
5	300.0	2.7220×10^{-17}	1.7705×10^{-12}	4.1961×10^{-13}	5.0856×10^{-07}	8.1591×10^{-07}
6	400.0	3.9796×10^{-17}	2.8976×10^{-12}	6.5450×10^{-13}	6.7195×10^{-07}	1.0754×10^{-06}
7	500.0	5.3883×10^{-17}	4.2533×10^{-12}	9.3146×10^{-13}	8.3268×10^{-07}	1.3294×10^{-06}
8	600.0	6.9375×10^{-17}	5.8256×10^{-12}	1.2480×10^{-12}	9.9097×10^{-07}	1.5783×10^{-06}
9	700.0	8.6174×10^{-17}	7.6044×10^{-12}	1.6018×10^{-12}	1.1470×10^{-06}	1.8223×10^{-06}
10	800.0	1.0420×10^{-16}	9.5811×10^{-12}	1.9909×10^{-12}	1.3009×10^{-06}	2.0617×10^{-06}
11	900.0	1.2338×10^{-16}	1.1749×10^{-11}	2.4137×10^{-12}	1.4527×10^{-06}	2.2968×10^{-06}
12	1000.0	1.4364×10^{-16}	1.4101×10^{-11}	2.8686×10^{-12}	1.6027×10^{-06}	2.5277×10^{-06}
13	1100.0	1.6494×10^{-16}	1.6634×10^{-11}	3.3541×10^{-12}	1.7509×10^{-06}	2.7546×10^{-06}
14	1200.0	1.8721×10^{-16}	1.9342×10^{-11}	3.8691×10^{-12}	1.8974×10^{-06}	2.9778×10^{-06}
15	1300.0	2.1042×10^{-16}	2.2223×10^{-11}	4.4125×10^{-12}	2.0423×10^{-06}	3.1973×10^{-06}

Table 2.16. Barium isotope concentrations for the reference solution of Problem 1.2.1.

				Shift		
Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{132}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{134}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{135}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{136}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{138}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	1.0103×10^{-17}	2.5861×10^{-14}	1.7001×10^{-15}	3.6169×10^{-11}	8.4864×10^{-08}
2	50.0	3.0395×10^{-17}	3.4304×10^{-13}	5.3205×10^{-15}	1.0079×10^{-10}	1.6983×10^{-07}
3	100.0	9.0693×10^{-17}	3.7510×10^{-12}	1.8306×10^{-14}	2.8493×10^{-10}	3.3950×10^{-07}
4	200.0	2.8506×10^{-16}	3.5152×10^{-11}	6.7438×10^{-14}	8.1997×10^{-10}	6.7784×10^{-07}
5	300.0	5.8463×10^{-16}	1.2362×10^{-10}	1.4920×10^{-13}	1.5532×10^{-09}	1.0150×10^{-06}
6	400.0	9.9027×10^{-16}	2.9622×10^{-10}	2.6799×10^{-13}	2.4715×10^{-09}	1.3510×10^{-06}
7	500.0	1.5040×10^{-15}	5.7783×10^{-10}	4.3042×10^{-13}	3.5646×10^{-09}	1.6860×10^{-06}
8	600.0	2.1225×10^{-15}	9.9142×10^{-10}	6.4504×10^{-13}	4.8247×10^{-09}	2.0201×10^{-06}
9	700.0	2.8552×10^{-15}	1.5582×10^{-09}	9.2251×10^{-13}	6.2441×10^{-09}	2.3532×10^{-06}
10	800.0	3.6968×10^{-15}	2.2977×10^{-09}	1.2747×10^{-12}	7.8168×10^{-09}	2.6855×10^{-06}
11	900.0	4.6597×10^{-15}	3.2282×10^{-09}	1.7153×10^{-12}	9.5359×10^{-09}	3.0171×10^{-06}
12	1000.0	5.7319×10^{-15}	4.3663×10^{-09}	2.2593×10^{-12}	1.1398×10^{-08}	3.3479×10^{-06}
13	1100.0	6.9164×10^{-15}	5.7280×10^{-09}	2.9230×10^{-12}	1.3398×10^{-08}	3.6780×10^{-06}
14	1200.0	8.2432×10^{-15}	7.3274×10^{-09}	3.7219×10^{-12}	1.5532×10^{-08}	4.0074×10^{-06}
15	1300.0	9.6679×10^{-15}	9.1778×10^{-09}	4.6794×10^{-12}	1.7798×10^{-08}	4.3362×10^{-06}
				MPACT		
Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{132}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{134}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{135}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{136}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{138}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	0.0000×10^{-00}	2.9481×10^{-14}	1.0788×10^{-15}	1.1071×10^{-11}	8.4065×10^{-08}
2	50.0	0.0000×10^{-00}	3.4445×10^{-13}	3.4532×10^{-15}	3.7871×10^{-11}	1.6803×10^{-07}
3	100.0	1.0020×10^{-21}	3.5217×10^{-12}	1.2166×10^{-14}	1.2176×10^{-10}	3.3569×10^{-07}
4	200.0	8.5373×10^{-20}	3.1935×10^{-11}	4.6062×10^{-14}	3.8195×10^{-10}	6.7007×10^{-07}
5	300.0	4.2871×10^{-19}	1.1115×10^{-10}	1.0456×10^{-13}	7.5347×10^{-10}	1.0032×10^{-06}
6	400.0	1.3394×10^{-18}	2.6497×10^{-10}	1.9291×10^{-13}	1.2300×10^{-09}	1.3353×10^{-06}
7	500.0	3.2424×10^{-18}	5.1523×10^{-10}	3.1853×10^{-13}	1.8070×10^{-09}	1.6663×10^{-06}
8	600.0	6.6726×10^{-18}	8.8205×10^{-10}	4.9083×10^{-13}	2.4804×10^{-09}	1.9964×10^{-06}
9	700.0	1.2268×10^{-17}	1.3840×10^{-09}	7.2098×10^{-13}	3.2470×10^{-09}	2.3257×10^{-06}
10	800.0	2.0765×10^{-17}	2.0381×10^{-09}	1.0218×10^{-12}	4.1038×10^{-09}	2.6541×10^{-06}
11	900.0	3.2990×10^{-17}	2.8601×10^{-09}	1.4077×10^{-12}	5.0482×10^{-09}	2.9818×10^{-06}
12	1000.0	4.9857×10^{-17}	3.8648×10^{-09}	1.8944×10^{-12}	6.0782×10^{-09}	3.3087×10^{-06}
13	1100.0	7.2363×10^{-17}	5.0655×10^{-09}	2.4989×10^{-12}	7.1917×10^{-09}	3.6349×10^{-06}
14	1200.0	1.0158×10^{-16}	6.4748×10^{-09}	3.2396×10^{-12}	8.3871×10^{-09}	3.9605×10^{-06}
15	1300.0	1.3866×10^{-16}	8.1041×10^{-09}	4.1357×10^{-12}	9.6627×10^{-09}	4.2855×10^{-06}

Table 2.17. Technetium isotope concentrations for the reference solution of Problem 1.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	MPACT ^{99}Tc $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	0.0000×10^{-00}
1	25.0	5.8550×10^{-08}
2	50.0	1.3587×10^{-07}
3	100.0	2.9087×10^{-07}
4	200.0	6.0046×10^{-07}
5	300.0	9.0954×10^{-07}
6	400.0	1.2181×10^{-06}
7	500.0	1.5262×10^{-06}
8	600.0	1.8338×10^{-06}
9	700.0	2.1409×10^{-06}
10	800.0	2.4476×10^{-06}
11	900.0	2.7538×10^{-06}
12	1000.0	3.0595×10^{-06}
13	1100.0	3.3648×10^{-06}
14	1200.0	3.6697×10^{-06}
15	1300.0	3.9741×10^{-06}

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	MPACT ^{99}Tc $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	0.0000×10^{-00}
1	25.0	5.7859×10^{-08}
2	50.0	1.3427×10^{-07}
3	100.0	2.8747×10^{-07}
4	200.0	5.9351×10^{-07}
5	300.0	8.9909×10^{-07}
6	400.0	1.2042×10^{-06}
7	500.0	1.5087×10^{-06}
8	600.0	1.8128×10^{-06}
9	700.0	2.1165×10^{-06}
10	800.0	2.4196×10^{-06}
11	900.0	2.7224×10^{-06}
12	1000.0	3.0247×10^{-06}
13	1100.0	3.3265×10^{-06}
14	1200.0	3.6280×10^{-06}
15	1300.0	3.9290×10^{-06}

Table 2.18. Rubidium isotope concentrations for the reference solution of Problem 1.2.1.

		Shift	
Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{85}Rb $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{87}Rb $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	1.2545×10^{-08}	3.1617×10^{-08}
2	50.0	2.5233×10^{-08}	6.3199×10^{-08}
3	100.0	5.0456×10^{-08}	1.2588×10^{-07}
4	200.0	1.0034×10^{-07}	2.4944×10^{-07}
5	300.0	1.4954×10^{-07}	3.7079×10^{-07}
6	400.0	1.9813×10^{-07}	4.9011×10^{-07}
7	500.0	2.4617×10^{-07}	6.0758×10^{-07}
8	600.0	2.9369×10^{-07}	7.2331×10^{-07}
9	700.0	3.4074×10^{-07}	8.3744×10^{-07}
10	800.0	3.8736×10^{-07}	9.5006×10^{-07}
11	900.0	4.3358×10^{-07}	1.0613×10^{-06}
12	1000.0	4.7942×10^{-07}	1.1711×10^{-06}
13	1100.0	5.2490×10^{-07}	1.2797×10^{-06}
14	1200.0	5.7006×10^{-07}	1.3872×10^{-06}
15	1300.0	6.1490×10^{-07}	1.4934×10^{-06}
		MPACT	
Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{85}Rb $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{87}Rb $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	0.0000×10^{-00}	0.0000×10^{-00}
1	25.0	3.2985×10^{-11}	3.1345×10^{-08}
2	50.0	7.6130×10^{-11}	6.2523×10^{-08}
3	100.0	1.9262×10^{-10}	1.2441×10^{-07}
4	200.0	5.4431×10^{-10}	2.4640×10^{-07}
5	300.0	1.0508×10^{-09}	3.6621×10^{-07}
6	400.0	1.7077×10^{-09}	4.8401×10^{-07}
7	500.0	2.5112×10^{-09}	5.9998×10^{-07}
8	600.0	3.4572×10^{-09}	7.1425×10^{-07}
9	700.0	4.5423×10^{-09}	8.2694×10^{-07}
10	800.0	5.7629×10^{-09}	9.3814×10^{-07}
11	900.0	7.1157×10^{-09}	1.0480×10^{-06}
12	1000.0	8.5974×10^{-09}	1.1565×10^{-06}
13	1100.0	1.0205×10^{-08}	1.2637×10^{-06}
14	1200.0	1.1935×10^{-08}	1.3698×10^{-06}
15	1300.0	1.3786×10^{-08}	1.4747×10^{-06}

Table 2.19. Relative difference between MPACT and Shift concentrations for uranium and plutonium isotopes

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	^{234}U [%]	^{235}U [%]	^{236}U [%]	^{238}U [%]	^{238}Pu [%]	^{239}Pu [%]	^{240}Pu [%]	^{241}Pu [%]	^{242}Pu [%]
0	0.0	-	-	-	-	-	-	-	-	-
1	25.0	0.00	0.01	-1.14	0.00	2.82	-0.93	-0.96	-1.86	-2.17
2	50.0	0.00	0.01	-1.14	0.00	2.74	-0.94	-1.07	-2.57	-2.70
3	100.0	0.01	0.02	-1.13	0.00	2.65	-0.94	-1.12	-2.68	-2.94
4	200.0	0.01	0.04	-1.12	0.00	2.58	-0.87	-1.24	-2.61	-3.02
5	300.0	0.02	0.07	-1.11	0.00	2.39	-0.85	-1.21	-2.85	-3.17
6	400.0	0.03	0.09	-1.10	0.00	2.15	-0.85	-1.16	-3.04	-3.32
7	500.0	0.04	0.11	-1.09	0.00	1.87	-0.85	-1.13	-2.99	-3.39
8	600.0	0.05	0.13	-1.08	0.00	1.60	-0.85	-1.12	-2.97	-3.41
9	700.0	0.06	0.16	-1.07	0.00	1.34	-0.86	-1.10	-2.85	-3.38
10	800.0	0.06	0.18	-1.06	0.00	1.08	-0.87	-1.08	-2.83	-3.34
11	900.0	0.07	0.20	-1.05	0.00	0.84	-0.87	-1.06	-2.79	-3.31
12	1000.0	0.08	0.23	-1.04	0.00	0.61	-0.87	-1.06	-2.65	-3.27
13	1100.0	0.09	0.25	-1.03	0.00	0.38	-0.88	-1.04	-2.55	-3.21
14	1200.0	0.10	0.27	-1.02	0.00	0.17	-0.88	-1.04	-2.38	-3.13
15	1300.0	0.11	0.29	-1.01	0.00	-0.02	-0.89	-1.04	-2.28	-3.05

Table 2.20. Relative difference between MPACT and Shift concentrations for americium and curium isotopes

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	^{241}Am [%]	^{243}Am [%]	^{243}Cm [%]	^{244}Cm [%]
0	0.0	-	-	-	-
1	25.0	-2.00	-3.37	-	-
2	50.0	-2.49	-2.58	-	-4.40
3	100.0	-2.77	-3.26	-4.30	-3.57
4	200.0	-2.83	-3.24	-2.94	-3.54
5	300.0	-2.90	-3.18	-3.18	-3.51
6	400.0	-3.01	-3.03	-3.25	-3.47
7	500.0	-3.04	-3.15	-3.52	-3.64
8	600.0	-3.03	-3.76	-3.77	-3.95
9	700.0	-2.99	-3.86	-3.74	-4.12
10	800.0	-2.94	-3.74	-3.78	-4.32
11	900.0	-2.90	-3.72	-3.78	-4.33
12	1000.0	-2.85	-3.69	-3.81	-4.33
13	1100.0	-2.78	-3.67	-3.75	-4.31
14	1200.0	-2.70	-3.62	-3.72	-4.30
15	1300.0	-2.60	-3.67	-3.67	-4.35

Table 2.21. Relative difference between MPACT and Shift concentrations for cesium and neodymium isotopes

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{133}Cs [%]	^{135}Cs [%]	^{137}Cs [%]	^{143}Nd [%]	^{144}Nd [%]	^{145}Nd [%]	^{146}Nd [%]	^{148}Nd [%]
0	0.0	-	-	-	-	-	-	-	-
1	25.0	11.64	-0.24	-1.23	-1.40	-2.99	0.87	-1.02	-1.17
2	50.0	4.04	-0.25	-1.22	-1.49	-2.92	-0.20	-1.12	-1.17
3	100.0	1.06	-0.25	-1.21	-1.53	-2.76	-0.71	-1.17	-1.16
4	200.0	-0.15	-0.25	-1.20	-1.55	-2.62	-0.97	-1.18	-1.15
5	300.0	-0.50	-0.25	-1.20	-1.52	-2.52	-1.05	-1.19	-1.15
6	400.0	-0.68	-0.25	-1.20	-1.51	-2.47	-1.09	-1.20	-1.15
7	500.0	-0.78	-0.26	-1.20	-1.49	-2.44	-1.12	-1.20	-1.15
8	600.0	-0.85	-0.26	-1.20	-1.48	-2.41	-1.14	-1.21	-1.15
9	700.0	-0.90	-0.26	-1.20	-1.48	-2.40	-1.15	-1.21	-1.15
10	800.0	-0.93	-0.27	-1.20	-1.47	-2.39	-1.16	-1.21	-1.15
11	900.0	-0.96	-0.27	-1.20	-1.46	-2.38	-1.16	-1.22	-1.15
12	1000.0	-0.98	-0.27	-1.20	-1.45	-2.37	-1.17	-1.22	-1.15
13	1100.0	-1.00	-0.27	-1.20	-1.44	-2.36	-1.17	-1.22	-1.15
14	1200.0	-1.01	-0.27	-1.20	-1.43	-2.36	-1.17	-1.22	-1.15
15	1300.0	-1.02	-0.27	-1.19	-1.42	-2.35	-1.17	-1.22	-1.14

Table 2.22. Relative difference between MPACT and Shift concentrations for miscellaneous fission product isotopes

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{88}Sr [%]	^{90}Sr [%]	^{138}Ba [%]	^{99}Tc [%]	^{87}Rb [%]
0	0.0	-	-	-	-	-
1	25.0	-0.17	-1.28	-0.95	-1.17	-0.88
2	50.0	-0.70	-1.28	-1.07	-1.17	-1.09
3	100.0	-0.96	-1.27	-1.13	-1.16	-1.20
4	200.0	-1.09	-1.27	-1.15	-1.15	-1.24
5	300.0	-1.13	-1.27	-1.16	-1.14	-1.26
6	400.0	-1.16	-1.27	-1.17	-1.14	-1.27
7	500.0	-1.17	-1.27	-1.18	-1.14	-1.28
8	600.0	-1.18	-1.27	-1.18	-1.14	-1.28
9	700.0	-1.18	-1.27	-1.18	-1.14	-1.28
10	800.0	-1.19	-1.26	-1.18	-1.14	-1.28
11	900.0	-1.19	-1.26	-1.18	-1.14	-1.28
12	1000.0	-1.19	-1.26	-1.18	-1.14	-1.28
13	1100.0	-1.19	-1.26	-1.18	-1.14	-1.28
14	1200.0	-1.19	-1.26	-1.18	-1.14	-1.28
15	1300.0	-1.19	-1.25	-1.18	-1.14	-1.27

3. PROBLEM 2: CHARGE-PAN 2D

In the parlance of Magnox reactors, a charge-pan is roughly equivalent to a fuel assembly or bundle. The primary difference is that Magnox fuel elements in adjacent channels are not physically bound to each other like those in a fuel assembly. Despite this difference, Problem 2 is essentially a lattice physics problem. Geometric dimensions are listed in Table 1.2. All external boundaries are fully reflected in this problem. Problem 2 is more complex than Problem 1 because it adds multiple fuel channels and the central control rod X-hole.

3.1 BEGINNING-OF-CYCLE

3.1.1 Problem 2.1.1

3.1.1.1 Description

This problem uses coolant channel radius C, which has the smallest radius. The geometry is shown in Figure 3. The layout of pins within the charge pan is shown in Figure 4. The x-axis (horizontal) and y-axis (vertical) projections of channels A,B,C, and D do not overlap with axis projections of the central X-hole. Owing to the ⅛ symmetry, fuel channels A, B, C and D will have the same power. Also because of symmetry, fuel channels E, F, G, H, J, K, L, and M will have the same power, and fuel channels P, Q, R, and S will have the same power. Material densities are listed in Table 1.4. Temperatures are listed in Table 2.4.

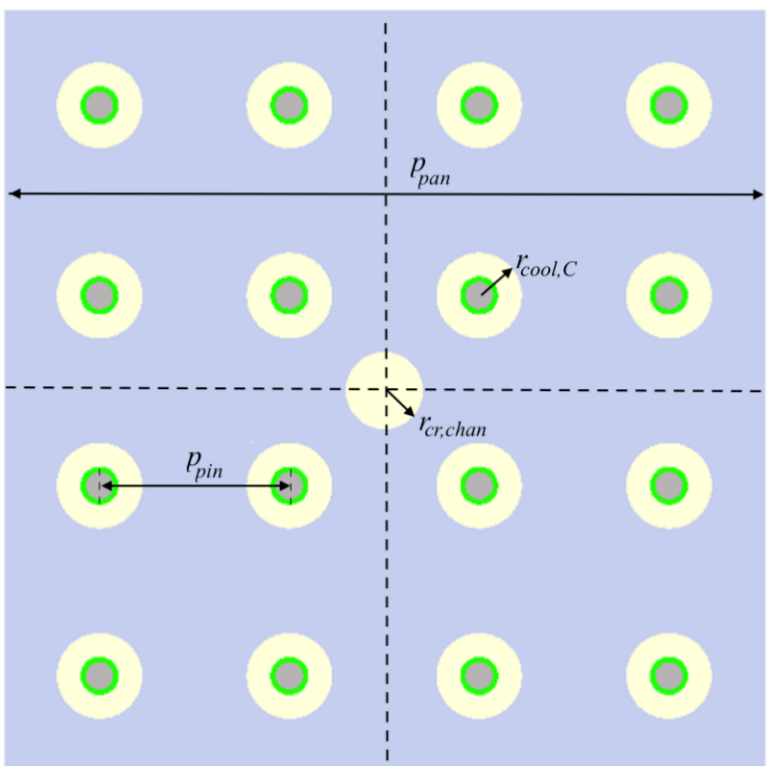


Figure 3. Magnox 2D charge-pan with Zone C coolant channel.

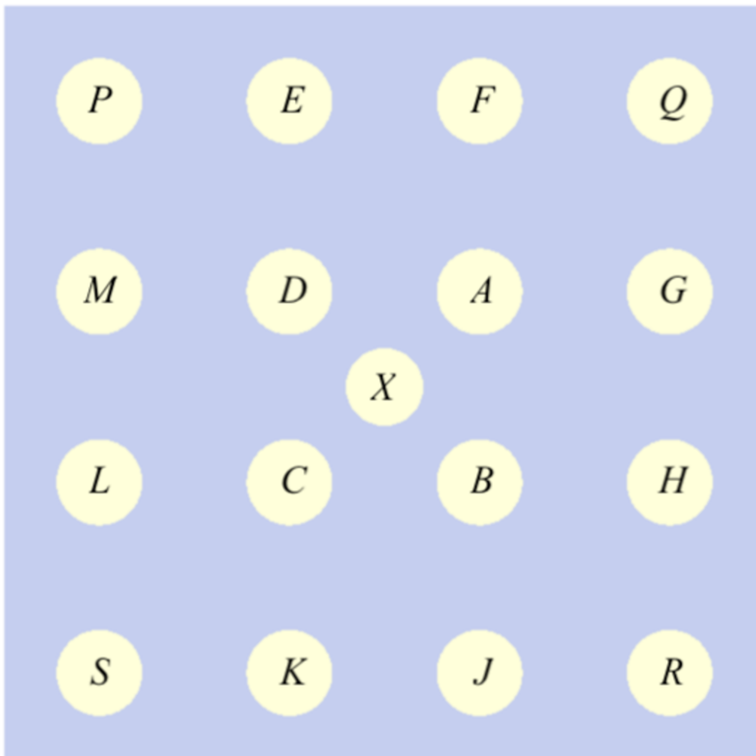


Figure 4. Holes within a charge-pan.

3.1.1.2 Reference Solution

Table 3.1. Neutron multiplication for the reference solution of Problem 2.1.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift k_{eff} (1σ)	MPACT k_{eff} (1σ)	Difference [pcm]
0	0.0	1.06949(10)	1.06976	28(10)

Table 3.2. Power peaking factors for the reference solution of Problem 2.1.1.

Channels	Shift Peaking Factor	MPACT Peaking Factor	Difference (MPACT-Shift)
A,B,C,D	0.992	0.992	0.000
E,F,G,H,J,K,L,M	1.002	1.002	0.000
P,Q,R,S	1.004	1.004	0.000

3.1.2 Problem 2.1.2

3.1.2.1 Description

Problem 2.1.2 uses the same geometry as Problem 2.1.1, except it uses coolant channel radius A shown in Figure 5. In this geometry, the x-axis (horizontal) and y-axis (vertical) projections of channels A, B, C, and D overlap with axis projections of the central X-hole. Material densities are listed in Table 1.4. Temperatures are listed in Table 2.4.

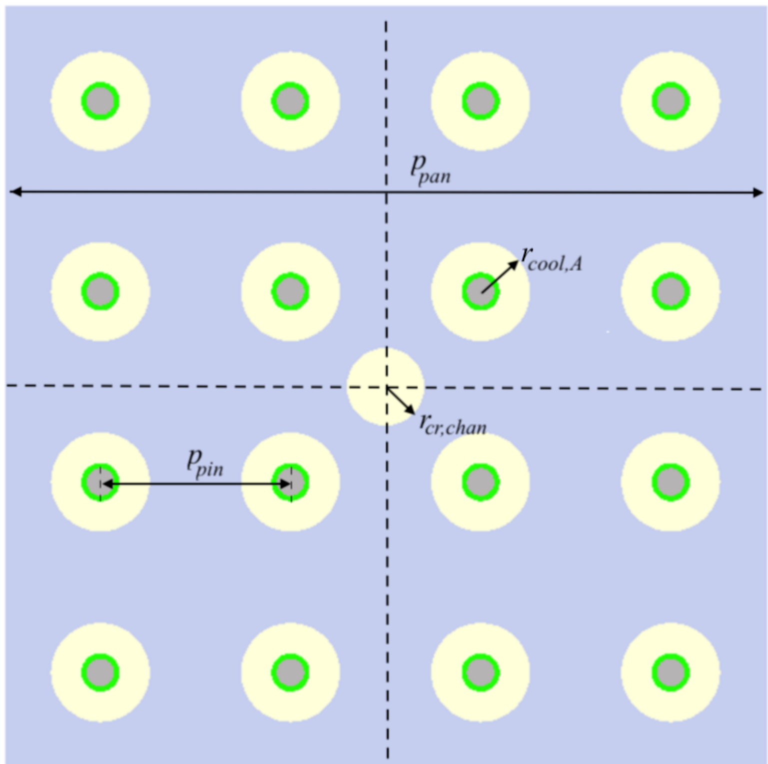


Figure 5. Magnox 2D charge-pan with Zone A coolant channel.

3.1.2.2 Reference Solution

Table 3.3. Neutron multiplication for the reference solution of Problem 2.1.2.

Step	Burnup	Shift		MPACT	Difference
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	k_{eff}	(1σ)	k_{eff} (1σ)	[pcm]
0	0.0	1.06460(10)		1.06518	58(10)

Table 3.4. Power peaking factors for the reference solution of Problem 2.1.2

Channels	Shift Peaking Factor	MPACT Peaking Factor	Difference (MPACT-Shift)
A, B, C, D	0.992	0.992	0.000
E, F, G, H, J, K, L, M	1.002	1.002	0.0000
P, Q, R, S	1.004	1.004	-0.001

3.1.3 Problem 2.1.3

3.1.3.1 Description

Problem 2.1.3 uses the same geometry as Problem 2.1.2, except it has a control rod inserted in the central coolant channel. The control rod has an outer stainless steel sheath and an internal stainless steel portion doped with 3 wt% boron. Similar to the geometry of Problems 2.1.1 and 2.1.2, the pins will still be symmetric within the charge pan. However, channels A, B, C, and D will have greatly suppressed power due to being nearest to the control rod. The goal of this problem is to introduce a burnable absorber material in comparing Shift and MPACT. Material densities are listed in Table 1.4. Temperatures are listed in Table 2.4.

3.1.3.2 Reference Solution

Table 3.5. Neutron multiplication for the reference solution of Problem 2.1.3.

Step	Burnup	Shift		MPACT	Difference
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	k_{eff}	(1σ)	k_{eff} (1σ)	[pcm]
0	0.0	0.94269(10)		0.94290	20(10)

Table 3.6. Power peaking factors for the reference solution of Problem 2.1.3.

Channels	Shift Peaking Factor	MPACT Peaking Factor	Difference (MPACT-Shift)
A, B, C, D	0.8812	0.8804	-0.0008
E, F, G, H, J, K, L, M	1.0282	1.0284	0.0002
P, Q, R, S	1.0624	1.0628	0.0004

3.2 DEPLETION

3.2.1 Problem 2.2.1

3.2.1.1 Description

This problem uses exactly the same geometry as Problem 2.1.2, using coolant channel radius A, shown in Figure 5. Material densities are listed in Table 1.4. Temperatures are listed in Table 2.4. Burnup states used for comparison are listed in Table 1.5, and the total system specific power is listed in Table 1.6.

3.2.1.2 Reference Solution

Table 3.7. Neutron multiplication factor for the reference solution of Problem 2.2.1.

Step	Burnup	Shift	MPACT	Difference
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	k_{eff} (1σ)	k_{eff} (1σ)	[pcm]
0	0.0	1.06462(10)	1.06496(0)	33(10)
1	25.0	1.04963(10)	1.04999(0)	36(10)
2	50.0	1.04954(10)	1.04978(0)	24(10)
3	100.0	1.05037(10)	1.05099(0)	63(10)
4	200.0	1.05396(10)	1.05484(0)	88(10)
5	300.0	1.05755(11)	1.05838(0)	83(11)
6	400.0	1.06013(10)	1.06129(0)	116(10)
7	500.0	1.06262(11)	1.06362(0)	100(11)
8	600.0	1.06417(11)	1.06547(0)	130(11)
9	700.0	1.06564(11)	1.06691(0)	127(11)
10	800.0	1.06675(11)	1.06802(0)	126(11)
11	900.0	1.06740(11)	1.06883(0)	142(11)
12	1000.0	1.06779(11)	1.06939(0)	161(11)
13	1100.0	1.06832(10)	1.06974(0)	142(10)
14	1200.0	1.06834(11)	1.06991(0)	157(11)

Fuel Pins A–D

Table 3.8. Power peaking factors for fuel channels A–D of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift Peaking Factor	MPACT Peaking Factor	Difference [MPACT-Shift]
1	0.0	0.9930	0.9921	-0.0009
2	25.0	0.9926	0.9921	-0.0005
3	50.0	0.9928	0.9921	-0.0007
4	100.0	0.9927	0.9920	-0.0006
5	200.0	0.9930	0.9920	-0.0010
6	300.0	0.9925	0.9919	-0.0006
7	400.0	0.9923	0.9919	-0.0004
8	500.0	0.9927	0.9919	-0.0008
9	600.0	0.9924	0.9919	-0.0005
10	700.0	0.9922	0.9919	-0.0003
11	800.0	0.9924	0.9919	-0.0005
12	900.0	0.9929	0.9919	-0.0010
13	1000.0	0.9923	0.9919	-0.0004
14	1100.0	0.9926	0.9919	-0.0006
15	1200.0	0.9924	0.9919	-0.0004
16	1300.0	0.9927	0.9919	-0.0008

Table 3.9. Uranium isotope concentrations for fuel channels A–D of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{234}U $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{235}U $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{236}U $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{238}U $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	2.5775×10^{-06}	3.4449×10^{-04}	$0.0000 \times 10^{+00}$	4.7470×10^{-02}
1	25.0	2.5750×10^{-06}	3.4309×10^{-04}	2.2440×10^{-07}	4.7469×10^{-02}
2	50.0	2.5724×10^{-06}	3.4171×10^{-04}	4.4675×10^{-07}	4.7467×10^{-02}
3	100.0	2.5675×10^{-06}	3.3897×10^{-04}	8.8514×10^{-07}	4.7465×10^{-02}
4	200.0	2.5577×10^{-06}	3.3364×10^{-04}	1.7385×10^{-06}	4.7459×10^{-02}
5	300.0	2.5481×10^{-06}	3.2849×10^{-04}	2.5633×10^{-06}	4.7454×10^{-02}
6	400.0	2.5387×10^{-06}	3.2349×10^{-04}	3.3627×10^{-06}	4.7449×10^{-02}
7	500.0	2.5294×10^{-06}	3.1864×10^{-04}	4.1384×10^{-06}	4.7444×10^{-02}
8	600.0	2.5203×10^{-06}	3.1391×10^{-04}	4.8921×10^{-06}	4.7439×10^{-02}
9	700.0	2.5114×10^{-06}	3.0931×10^{-04}	5.6259×10^{-06}	4.7434×10^{-02}
10	800.0	2.5025×10^{-06}	3.0482×10^{-04}	6.3410×10^{-06}	4.7429×10^{-02}
11	900.0	2.4938×10^{-06}	3.0044×10^{-04}	7.0385×10^{-06}	4.7425×10^{-02}
12	1000.0	2.4852×10^{-06}	2.9615×10^{-04}	7.7198×10^{-06}	4.7420×10^{-02}
13	1100.0	2.4766×10^{-06}	2.9196×10^{-04}	8.3858×10^{-06}	4.7415×10^{-02}
14	1200.0	2.4682×10^{-06}	2.8786×10^{-04}	9.0368×10^{-06}	4.7410×10^{-02}
15	1300.0	2.4598×10^{-06}	2.8383×10^{-04}	9.6742×10^{-06}	4.7406×10^{-02}

Table 3.10. Plutonium isotope concentrations for fuel channels A through D of the reference solution of Problem 2.2.1

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{238}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{239}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{240}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{241}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{242}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	7.5702×10^{-13}	9.9886×10^{-07}	2.2382×10^{-09}	5.8112×10^{-12}	4.4670×10^{-15}
2	50.0	5.6451×10^{-12}	2.2372×10^{-06}	1.0355×10^{-08}	5.5697×10^{-11}	8.8064×10^{-14}
3	100.0	3.2822×10^{-11}	4.6487×10^{-06}	4.3994×10^{-08}	4.8390×10^{-10}	1.5679×10^{-12}
4	200.0	1.5930×10^{-10}	9.2130×10^{-06}	1.7512×10^{-07}	3.8596×10^{-09}	2.5379×10^{-11}
5	300.0	3.8140×10^{-10}	1.3465×10^{-05}	3.8172×10^{-07}	1.2502×10^{-08}	1.2389×10^{-10}
6	400.0	6.9884×10^{-10}	1.7439×10^{-05}	6.5398×10^{-07}	2.8224×10^{-08}	3.7374×10^{-10}
7	500.0	1.1119×10^{-09}	2.1160×10^{-05}	9.8346×10^{-07}	5.2391×10^{-08}	8.6840×10^{-10}
8	600.0	1.6218×10^{-09}	2.4651×10^{-05}	1.3628×10^{-06}	8.6011×10^{-08}	1.7127×10^{-09}
9	700.0	2.2309×10^{-09}	2.7932×10^{-05}	1.7861×10^{-06}	1.2986×10^{-07}	3.0202×10^{-09}
10	800.0	2.9429×10^{-09}	3.1021×10^{-05}	2.2478×10^{-06}	1.8445×10^{-07}	4.9092×10^{-09}
11	900.0	3.7625×10^{-09}	3.3934×10^{-05}	2.7431×10^{-06}	2.5016×10^{-07}	7.5010×10^{-09}
12	1000.0	4.6962×10^{-09}	3.6684×10^{-05}	3.2682×10^{-06}	3.2723×10^{-07}	1.0920×10^{-08}
13	1100.0	5.7516×10^{-09}	3.9284×10^{-05}	3.8193×10^{-06}	4.1575×10^{-07}	1.5289×10^{-08}
14	1200.0	6.9372×10^{-09}	4.1742×10^{-05}	4.3927×10^{-06}	5.1567×10^{-07}	2.0728×10^{-08}
15	1300.0	8.2641×10^{-09}	4.4070×10^{-05}	4.9859×10^{-06}	6.2700×10^{-07}	2.7363×10^{-08}

Table 3.11. Americium isotope concentrations for fuel channels A–D of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{241}Am $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{243}Am $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	2.8778×10^{-15}	7.3895×10^{-19}
2	50.0	5.6876×10^{-14}	3.1225×10^{-17}
3	100.0	1.0177×10^{-12}	1.1626×10^{-15}
4	200.0	1.6614×10^{-11}	3.8584×10^{-14}
5	300.0	8.1672×10^{-11}	2.8475×10^{-13}
6	400.0	2.4776×10^{-10}	1.1493×10^{-12}
7	500.0	5.7839×10^{-10}	3.3440×10^{-12}
8	600.0	1.1453×10^{-09}	7.9214×10^{-12}
9	700.0	2.0258×10^{-09}	1.6307×10^{-11}
10	800.0	3.3005×10^{-09}	3.0306×10^{-11}
11	900.0	5.0516×10^{-09}	5.2115×10^{-11}
12	1000.0	7.3615×10^{-09}	8.4333×10^{-11}
13	1100.0	1.0312×10^{-08}	1.2994×10^{-10}
14	1200.0	1.3983×10^{-08}	1.9227×10^{-10}
15	1300.0	1.8452×10^{-08}	2.7510×10^{-10}

Table 3.12. Curium isotope concentrations for fuel channels A–D of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{243}Cm $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{244}Cm $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
2	50.0	$0.0000 \times 10^{+00}$	2.0426×10^{-20}
3	100.0	5.7970×10^{-19}	1.5593×10^{-18}
4	200.0	3.8570×10^{-17}	1.0474×10^{-16}
5	300.0	4.1548×10^{-16}	1.1602×10^{-15}
6	400.0	2.1600×10^{-15}	6.2305×10^{-15}
7	500.0	7.5686×10^{-15}	2.2588×10^{-14}
8	600.0	2.0709×10^{-14}	6.3982×10^{-14}
9	700.0	4.7868×10^{-14}	1.5312×10^{-13}
10	800.0	9.7866×10^{-14}	3.2412×10^{-13}
11	900.0	1.8230×10^{-13}	6.2497×10^{-13}
12	1000.0	3.1577×10^{-13}	1.1203×10^{-12}
13	1100.0	5.1582×10^{-13}	1.8933×10^{-12}
14	1200.0	8.0293×10^{-13}	3.0480×10^{-12}
15	1300.0	1.2008×10^{-12}	4.7128×10^{-12}

Table 3.13. Cesium isotope concentrations for fuel channels A–D of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{133}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{135}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{137}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	4.3758×10^{-08}	4.7992×10^{-08}	7.7813×10^{-08}
2	50.0	1.2326×10^{-07}	9.8338×10^{-08}	1.5559×10^{-07}
3	100.0	2.9133×10^{-07}	1.9948×10^{-07}	3.1094×10^{-07}
4	200.0	6.2839×10^{-07}	4.0344×10^{-07}	6.2087×10^{-07}
5	300.0	9.6515×10^{-07}	6.0949×10^{-07}	9.2986×10^{-07}
6	400.0	1.3017×10^{-06}	8.1746×10^{-07}	1.2380×10^{-06}
7	500.0	1.6379×10^{-06}	1.0271×10^{-06}	1.5451×10^{-06}
8	600.0	1.9738×10^{-06}	1.2383×10^{-06}	1.8511×10^{-06}
9	700.0	2.3093×10^{-06}	1.4508×10^{-06}	2.1562×10^{-06}
10	800.0	2.6445×10^{-06}	1.6646×10^{-06}	2.4602×10^{-06}
11	900.0	2.9794×10^{-06}	1.8796×10^{-06}	2.7630×10^{-06}
12	1000.0	3.3139×10^{-06}	2.0956×10^{-06}	3.0649×10^{-06}
13	1100.0	3.6482×10^{-06}	2.3126×10^{-06}	3.3658×10^{-06}
14	1200.0	3.9819×10^{-06}	2.5305×10^{-06}	3.6653×10^{-06}
15	1300.0	4.3153×10^{-06}	2.7491×10^{-06}	3.9639×10^{-06}

Table 3.14. Neodymium isotope concentrations for fuel channels A–D of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{143}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{144}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{145}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{146}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{148}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	1.9157×10^{-08}	1.3685×10^{-09}	4.8296×10^{-08}	3.7979×10^{-08}	2.1454×10^{-08}
2	50.0	6.8828×10^{-08}	5.4467×10^{-09}	9.7560×10^{-08}	7.5998×10^{-08}	4.2933×10^{-08}
3	100.0	2.0081×10^{-07}	2.1393×10^{-08}	1.9567×10^{-07}	1.5187×10^{-07}	8.5874×10^{-08}
4	200.0	4.8786×10^{-07}	8.1755×10^{-08}	3.9034×10^{-07}	3.0303×10^{-07}	1.7162×10^{-07}
5	300.0	7.7343×10^{-07}	1.7527×10^{-07}	5.8318×10^{-07}	4.5353×10^{-07}	2.5720×10^{-07}
6	400.0	1.0548×10^{-06}	2.9691×10^{-07}	7.7441×10^{-07}	6.0351×10^{-07}	3.4268×10^{-07}
7	500.0	1.3320×10^{-06}	4.4241×10^{-07}	9.6409×10^{-07}	7.5298×10^{-07}	4.2802×10^{-07}
8	600.0	1.6054×10^{-06}	6.0816×10^{-07}	1.1523×10^{-06}	9.0194×10^{-07}	5.1321×10^{-07}
9	700.0	1.8751×10^{-06}	7.9111×10^{-07}	1.3392×10^{-06}	1.0505×10^{-06}	5.9830×10^{-07}
10	800.0	2.1413×10^{-06}	9.8866×10^{-07}	1.5248×10^{-06}	1.1988×10^{-06}	6.8330×10^{-07}
11	900.0	2.4041×10^{-06}	1.1986×10^{-06}	1.7093×10^{-06}	1.3467×10^{-06}	7.6819×10^{-07}
12	1000.0	2.6639×10^{-06}	1.4192×10^{-06}	1.8927×10^{-06}	1.4943×10^{-06}	8.5301×10^{-07}
13	1100.0	2.9206×10^{-06}	1.6488×10^{-06}	2.0750×10^{-06}	1.6417×10^{-06}	9.3775×10^{-07}
14	1200.0	3.1742×10^{-06}	1.8860×10^{-06}	2.2562×10^{-06}	1.7888×10^{-06}	1.0224×10^{-06}
15	1300.0	3.4250×10^{-06}	2.1299×10^{-06}	2.4366×10^{-06}	1.9356×10^{-06}	1.1069×10^{-06}

Table 3.15. Strontium isotope concentrations for fuel channels A–D of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{84}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{86}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{87}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{88}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{90}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	2.8266×10^{-19}	3.1548×10^{-14}	1.6788×10^{-14}	4.3235×10^{-08}	7.0656×10^{-08}
2	50.0	1.1157×10^{-18}	1.5006×10^{-13}	3.6682×10^{-14}	8.6731×10^{-08}	1.4085×10^{-07}
3	100.0	4.3497×10^{-18}	7.2961×10^{-13}	8.5744×10^{-14}	1.7297×10^{-07}	2.7979×10^{-07}
4	200.0	1.6663×10^{-17}	3.4180×10^{-12}	2.1865×10^{-13}	3.4266×10^{-07}	5.5221×10^{-07}
5	300.0	3.6202×10^{-17}	8.1433×10^{-12}	3.9405×10^{-13}	5.0899×10^{-07}	8.1798×10^{-07}
6	400.0	6.2461×10^{-17}	1.4819×10^{-11}	6.0803×10^{-13}	6.7233×10^{-07}	1.0777×10^{-06}
7	500.0	9.5027×10^{-17}	2.3357×10^{-11}	8.5711×10^{-13}	8.3290×10^{-07}	1.3318×10^{-06}
8	600.0	1.3354×10^{-16}	3.3679×10^{-11}	1.1383×10^{-12}	9.9085×10^{-07}	1.5805×10^{-06}
9	700.0	1.7772×10^{-16}	4.5723×10^{-11}	1.4491×10^{-12}	1.1465×10^{-06}	1.8244×10^{-06}
10	800.0	2.2733×10^{-16}	5.9435×10^{-11}	1.7874×10^{-12}	1.2999×10^{-06}	2.0636×10^{-06}
11	900.0	2.8216×10^{-16}	7.4767×10^{-11}	2.1511×10^{-12}	1.4512×10^{-06}	2.2984×10^{-06}
12	1000.0	3.4206×10^{-16}	9.1679×10^{-11}	2.5387×10^{-12}	1.6007×10^{-06}	2.5291×10^{-06}
13	1100.0	4.0686×10^{-16}	1.1014×10^{-10}	2.9485×10^{-12}	1.7483×10^{-06}	2.7558×10^{-06}
14	1200.0	4.7639×10^{-16}	1.3010×10^{-10}	3.3790×10^{-12}	1.8942×10^{-06}	2.9787×10^{-06}
15	1300.0	5.5054×10^{-16}	1.5155×10^{-10}	3.8292×10^{-12}	2.0385×10^{-06}	3.1980×10^{-06}

Table 3.16. Barium isotope concentrations for fuel channels A–D of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{132}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{134}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{135}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{136}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{138}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	$0.0000 \times 10^{+00}$	2.3356×10^{-14}	1.6999×10^{-15}	3.5277×10^{-11}	8.4156×10^{-08}
2	50.0	$0.0000 \times 10^{+00}$	3.1273×10^{-13}	5.3931×10^{-15}	9.8943×10^{-11}	1.6847×10^{-07}
3	100.0	$0.0000 \times 10^{+00}$	3.4516×10^{-12}	1.8739×10^{-14}	2.8360×10^{-10}	3.3679×10^{-07}
4	200.0	$0.0000 \times 10^{+00}$	3.2480×10^{-11}	6.9167×10^{-14}	8.2899×10^{-10}	6.7238×10^{-07}
5	300.0	$0.0000 \times 10^{+00}$	1.1414×10^{-10}	1.5244×10^{-13}	1.5820×10^{-09}	1.0068×10^{-06}
6	400.0	$0.0000 \times 10^{+00}$	2.7297×10^{-10}	2.7190×10^{-13}	2.5269×10^{-09}	1.3402×10^{-06}
7	500.0	$0.0000 \times 10^{+00}$	5.3128×10^{-10}	4.3267×10^{-13}	3.6513×10^{-09}	1.6727×10^{-06}
8	600.0	$0.0000 \times 10^{+00}$	9.0934×10^{-10}	6.4143×10^{-13}	4.9442×10^{-09}	2.0041×10^{-06}
9	700.0	$0.0000 \times 10^{+00}$	1.4257×10^{-09}	9.0637×10^{-13}	6.3967×10^{-09}	2.3347×10^{-06}
10	800.0	$0.0000 \times 10^{+00}$	2.0972×10^{-09}	1.2368×10^{-12}	8.0011×10^{-09}	2.6646×10^{-06}
11	900.0	$0.0000 \times 10^{+00}$	2.9395×10^{-09}	1.6430×10^{-12}	9.7502×10^{-09}	2.9937×10^{-06}
12	1000.0	$0.0000 \times 10^{+00}$	3.9668×10^{-09}	2.1366×10^{-12}	1.1638×10^{-08}	3.3222×10^{-06}
13	1100.0	$0.0000 \times 10^{+00}$	5.1923×10^{-09}	2.7298×10^{-12}	1.3660×10^{-08}	3.6501×10^{-06}
14	1200.0	$0.0000 \times 10^{+00}$	6.6282×10^{-09}	3.4354×10^{-12}	1.5810×10^{-08}	3.9772×10^{-06}
15	1300.0	$0.0000 \times 10^{+00}$	8.2854×10^{-09}	4.2674×10^{-12}	1.8084×10^{-08}	4.3037×10^{-06}

Table 3.17. Technetium isotope concentrations for fuel channels A–D of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{99}Tc $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$
1	25.0	5.7134×10^{-08}
2	50.0	1.3377×10^{-07}
3	100.0	2.8757×10^{-07}
4	200.0	5.9473×10^{-07}
5	300.0	9.0142×10^{-07}
6	400.0	1.2078×10^{-06}
7	500.0	1.5137×10^{-06}
8	600.0	1.8191×10^{-06}
9	700.0	2.1242×10^{-06}
10	800.0	2.4289×10^{-06}
11	900.0	2.7332×10^{-06}
12	1000.0	3.0371×10^{-06}
13	1100.0	3.3407×10^{-06}
14	1200.0	3.6437×10^{-06}
15	1300.0	3.9464×10^{-06}

Table 3.18. Rubidium isotope concentrations for fuel channels A–D of the reference solution of Problem 2.2.1

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{85}Rb $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{87}Rb $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	1.2427×10^{-08}	3.1341×10^{-08}
2	50.0	2.5010×10^{-08}	6.2662×10^{-08}
3	100.0	5.0007×10^{-08}	1.2478×10^{-07}
4	200.0	9.9382×10^{-08}	2.4707×10^{-07}
5	300.0	1.4802×10^{-07}	3.6702×10^{-07}
6	400.0	1.9602×10^{-07}	4.8489×10^{-07}
7	500.0	2.4343×10^{-07}	6.0082×10^{-07}
8	600.0	2.9029×10^{-07}	7.1493×10^{-07}
9	700.0	3.3667×10^{-07}	8.2741×10^{-07}
10	800.0	3.8259×10^{-07}	9.3836×10^{-07}
11	900.0	4.2811×10^{-07}	1.0479×10^{-06}
12	1000.0	4.7324×10^{-07}	1.1561×10^{-06}
13	1100.0	5.1803×10^{-07}	1.2630×10^{-06}
14	1200.0	5.6246×10^{-07}	1.3687×10^{-06}
15	1300.0	6.0658×10^{-07}	1.4733×10^{-06}

Fuel Pins E–M

Table 3.19. Power peaking factors for fuel channels E–M of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift Peaking Factor	MPACT Peaking Factor	Difference [MPACT-Shift]
1	0.0	1.0027	1.0020	-0.0007
2	25.0	1.0027	1.0020	-0.0007
3	50.0	1.0027	1.0020	-0.0007
4	100.0	1.0028	1.0021	-0.0007
5	200.0	1.0026	1.0021	-0.0005
6	300.0	1.0028	1.0021	-0.0008
7	400.0	1.0028	1.0021	-0.0008
8	500.0	1.0030	1.0021	-0.0009
9	600.0	1.0026	1.0021	-0.0005
10	700.0	1.0030	1.0021	-0.0009
11	800.0	1.0028	1.0021	-0.0006
12	900.0	1.0028	1.0021	-0.0007
13	1000.0	1.0028	1.0021	-0.0007
14	1100.0	1.0025	1.0021	-0.0004
15	1200.0	1.0028	1.0021	-0.0007
16	1300.0	1.0030	1.0021	-0.0009

Table 3.20. Uranium isotope concentrations for fuel channels E–M of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{234}U $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{235}U $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{236}U $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{238}U $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	2.5775×10^{-06}	3.4449×10^{-04}	$0.0000 \times 10^{+00}$	4.7470×10^{-02}
1	25.0	2.5749×10^{-06}	3.4308×10^{-04}	2.2666×10^{-07}	4.7469×10^{-02}
2	50.0	2.5724×10^{-06}	3.4167×10^{-04}	4.5123×10^{-07}	4.7467×10^{-02}
3	100.0	2.5674×10^{-06}	3.3891×10^{-04}	8.9408×10^{-07}	4.7465×10^{-02}
4	200.0	2.5575×10^{-06}	3.3352×10^{-04}	1.7562×10^{-06}	4.7459×10^{-02}
5	300.0	2.5479×10^{-06}	3.2831×10^{-04}	2.5892×10^{-06}	4.7454×10^{-02}
6	400.0	2.5384×10^{-06}	3.2326×10^{-04}	3.3963×10^{-06}	4.7449×10^{-02}
7	500.0	2.5291×10^{-06}	3.1835×10^{-04}	4.1791×10^{-06}	4.7444×10^{-02}
8	600.0	2.5199×10^{-06}	3.1358×10^{-04}	4.9400×10^{-06}	4.7439×10^{-02}
9	700.0	2.5109×10^{-06}	3.0893×10^{-04}	5.6804×10^{-06}	4.7434×10^{-02}
10	800.0	2.5020×10^{-06}	3.0440×10^{-04}	6.4016×10^{-06}	4.7429×10^{-02}
11	900.0	2.4932×10^{-06}	2.9997×10^{-04}	7.1052×10^{-06}	4.7424×10^{-02}
12	1000.0	2.4845×10^{-06}	2.9564×10^{-04}	7.7921×10^{-06}	4.7420×10^{-02}
13	1100.0	2.4760×10^{-06}	2.9141×10^{-04}	8.4633×10^{-06}	4.7415×10^{-02}
14	1200.0	2.4675×10^{-06}	2.8727×10^{-04}	9.1198×10^{-06}	4.7410×10^{-02}
15	1300.0	2.4590×10^{-06}	2.8321×10^{-04}	9.7622×10^{-06}	4.7405×10^{-02}

Table 3.21. Plutonium isotope concentrations for fuel channels E–M of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{238}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{239}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{240}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{241}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{242}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	7.6665×10^{-13}	1.0040×10^{-06}	2.2708×10^{-09}	5.9041×10^{-12}	4.5877×10^{-15}
2	50.0	5.7168×10^{-12}	2.2485×10^{-06}	1.0506×10^{-08}	5.6589×10^{-11}	9.0450×10^{-14}
3	100.0	3.3248×10^{-11}	4.6721×10^{-06}	4.4645×10^{-08}	4.9180×10^{-10}	1.6112×10^{-12}
4	200.0	1.6144×10^{-10}	9.2585×10^{-06}	1.7774×10^{-07}	3.9236×10^{-09}	2.6092×10^{-11}
5	300.0	3.8657×10^{-10}	1.3529×10^{-05}	3.8737×10^{-07}	1.2707×10^{-08}	1.2735×10^{-10}
6	400.0	7.0835×10^{-10}	1.7516×10^{-05}	6.6353×10^{-07}	2.8676×10^{-08}	3.8407×10^{-10}
7	500.0	1.1270×10^{-09}	2.1248×10^{-05}	9.9752×10^{-07}	5.3207×10^{-08}	8.9201×10^{-10}
8	600.0	1.6440×10^{-09}	2.4747×10^{-05}	1.3821×10^{-06}	8.7337×10^{-08}	1.7591×10^{-09}
9	700.0	2.2617×10^{-09}	2.8035×10^{-05}	1.8110×10^{-06}	1.3181×10^{-07}	3.1011×10^{-09}
10	800.0	2.9835×10^{-09}	3.1128×10^{-05}	2.2786×10^{-06}	1.8716×10^{-07}	5.0388×10^{-09}
11	900.0	3.8147×10^{-09}	3.4043×10^{-05}	2.7803×10^{-06}	2.5377×10^{-07}	7.6973×10^{-09}
12	1000.0	4.7615×10^{-09}	3.6793×10^{-05}	3.3117×10^{-06}	3.3183×10^{-07}	1.1202×10^{-08}
13	1100.0	5.8318×10^{-09}	3.9392×10^{-05}	3.8692×10^{-06}	4.2145×10^{-07}	1.5678×10^{-08}
14	1200.0	7.0350×10^{-09}	4.1849×10^{-05}	4.4495×10^{-06}	5.2266×10^{-07}	2.1254×10^{-08}
15	1300.0	8.3816×10^{-09}	4.4174×10^{-05}	5.0495×10^{-06}	6.3533×10^{-07}	2.8050×10^{-08}

Table 3.22. Americium isotope concentrations for fuel channels E–M of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{241}Am $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{243}Am $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	2.9308×10^{-15}	7.5808×10^{-19}
2	50.0	5.7905×10^{-14}	3.2007×10^{-17}
3	100.0	1.0359×10^{-12}	1.1917×10^{-15}
4	200.0	1.6911×10^{-11}	3.9568×10^{-14}
5	300.0	8.3125×10^{-11}	2.9207×10^{-13}
6	400.0	2.5208×10^{-10}	1.1779×10^{-12}
7	500.0	5.8824×10^{-10}	3.4256×10^{-12}
8	600.0	1.1645×10^{-09}	8.1152×10^{-12}
9	700.0	2.0591×10^{-09}	1.6702×10^{-11}
10	800.0	3.3539×10^{-09}	3.1037×10^{-11}
11	900.0	5.1321×10^{-09}	5.3363×10^{-11}
12	1000.0	7.4770×10^{-09}	8.6326×10^{-11}
13	1100.0	1.0471×10^{-08}	1.3297×10^{-10}
14	1200.0	1.4195×10^{-08}	1.9675×10^{-10}
15	1300.0	1.8727×10^{-08}	2.8148×10^{-10}

Table 3.23. Curium isotope concentrations for fuel channels E–M of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{243}Cm $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{244}Cm $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
2	50.0	$0.0000 \times 10^{+00}$	2.1019×10^{-20}
3	100.0	5.9654×10^{-19}	1.6045×10^{-18}
4	200.0	3.9703×10^{-17}	1.0785×10^{-16}
5	300.0	4.2775×10^{-16}	1.1950×10^{-15}
6	400.0	2.2217×10^{-15}	6.4115×10^{-15}
7	500.0	7.7814×10^{-15}	2.3232×10^{-14}
8	600.0	2.1293×10^{-14}	6.5814×10^{-14}
9	700.0	4.9204×10^{-14}	1.5748×10^{-13}
10	800.0	1.0058×10^{-13}	3.3330×10^{-13}
11	900.0	1.8731×10^{-13}	6.4260×10^{-13}
12	1000.0	3.2432×10^{-13}	1.1515×10^{-12}
13	1100.0	5.2959×10^{-13}	1.9455×10^{-12}
14	1200.0	8.2429×10^{-13}	3.1319×10^{-12}
15	1300.0	1.2326×10^{-12}	4.8422×10^{-12}

Table 3.24. Cesium isotope concentrations for fuel channels E–M of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{133}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{135}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{137}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	4.4188×10^{-08}	4.8254×10^{-08}	7.8578×10^{-08}
2	50.0	1.2446×10^{-07}	9.8859×10^{-08}	1.5709×10^{-07}
3	100.0	2.9413×10^{-07}	2.0053×10^{-07}	3.1393×10^{-07}
4	200.0	6.3448×10^{-07}	4.0560×10^{-07}	6.2691×10^{-07}
5	300.0	9.7456×10^{-07}	6.1279×10^{-07}	9.3896×10^{-07}
6	400.0	1.3142×10^{-06}	8.2183×10^{-07}	1.2499×10^{-06}
7	500.0	1.6535×10^{-06}	1.0326×10^{-06}	1.5599×10^{-06}
8	600.0	1.9926×10^{-06}	1.2449×10^{-06}	1.8688×10^{-06}
9	700.0	2.3312×10^{-06}	1.4585×10^{-06}	2.1767×10^{-06}
10	800.0	2.6695×10^{-06}	1.6735×10^{-06}	2.4835×10^{-06}
11	900.0	3.0074×10^{-06}	1.8895×10^{-06}	2.7892×10^{-06}
12	1000.0	3.3449×10^{-06}	2.1066×10^{-06}	3.0937×10^{-06}
13	1100.0	3.6820×10^{-06}	2.3247×10^{-06}	3.3971×10^{-06}
14	1200.0	4.0187×10^{-06}	2.5436×10^{-06}	3.6995×10^{-06}
15	1300.0	4.3551×10^{-06}	2.7634×10^{-06}	4.0006×10^{-06}

Table 3.25. Neodymium isotope concentrations for fuel channels E–M of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{143}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{144}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{145}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{146}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{148}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000\times10^{+00}$	$0.0000\times10^{+00}$	$0.0000\times10^{+00}$	$0.0000\times10^{+00}$	$0.0000\times10^{+00}$
1	25.0	1.9347×10^{-08}	1.3823×10^{-09}	4.8771×10^{-08}	3.8351×10^{-08}	2.1663×10^{-08}
2	50.0	6.9500×10^{-08}	5.5014×10^{-09}	9.8500×10^{-08}	7.6726×10^{-08}	4.3344×10^{-08}
3	100.0	2.0275×10^{-07}	2.1608×10^{-08}	1.9755×10^{-07}	1.5332×10^{-07}	8.6695×10^{-08}
4	200.0	4.9257×10^{-07}	8.2586×10^{-08}	3.9412×10^{-07}	3.0595×10^{-07}	1.7328×10^{-07}
5	300.0	7.8090×10^{-07}	1.7706×10^{-07}	5.8885×10^{-07}	4.5793×10^{-07}	2.5970×10^{-07}
6	400.0	1.0648×10^{-06}	2.9995×10^{-07}	7.8181×10^{-07}	6.0927×10^{-07}	3.4595×10^{-07}
7	500.0	1.3445×10^{-06}	4.4692×10^{-07}	9.7321×10^{-07}	7.6010×10^{-07}	4.3207×10^{-07}
8	600.0	1.6203×10^{-06}	6.1435×10^{-07}	1.1632×10^{-06}	9.1049×10^{-07}	5.1807×10^{-07}
9	700.0	1.8924×10^{-06}	7.9914×10^{-07}	1.3518×10^{-06}	1.0604×10^{-06}	6.0395×10^{-07}
10	800.0	2.1609×10^{-06}	9.9869×10^{-07}	1.5391×10^{-06}	1.2100×10^{-06}	6.8973×10^{-07}
11	900.0	2.4260×10^{-06}	1.2108×10^{-06}	1.7252×10^{-06}	1.3593×10^{-06}	7.7539×10^{-07}
12	1000.0	2.6878×10^{-06}	1.4336×10^{-06}	1.9101×10^{-06}	1.5082×10^{-06}	8.6096×10^{-07}
13	1100.0	2.9465×10^{-06}	1.6654×10^{-06}	2.0940×10^{-06}	1.6568×10^{-06}	9.4642×10^{-07}
14	1200.0	3.2021×10^{-06}	1.9050×10^{-06}	2.2768×10^{-06}	1.8053×10^{-06}	1.0318×10^{-06}
15	1300.0	3.4549×10^{-06}	2.1513×10^{-06}	2.4587×10^{-06}	1.9534×10^{-06}	1.1171×10^{-06}

Table 3.26. Strontium isotope concentrations for fuel channels E–M of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{84}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{86}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{87}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{88}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{90}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000\times10^{+00}$	$0.0000\times10^{+00}$	$0.0000\times10^{+00}$	$0.0000\times10^{+00}$	$0.0000\times10^{+00}$
1	25.0	2.8586×10^{-19}	3.1871×10^{-14}	1.6984×10^{-14}	4.3721×10^{-08}	7.1450×10^{-08}
2	50.0	1.1307×10^{-18}	1.5153×10^{-13}	3.7120×10^{-14}	8.7702×10^{-08}	1.4243×10^{-07}
3	100.0	4.4240×10^{-18}	7.3659×10^{-13}	8.6820×10^{-14}	1.7492×10^{-07}	2.8295×10^{-07}
4	200.0	1.7029×10^{-17}	3.4507×10^{-12}	2.2157×10^{-13}	3.4656×10^{-07}	5.5850×10^{-07}
5	300.0	3.7087×10^{-17}	8.2208×10^{-12}	3.9943×10^{-13}	5.1476×10^{-07}	8.2726×10^{-07}
6	400.0	6.4074×10^{-17}	1.4958×10^{-11}	6.1639×10^{-13}	6.7990×10^{-07}	1.0899×10^{-06}
7	500.0	9.7575×10^{-17}	2.3572×10^{-11}	8.6886×10^{-13}	8.4217×10^{-07}	1.3466×10^{-06}
8	600.0	1.3724×10^{-16}	3.3987×10^{-11}	1.1539×10^{-12}	1.0018×10^{-06}	1.5981×10^{-06}
9	700.0	1.8281×10^{-16}	4.6136×10^{-11}	1.4690×10^{-12}	1.1591×10^{-06}	1.8445×10^{-06}
10	800.0	2.3399×10^{-16}	5.9964×10^{-11}	1.8117×10^{-12}	1.3141×10^{-06}	2.0861×10^{-06}
11	900.0	2.9058×10^{-16}	7.5424×10^{-11}	2.1802×10^{-12}	1.4670×10^{-06}	2.3233×10^{-06}
12	1000.0	3.5241×10^{-16}	9.2473×10^{-11}	2.5726×10^{-12}	1.6179×10^{-06}	2.5562×10^{-06}
13	1100.0	4.1928×10^{-16}	1.1108×10^{-10}	2.9876×10^{-12}	1.7669×10^{-06}	2.7851×10^{-06}
14	1200.0	4.9108×10^{-16}	1.3120×10^{-10}	3.4236×10^{-12}	1.9143×10^{-06}	3.0102×10^{-06}
15	1300.0	5.6764×10^{-16}	1.5282×10^{-10}	3.8793×10^{-12}	2.0599×10^{-06}	3.2316×10^{-06}

Table 3.27. Barium isotope concentrations for fuel channels E–M of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{132}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{134}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{135}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{136}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{138}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	$0.0000 \times 10^{+00}$	2.3695×10^{-14}	1.7168×10^{-15}	3.5635×10^{-11}	8.4987×10^{-08}
2	50.0	$0.0000 \times 10^{+00}$	3.1722×10^{-13}	5.4476×10^{-15}	9.9952×10^{-11}	1.7010×10^{-07}
3	100.0	$0.0000 \times 10^{+00}$	3.5008×10^{-12}	1.8933×10^{-14}	2.8656×10^{-10}	3.4004×10^{-07}
4	200.0	$0.0000 \times 10^{+00}$	3.2947×10^{-11}	6.9902×10^{-14}	8.3810×10^{-10}	6.7893×10^{-07}
5	300.0	$0.0000 \times 10^{+00}$	1.1579×10^{-10}	1.5409×10^{-13}	1.5998×10^{-09}	1.0166×10^{-06}
6	400.0	$0.0000 \times 10^{+00}$	2.7691×10^{-10}	2.7480×10^{-13}	2.5554×10^{-09}	1.3531×10^{-06}
7	500.0	$0.0000 \times 10^{+00}$	5.3889×10^{-10}	4.3730×10^{-13}	3.6921×10^{-09}	1.6886×10^{-06}
8	600.0	$0.0000 \times 10^{+00}$	9.2229×10^{-10}	6.4840×10^{-13}	4.9996×10^{-09}	2.0232×10^{-06}
9	700.0	$0.0000 \times 10^{+00}$	1.4459×10^{-09}	9.1633×10^{-13}	6.4683×10^{-09}	2.3569×10^{-06}
10	800.0	$0.0000 \times 10^{+00}$	2.1269×10^{-09}	1.2506×10^{-12}	8.0904×10^{-09}	2.6898×10^{-06}
11	900.0	$0.0000 \times 10^{+00}$	2.9811×10^{-09}	1.6616×10^{-12}	9.8586×10^{-09}	3.0220×10^{-06}
12	1000.0	$0.0000 \times 10^{+00}$	4.0228×10^{-09}	2.1611×10^{-12}	1.1767×10^{-08}	3.3533×10^{-06}
13	1100.0	$0.0000 \times 10^{+00}$	5.2654×10^{-09}	2.7614×10^{-12}	1.3810×10^{-08}	3.6840×10^{-06}
14	1200.0	$0.0000 \times 10^{+00}$	6.7211×10^{-09}	3.4758×10^{-12}	1.5982×10^{-08}	4.0141×10^{-06}
15	1300.0	$0.0000 \times 10^{+00}$	8.4013×10^{-09}	4.3184×10^{-12}	1.8280×10^{-08}	4.3435×10^{-06}

Table 3.28. Technetium isotope concentrations for fuel channels E–M of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{99}Tc $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$
1	25.0	5.7696×10^{-08}
2	50.0	1.3507×10^{-07}
3	100.0	2.9033×10^{-07}
4	200.0	6.0050×10^{-07}
5	300.0	9.1022×10^{-07}
6	400.0	1.2194×10^{-06}
7	500.0	1.5281×10^{-06}
8	600.0	1.8365×10^{-06}
9	700.0	2.1444×10^{-06}
10	800.0	2.4518×10^{-06}
11	900.0	2.7589×10^{-06}
12	1000.0	3.0655×10^{-06}
13	1100.0	3.3716×10^{-06}
14	1200.0	3.6774×10^{-06}
15	1300.0	3.9828×10^{-06}

Table 3.29. Rubidium isotope concentrations for fuel channels E–M of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{85}Rb $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{87}Rb $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	1.2551×10^{-08}	3.1652×10^{-08}
2	50.0	2.5254×10^{-08}	6.3272×10^{-08}
3	100.0	5.0493×10^{-08}	1.2599×10^{-07}
4	200.0	1.0035×10^{-07}	2.4948×10^{-07}
5	300.0	1.4947×10^{-07}	3.7060×10^{-07}
6	400.0	1.9791×10^{-07}	4.8953×10^{-07}
7	500.0	2.4574×10^{-07}	6.0651×10^{-07}
8	600.0	2.9304×10^{-07}	7.2168×10^{-07}
9	700.0	3.3984×10^{-07}	8.3518×10^{-07}
10	800.0	3.8618×10^{-07}	9.4713×10^{-07}
11	900.0	4.3210×10^{-07}	1.0576×10^{-06}
12	1000.0	4.7762×10^{-07}	1.1667×10^{-06}
13	1100.0	5.2277×10^{-07}	1.2745×10^{-06}
14	1200.0	5.6759×10^{-07}	1.3811×10^{-06}
15	1300.0	6.1209×10^{-07}	1.4866×10^{-06}

Fuel Pins P–S

Table 3.30. Power peaking factors for fuel channels P–S of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift Peaking Factor	MPACT Peaking Factor	Difference [MPACT-Shift]
1	0.0	1.0044	1.0039	-0.0005
2	25.0	1.0047	1.0039	-0.0008
3	50.0	1.0045	1.0039	-0.0006
4	100.0	1.0046	1.0039	-0.0007
5	200.0	1.0044	1.0039	-0.0006
6	300.0	1.0046	1.0039	-0.0007
7	400.0	1.0048	1.0039	-0.0009
8	500.0	1.0043	1.0039	-0.0004
9	600.0	1.0050	1.0039	-0.0011
10	700.0	1.0048	1.0039	-0.0009
11	800.0	1.0048	1.0039	-0.0009
12	900.0	1.0043	1.0039	-0.0004
13	1000.0	1.0048	1.0039	-0.0009
14	1100.0	1.0049	1.0039	-0.0010
15	1200.0	1.0048	1.0039	-0.0009
16	1300.0	1.0043	1.0039	-0.0005

Table 3.31. Uranium isotope concentrations for fuel channels P–S of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{234}U $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{235}U $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{236}U $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{238}U $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	2.5775×10^{-06}	3.4449×10^{-04}	$0.0000 \times 10^{+00}$	4.7470×10^{-02}
1	25.0	2.5749×10^{-06}	3.4308×10^{-04}	2.2666×10^{-07}	4.7469×10^{-02}
2	50.0	2.5724×10^{-06}	3.4167×10^{-04}	4.5123×10^{-07}	4.7467×10^{-02}
3	100.0	2.5674×10^{-06}	3.3891×10^{-04}	8.9408×10^{-07}	4.7465×10^{-02}
4	200.0	2.5575×10^{-06}	3.3352×10^{-04}	1.7562×10^{-06}	4.7459×10^{-02}
5	300.0	2.5479×10^{-06}	3.2831×10^{-04}	2.5892×10^{-06}	4.7454×10^{-02}
6	400.0	2.5384×10^{-06}	3.2326×10^{-04}	3.3963×10^{-06}	4.7449×10^{-02}
7	500.0	2.5291×10^{-06}	3.1835×10^{-04}	4.1791×10^{-06}	4.7444×10^{-02}
8	600.0	2.5199×10^{-06}	3.1358×10^{-04}	4.9400×10^{-06}	4.7439×10^{-02}
9	700.0	2.5109×10^{-06}	3.0893×10^{-04}	5.6804×10^{-06}	4.7434×10^{-02}
10	800.0	2.5020×10^{-06}	3.0440×10^{-04}	6.4016×10^{-06}	4.7429×10^{-02}
11	900.0	2.4932×10^{-06}	2.9997×10^{-04}	7.1052×10^{-06}	4.7424×10^{-02}
12	1000.0	2.4845×10^{-06}	2.9564×10^{-04}	7.7921×10^{-06}	4.7420×10^{-02}
13	1100.0	2.4760×10^{-06}	2.9141×10^{-04}	8.4633×10^{-06}	4.7415×10^{-02}
14	1200.0	2.4675×10^{-06}	2.8727×10^{-04}	9.1198×10^{-06}	4.7410×10^{-02}
15	1300.0	2.4590×10^{-06}	2.8321×10^{-04}	9.7622×10^{-06}	4.7405×10^{-02}

Table 3.32. Plutonium isotope concentrations for fuel channels P–S of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{238}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{239}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{240}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{241}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{242}Pu $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000\times10^{+00}$	$0.0000\times10^{+00}$	$0.0000\times10^{+00}$	$0.0000\times10^{+00}$	$0.0000\times10^{+00}$
1	25.0	7.6665×10^{-13}	1.0040×10^{-06}	2.2708×10^{-09}	5.9041×10^{-12}	4.5877×10^{-15}
2	50.0	5.7168×10^{-12}	2.2485×10^{-06}	1.0506×10^{-08}	5.6589×10^{-11}	9.0450×10^{-14}
3	100.0	3.3248×10^{-11}	4.6721×10^{-06}	4.4645×10^{-08}	4.9180×10^{-10}	1.6112×10^{-12}
4	200.0	1.6144×10^{-10}	9.2585×10^{-06}	1.7774×10^{-07}	3.9236×10^{-09}	2.6092×10^{-11}
5	300.0	3.8657×10^{-10}	1.3529×10^{-05}	3.8737×10^{-07}	1.2707×10^{-08}	1.2735×10^{-10}
6	400.0	7.0835×10^{-10}	1.7516×10^{-05}	6.6353×10^{-07}	2.8676×10^{-08}	3.8407×10^{-10}
7	500.0	1.1270×10^{-09}	2.1248×10^{-05}	9.9752×10^{-07}	5.3207×10^{-08}	8.9201×10^{-10}
8	600.0	1.6440×10^{-09}	2.4747×10^{-05}	1.3821×10^{-06}	8.7337×10^{-08}	1.7591×10^{-09}
9	700.0	2.2617×10^{-09}	2.8035×10^{-05}	1.8110×10^{-06}	1.3181×10^{-07}	3.1011×10^{-09}
10	800.0	2.9835×10^{-09}	3.1128×10^{-05}	2.2786×10^{-06}	1.8716×10^{-07}	5.0388×10^{-09}
11	900.0	3.8147×10^{-09}	3.4043×10^{-05}	2.7803×10^{-06}	2.5377×10^{-07}	7.6973×10^{-09}
12	1000.0	4.7615×10^{-09}	3.6793×10^{-05}	3.3117×10^{-06}	3.3183×10^{-07}	1.1202×10^{-08}
13	1100.0	5.8318×10^{-09}	3.9392×10^{-05}	3.8692×10^{-06}	4.2145×10^{-07}	1.5678×10^{-08}
14	1200.0	7.0350×10^{-09}	4.1849×10^{-05}	4.4495×10^{-06}	5.2266×10^{-07}	2.1254×10^{-08}
15	1300.0	8.3816×10^{-09}	4.4174×10^{-05}	5.0495×10^{-06}	6.3533×10^{-07}	2.8050×10^{-08}

Table 3.33. Americium isotope concentrations for fuel channels P–S of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{241}Am $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{243}Am $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000\times10^{+00}$	$0.0000\times10^{+00}$
1	25.0	2.9235×10^{-15}	7.6205×10^{-19}
2	50.0	5.7785×10^{-14}	3.2204×10^{-17}
3	100.0	1.0342×10^{-12}	1.1998×10^{-15}
4	200.0	1.6886×10^{-11}	3.9849×10^{-14}
5	300.0	8.3003×10^{-11}	2.9405×10^{-13}
6	400.0	2.5173×10^{-10}	1.1865×10^{-12}
7	500.0	5.8747×10^{-10}	3.4507×10^{-12}
8	600.0	1.1630×10^{-09}	8.1742×10^{-12}
9	700.0	2.0565×10^{-09}	1.6822×10^{-11}
10	800.0	3.3494×10^{-09}	3.1251×10^{-11}
11	900.0	5.1249×10^{-09}	5.3729×10^{-11}
12	1000.0	7.4661×10^{-09}	8.6912×10^{-11}
13	1100.0	1.0455×10^{-08}	1.3387×10^{-10}
14	1200.0	1.4173×10^{-08}	1.9807×10^{-10}
15	1300.0	1.8698×10^{-08}	2.8334×10^{-10}

Table 3.34. Curium isotope concentrations for fuel channels P–S of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{243}Cm $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{244}Cm $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
2	50.0	$0.0000 \times 10^{+00}$	2.1120×10^{-20}
3	100.0	5.9659×10^{-19}	1.6135×10^{-18}
4	200.0	3.9719×10^{-17}	1.0849×10^{-16}
5	300.0	4.2780×10^{-16}	1.2017×10^{-15}
6	400.0	2.2234×10^{-15}	6.4513×10^{-15}
7	500.0	7.7867×10^{-15}	2.3377×10^{-14}
8	600.0	2.1306×10^{-14}	6.6220×10^{-14}
9	700.0	4.9230×10^{-14}	1.5843×10^{-13}
10	800.0	1.0060×10^{-13}	3.3521×10^{-13}
11	900.0	1.8736×10^{-13}	6.4626×10^{-13}
12	1000.0	3.2438×10^{-13}	1.1580×10^{-12}
13	1100.0	5.2969×10^{-13}	1.9563×10^{-12}
14	1200.0	8.2445×10^{-13}	3.1493×10^{-12}
15	1300.0	1.2327×10^{-12}	4.8685×10^{-12}

Table 3.35. Cesium isotope concentrations for fuel channels P–S of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{133}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{135}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{137}Cs $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	4.4243×10^{-08}	4.8288×10^{-08}	7.8677×10^{-08}
2	50.0	1.2463×10^{-07}	9.8939×10^{-08}	1.5731×10^{-07}
3	100.0	2.9458×10^{-07}	2.0070×10^{-07}	3.1441×10^{-07}
4	200.0	6.3549×10^{-07}	4.0597×10^{-07}	6.2791×10^{-07}
5	300.0	9.7606×10^{-07}	6.1333×10^{-07}	9.4040×10^{-07}
6	400.0	1.3164×10^{-06}	8.2260×10^{-07}	1.2520×10^{-06}
7	500.0	1.6562×10^{-06}	1.0335×10^{-06}	1.5624×10^{-06}
8	600.0	1.9958×10^{-06}	1.2460×10^{-06}	1.8719×10^{-06}
9	700.0	2.3349×10^{-06}	1.4599×10^{-06}	2.1802×10^{-06}
10	800.0	2.6736×10^{-06}	1.6749×10^{-06}	2.4873×10^{-06}
11	900.0	3.0120×10^{-06}	1.8912×10^{-06}	2.7934×10^{-06}
12	1000.0	3.3499×10^{-06}	2.1084×10^{-06}	3.0984×10^{-06}
13	1100.0	3.6875×10^{-06}	2.3266×10^{-06}	3.4022×10^{-06}
14	1200.0	4.0247×10^{-06}	2.5457×10^{-06}	3.7049×10^{-06}
15	1300.0	4.3614×10^{-06}	2.7656×10^{-06}	4.0064×10^{-06}

Table 3.36. Neodymium isotope concentrations for fuel channels P–S of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{143}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{144}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{145}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{146}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{148}Nd $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	1.9371×10^{-08}	1.3840×10^{-09}	4.8832×10^{-08}	3.8398×10^{-08}	2.1690×10^{-08}
2	50.0	6.9594×10^{-08}	5.5091×10^{-09}	9.8639×10^{-08}	7.6834×10^{-08}	4.3405×10^{-08}
3	100.0	2.0305×10^{-07}	2.1641×10^{-08}	1.9785×10^{-07}	1.5356×10^{-07}	8.6828×10^{-08}
4	200.0	4.9335×10^{-07}	8.2721×10^{-08}	3.9475×10^{-07}	3.0644×10^{-07}	1.7355×10^{-07}
5	300.0	7.8210×10^{-07}	1.7736×10^{-07}	5.8975×10^{-07}	4.5863×10^{-07}	2.6010×10^{-07}
6	400.0	1.0665×10^{-06}	3.0045×10^{-07}	7.8308×10^{-07}	6.1027×10^{-07}	3.4652×10^{-07}
7	500.0	1.3467×10^{-06}	4.4769×10^{-07}	9.7479×10^{-07}	7.6135×10^{-07}	4.3278×10^{-07}
8	600.0	1.6229×10^{-06}	6.1541×10^{-07}	1.1650×10^{-06}	9.1197×10^{-07}	5.1891×10^{-07}
9	700.0	1.8953×10^{-06}	8.0052×10^{-07}	1.3539×10^{-06}	1.0621×10^{-06}	6.0492×10^{-07}
10	800.0	2.1641×10^{-06}	1.0004×10^{-06}	1.5414×10^{-06}	1.2119×10^{-06}	6.9079×10^{-07}
11	900.0	2.4295×10^{-06}	1.2128×10^{-06}	1.7278×10^{-06}	1.3614×10^{-06}	7.7657×10^{-07}
12	1000.0	2.6917×10^{-06}	1.4360×10^{-06}	1.9130×10^{-06}	1.5105×10^{-06}	8.6225×10^{-07}
13	1100.0	2.9506×10^{-06}	1.6682×10^{-06}	2.0971×10^{-06}	1.6593×10^{-06}	9.4783×10^{-07}
14	1200.0	3.2066×10^{-06}	1.9082×10^{-06}	2.2802×10^{-06}	1.8079×10^{-06}	1.0333×10^{-06}
15	1300.0	3.4597×10^{-06}	2.1548×10^{-06}	2.4622×10^{-06}	1.9563×10^{-06}	1.1187×10^{-06}

Table 3.37. Strontium isotope concentrations for fuel channels P–S of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{84}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{86}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{87}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{88}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{90}Sr $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	2.8586×10^{-19}	3.1871×10^{-14}	1.6984×10^{-14}	4.3721×10^{-08}	7.1450×10^{-08}
2	50.0	1.1307×10^{-18}	1.5153×10^{-13}	3.7120×10^{-14}	8.7702×10^{-08}	1.4243×10^{-07}
3	100.0	4.4240×10^{-18}	7.3659×10^{-13}	8.6820×10^{-14}	1.7492×10^{-07}	2.8295×10^{-07}
4	200.0	1.7029×10^{-17}	3.4507×10^{-12}	2.2157×10^{-13}	3.4656×10^{-07}	5.5850×10^{-07}
5	300.0	3.7087×10^{-17}	8.2208×10^{-12}	3.9943×10^{-13}	5.1476×10^{-07}	8.2726×10^{-07}
6	400.0	6.4074×10^{-17}	1.4958×10^{-11}	6.1639×10^{-13}	6.7990×10^{-07}	1.0899×10^{-06}
7	500.0	9.7575×10^{-17}	2.3572×10^{-11}	8.6886×10^{-13}	8.4217×10^{-07}	1.3466×10^{-06}
8	600.0	1.3724×10^{-16}	3.3987×10^{-11}	1.1539×10^{-12}	1.0018×10^{-06}	1.5981×10^{-06}
9	700.0	1.8281×10^{-16}	4.6136×10^{-11}	1.4690×10^{-12}	1.1591×10^{-06}	1.8445×10^{-06}
10	800.0	2.3399×10^{-16}	5.9964×10^{-11}	1.8117×10^{-12}	1.3141×10^{-06}	2.0861×10^{-06}
11	900.0	2.9058×10^{-16}	7.5424×10^{-11}	2.1802×10^{-12}	1.4670×10^{-06}	2.3233×10^{-06}
12	1000.0	3.5241×10^{-16}	9.2473×10^{-11}	2.5726×10^{-12}	1.6179×10^{-06}	2.5562×10^{-06}
13	1100.0	4.1928×10^{-16}	1.1108×10^{-10}	2.9876×10^{-12}	1.7669×10^{-06}	2.7851×10^{-06}
14	1200.0	4.9108×10^{-16}	1.3120×10^{-10}	3.4236×10^{-12}	1.9143×10^{-06}	3.0102×10^{-06}
15	1300.0	5.6764×10^{-16}	1.5282×10^{-10}	3.8793×10^{-12}	2.0599×10^{-06}	3.2316×10^{-06}

Table 3.38. Barium isotope concentrations for fuel channels P–S of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{132}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{134}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{135}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{136}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{138}Ba $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	$0.0000 \times 10^{+00}$	2.3726×10^{-14}	1.7187×10^{-15}	3.5680×10^{-11}	8.5094×10^{-08}
2	50.0	$0.0000 \times 10^{+00}$	3.1771×10^{-13}	5.4544×10^{-15}	1.0009×10^{-10}	1.7034×10^{-07}
3	100.0	$0.0000 \times 10^{+00}$	3.5071×10^{-12}	1.8960×10^{-14}	2.8699×10^{-10}	3.4057×10^{-07}
4	200.0	$0.0000 \times 10^{+00}$	3.3011×10^{-11}	7.0013×10^{-14}	8.3942×10^{-10}	6.8002×10^{-07}
5	300.0	$0.0000 \times 10^{+00}$	1.1601×10^{-10}	1.5433×10^{-13}	1.6022×10^{-09}	1.0182×10^{-06}
6	400.0	$0.0000 \times 10^{+00}$	2.7746×10^{-10}	2.7531×10^{-13}	2.5594×10^{-09}	1.3553×10^{-06}
7	500.0	$0.0000 \times 10^{+00}$	5.3999×10^{-10}	4.3816×10^{-13}	3.6981×10^{-09}	1.6914×10^{-06}
8	600.0	$0.0000 \times 10^{+00}$	9.2421×10^{-10}	6.4978×10^{-13}	5.0075×10^{-09}	2.0265×10^{-06}
9	700.0	$0.0000 \times 10^{+00}$	1.4489×10^{-09}	9.1840×10^{-13}	6.4783×10^{-09}	2.3607×10^{-06}
10	800.0	$0.0000 \times 10^{+00}$	2.1313×10^{-09}	1.2535×10^{-12}	8.1021×10^{-09}	2.6940×10^{-06}
11	900.0	$0.0000 \times 10^{+00}$	2.9871×10^{-09}	1.6658×10^{-12}	9.8726×10^{-09}	3.0266×10^{-06}
12	1000.0	$0.0000 \times 10^{+00}$	4.0308×10^{-09}	2.1668×10^{-12}	1.1783×10^{-08}	3.3584×10^{-06}
13	1100.0	$0.0000 \times 10^{+00}$	5.2757×10^{-09}	2.7691×10^{-12}	1.3828×10^{-08}	3.6895×10^{-06}
14	1200.0	$0.0000 \times 10^{+00}$	6.7342×10^{-09}	3.4860×10^{-12}	1.6003×10^{-08}	4.0200×10^{-06}
15	1300.0	$0.0000 \times 10^{+00}$	8.4175×10^{-09}	4.3314×10^{-12}	1.8304×10^{-08}	4.3498×10^{-06}

Table 3.39. Technetium isotope concentrations for fuel channels P–S of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{99}Tc $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$
1	25.0	5.7768×10^{-08}
2	50.0	1.3525×10^{-07}
3	100.0	2.9078×10^{-07}
4	200.0	6.0145×10^{-07}
5	300.0	9.1161×10^{-07}
6	400.0	1.2214×10^{-06}
7	500.0	1.5306×10^{-06}
8	600.0	1.8394×10^{-06}
9	700.0	2.1478×10^{-06}
10	800.0	2.4556×10^{-06}
11	900.0	2.7631×10^{-06}
12	1000.0	3.0701×10^{-06}
13	1100.0	3.3766×10^{-06}
14	1200.0	3.6828×10^{-06}
15	1300.0	3.9886×10^{-06}

Table 3.40. Rubidium isotope concentrations for fuel channels P–S of the reference solution of Problem 2.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	^{85}Rb $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$	^{87}Rb $\left[\frac{\text{atoms}}{\text{b-cm}}\right]$
0	0.0	$0.0000 \times 10^{+00}$	$0.0000 \times 10^{+00}$
1	25.0	1.2567×10^{-08}	3.1692×10^{-08}
2	50.0	2.5290×10^{-08}	6.3362×10^{-08}
3	100.0	5.0571×10^{-08}	1.2618×10^{-07}
4	200.0	1.0051×10^{-07}	2.4988×10^{-07}
5	300.0	1.4970×10^{-07}	3.7117×10^{-07}
6	400.0	1.9823×10^{-07}	4.9033×10^{-07}
7	500.0	2.4615×10^{-07}	6.0750×10^{-07}
8	600.0	2.9352×10^{-07}	7.2285×10^{-07}
9	700.0	3.4038×10^{-07}	8.3651×10^{-07}
10	800.0	3.8678×10^{-07}	9.4858×10^{-07}
11	900.0	4.3276×10^{-07}	1.0592×10^{-06}
12	1000.0	4.7834×10^{-07}	1.1685×10^{-06}
13	1100.0	5.2355×10^{-07}	1.2764×10^{-06}
14	1200.0	5.6843×10^{-07}	1.3832×10^{-06}
15	1300.0	6.1298×10^{-07}	1.4887×10^{-06}

4. PROBLEM 3: 2D CORE

Problem 3 is a 2D transverse slice of a Magnox core and radial reflector region. The core contains three regions, each with its own coolant channel radius. This problem uses fully reflected boundary conditions on the west and south (internal) faces, and vacuum (zero-return) boundary conditions on the north and east (external) faces.

Problem 3 is more complex than the previous problems because it adds multiple charge pans, multiple coolant channel zones, the peripheral region with the radial reflector, and strong absorbers in the control rods.

4.1 BEGINNING-OF-CYCLE

4.1.1 Problem 3.1.1

4.1.1.1 Description

Figure 6 shows the quarter core geometry for Problem 3.1.1, but the geometry is ⅛ symmetric and may be modeled as such. The diagonal dashed line illustrates an axis of reflected symmetry. The core is composed of three zones (A, B, and C), where each zone represents the coolant channel radius of each rod in the charge-pan as noted in Table 1.2. Zone A comprises the following charge-pans: 0727, 0728, 0827, and 0828. Zone B comprises the following charge-pans: 0729, 0730, 0829, 0830, 0927, 0928, 0929, 1027, and 1028. Zone C comprises the following charge-pans: 0721, 0732, 0831, 0832, 0930, 0931, 0932, 1029, 1030, 1031, 1127, 1128, 1129, 1130, 1227, and 1228. Coolant channel radii for each zone and other geometric dimensions are listed in Table 1.2. Problem 3.1.1 models all rods out (ARO), and the empty coolant channels are shown in blue in Figure 6. Material densities are listed in Table 1.4. Temperatures are listed in Table 2.4.

4.1.1.2 Reference Solution

Table 4.1 shows the neutron multiplication factor comparison for Shift and MPACT. Timing variables are shown in Table 4.2. The power peaking factors and their difference are shown in Figures 7-8. The power peaking factors are tabulated in Tables 4.3-4.4. The power peaking factors agree well, within 0.005 absolute difference between MPACT and Shift.

Table 4.1. Neutron multiplication for the reference solution of Problem 3.1.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift k_{eff} (1σ)	MPACT k_{eff} (1σ)	Difference [pcm]
0	0.0	1.05021(3)	1.05028	7(3)

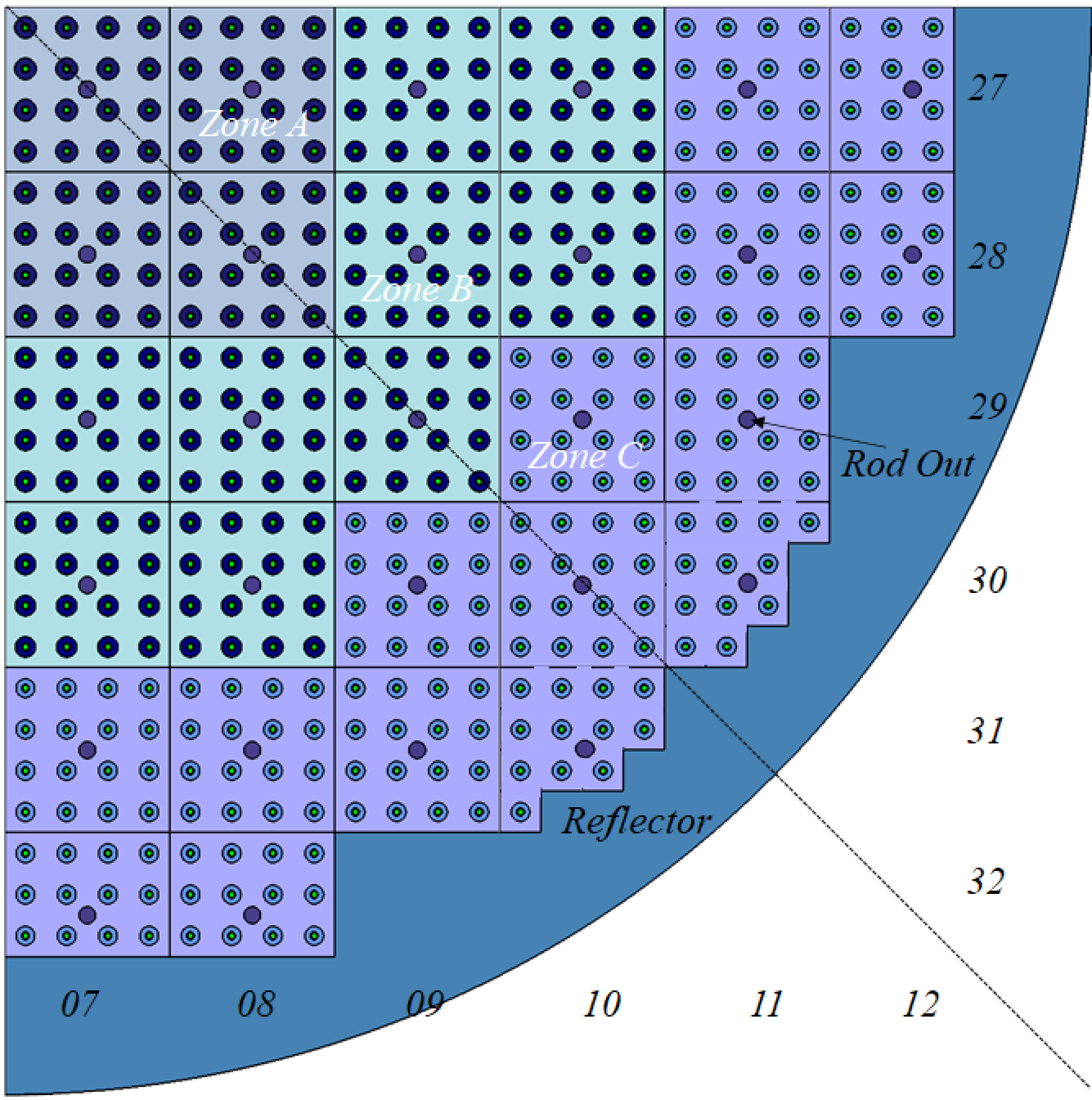
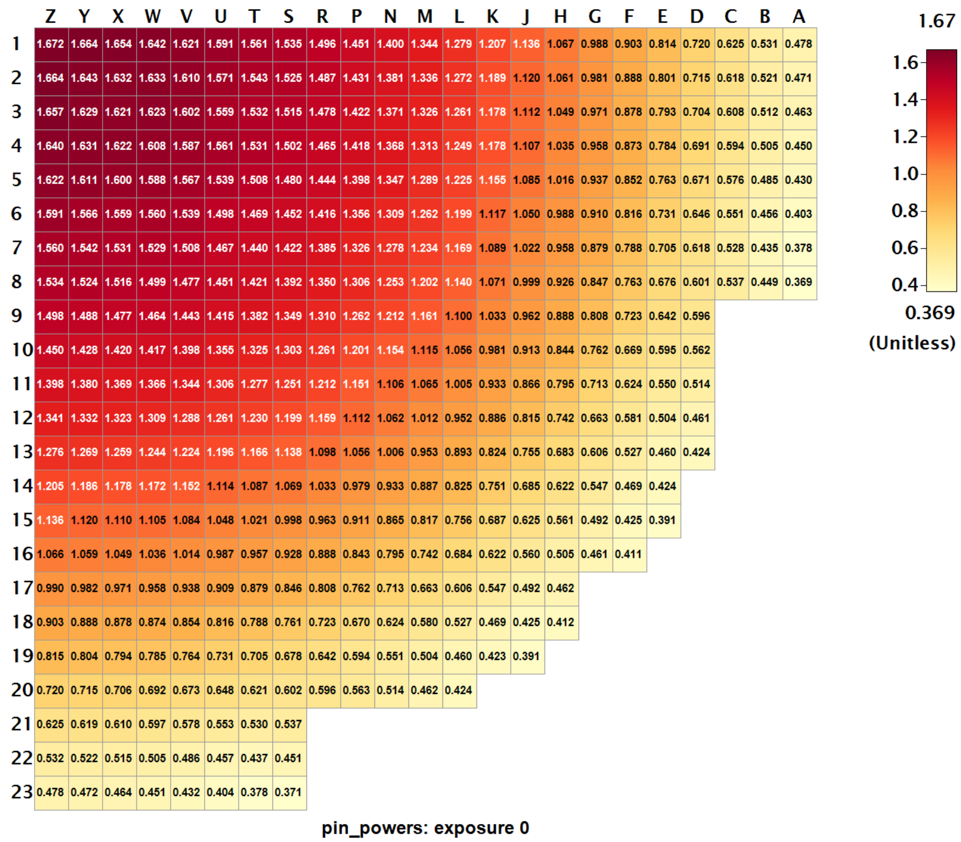


Figure 6. Quarter core 2D with all rods out (ARO).



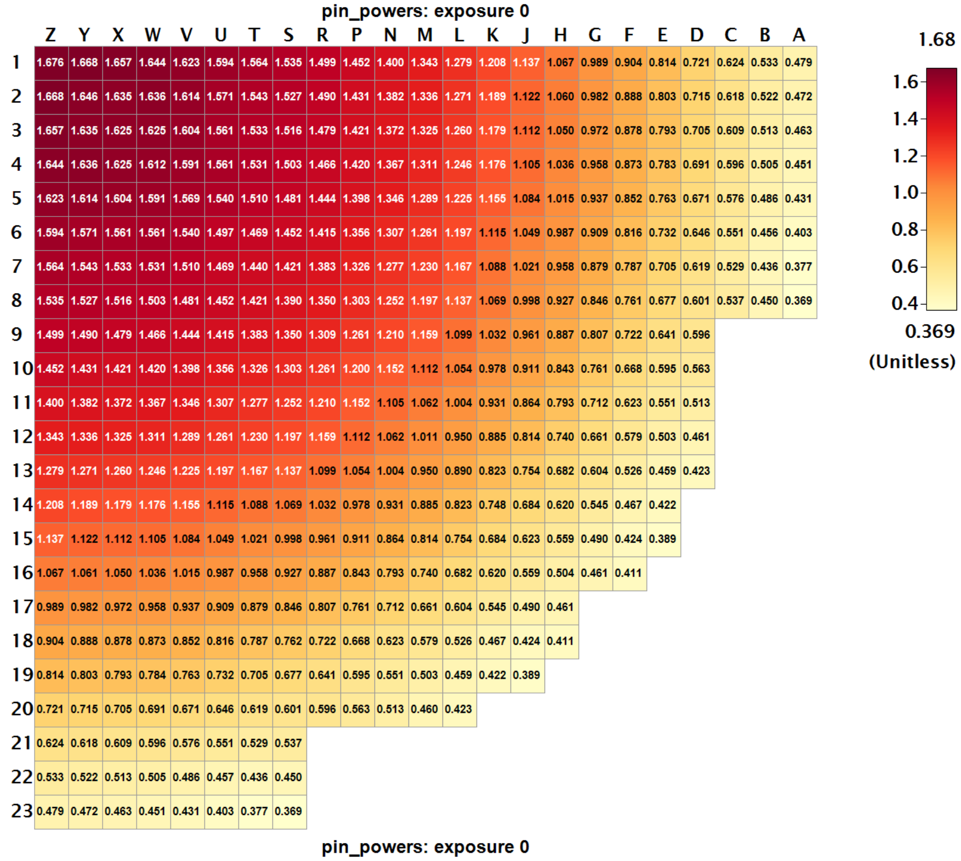


Figure 7. Shift (top) and MPACT (bottom) power peaking factors for Problem 3.1.1

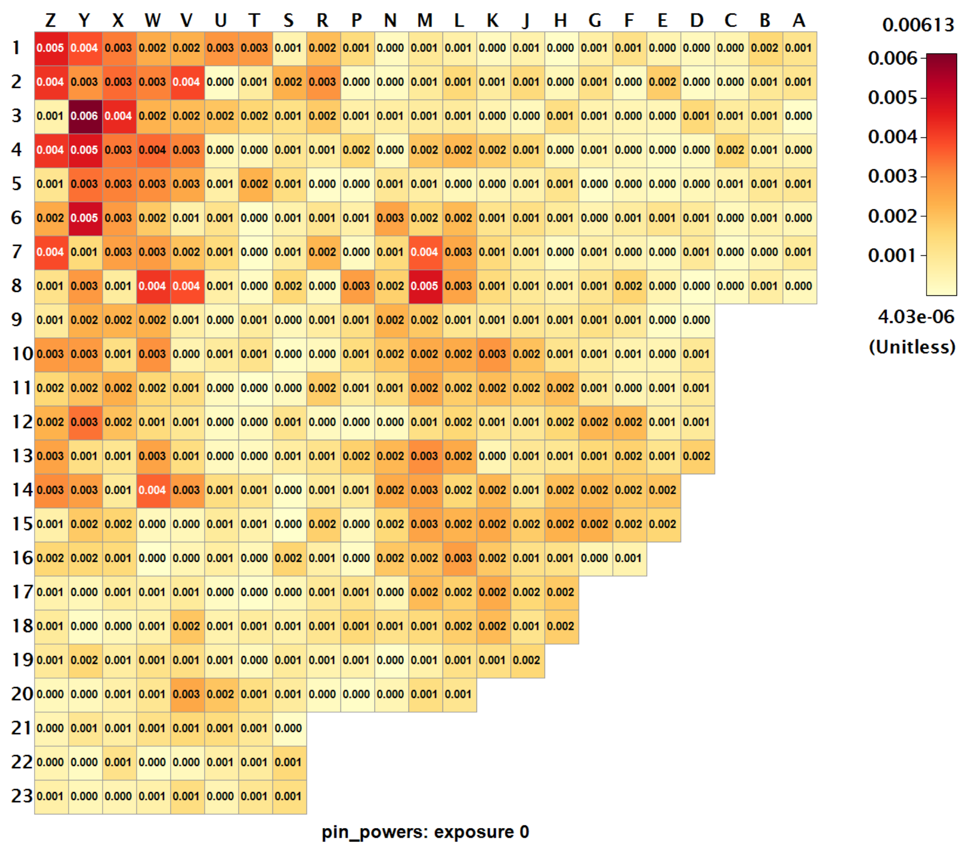


Figure 8. Absolute difference between Shift and MPACT power peaking factors for Problem 3.1.1

Table 4.2. Timing variables for the reference solution of Problem 3.1.1

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1500	1200	500000	2	48	9.64

MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1.0×10^{-04}	1.0×10^{-04}	0.01	3	128	5.30

Table 4.3. Power peaking factors A–H and P–S of the reference solution of Problem 3.1.1.

Charge Pans	Shift Power Peaking Factors							
	A	B	C	D	P	Q	R	S
	(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0727	1.632	1.621	1.629	1.643	1.672	1.642	1.608	1.640
0827 (0728)	1.543	1.532	1.559	1.571	1.621	1.535	1.502	1.587
0927 (0729)	1.382	1.371	1.422	1.431	1.496	1.344	1.313	1.465
1027 (0730)	1.120	1.112	1.178	1.189	1.279	1.067	1.035	1.249
1127 (0731)	0.801	0.793	0.878	0.888	0.988	0.720	0.691	0.958
1227 (0732)	0.471	0.463	0.512	0.521	0.625	-	-	0.594
0828	1.469	1.440	1.467	1.498	1.567	1.480	1.392	1.477
0928 (0829)	1.309	1.278	1.326	1.356	1.444	1.289	1.202	1.350
1028 (0830)	1.050	1.022	1.089	1.117	1.225	1.016	0.926	1.140
1128 (0831)	0.731	0.705	0.788	0.816	0.937	0.671	0.601	0.847
1228 (0832)	0.403	0.378	0.435	0.456	0.576	-	-	0.537
0929	1.154	1.106	1.151	1.201	1.310	1.161	1.012	1.159
0930 (1029)	0.913	0.866	0.933	0.981	1.100	0.888	0.742	0.952
1129 (0931)	0.595	0.550	0.624	0.669	0.808	0.596	0.461	0.663
1030	0.685	0.625	0.687	0.751	0.893	0.683	0.505	0.684
1031 (1130)	0.424	0.391	0.425	0.469	0.606	0.424	-	0.461
Charge Pans	MPACT Power Peaking Factors							
	A	B	C	D	P	Q	R	S
	(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0727	1.635	1.625	1.635	1.646	1.676	1.644	1.612	1.644
0827 (0728)	1.543	1.533	1.561	1.571	1.623	1.535	1.503	1.591
0927 (0729)	1.382	1.372	1.421	1.431	1.499	1.343	1.311	1.466
1027 (0730)	1.122	1.112	1.179	1.189	1.279	1.067	1.036	1.246
1127 (0731)	0.803	0.793	0.878	0.888	0.989	0.721	0.691	0.958
1227 (0732)	0.472	0.463	0.513	0.522	0.624	-	-	0.596
0828	1.469	1.440	1.469	1.497	1.569	1.481	1.390	1.481
0928 (0829)	1.307	1.277	1.326	1.356	1.444	1.289	1.197	1.350
1028 (0830)	1.049	1.021	1.088	1.115	1.225	1.015	0.927	1.137
1128 (0831)	0.732	0.705	0.787	0.816	0.937	0.671	0.601	0.846
1228 (0832)	0.403	0.377	0.436	0.456	0.576	-	-	0.537
0929	1.152	1.105	1.152	1.200	1.309	1.159	1.011	1.159
0930 (1029)	0.911	0.864	0.931	0.978	1.099	0.887	0.740	0.950
1129 (0931)	0.595	0.551	0.623	0.668	0.807	0.596	0.461	0.661
1030	0.684	0.623	0.684	0.748	0.890	0.682	0.504	0.682
1031 (1130)	0.422	0.389	0.424	0.467	0.604	0.423	-	0.461

Table 4.4. Power peaking factors E–M of the reference solution of Problem 3.1.1.

Charge Pans	Shift Power Peaking Factors							
	E	F	G	H	J	K	L	M
	(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0727	1.664	1.654	1.633	1.623	1.622	1.631	1.657	1.664
0827 (0728)	1.591	1.561	1.525	1.515	1.531	1.561	1.602	1.610
0927 (0729)	1.451	1.400	1.336	1.326	1.368	1.418	1.478	1.487
1027 (0730)	1.207	1.136	1.061	1.049	1.107	1.178	1.261	1.272
1127 (0731)	0.903	0.814	0.715	0.704	0.784	0.873	0.971	0.981
1227 (0732)	0.531	0.478	-	-	0.450	0.505	0.608	0.618
0828	1.539	1.507	1.452	1.422	1.421	1.451	1.508	1.539
0928 (0829)	1.398	1.347	1.262	1.234	1.253	1.306	1.385	1.416
1028 (0830)	1.155	1.085	0.988	0.958	0.999	1.071	1.169	1.199
1128 (0831)	0.852	0.763	0.646	0.618	0.676	0.763	0.879	0.910
1228 (0832)	0.485	0.430	-	-	0.369	0.449	0.528	0.551
0929	1.262	1.212	1.115	1.065	1.062	1.112	1.212	1.261
0930 (1029)	1.033	0.962	0.844	0.795	0.815	0.886	1.005	1.056
1129 (0931)	0.723	0.642	0.562	0.514	0.504	0.581	0.713	0.762
1030	0.824	0.755	0.622	0.561	0.560	0.622	0.756	0.825
1031 (1130)	0.527	0.460	-	-	-	0.411	0.492	0.547
Charge Pans	MPACT Power Peaking Factors							
	E	F	G	H	J	K	L	M
	(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0727	1.668	1.657	1.636	1.625	1.625	1.636	1.657	1.668
0827 (0728)	1.594	1.564	1.527	1.516	1.531	1.561	1.604	1.614
0927 (0729)	1.452	1.400	1.336	1.325	1.367	1.420	1.479	1.490
1027 (0730)	1.208	1.137	1.060	1.050	1.105	1.176	1.260	1.271
1127 (0731)	0.904	0.814	0.715	0.705	0.783	0.873	0.972	0.982
1227 (0732)	0.533	0.479	-	-	0.451	0.505	0.609	0.618
0828	1.540	1.510	1.452	1.421	1.421	1.452	1.510	1.540
0928 (0829)	1.398	1.346	1.261	1.230	1.252	1.303	1.383	1.415
1028 (0830)	1.155	1.084	0.987	0.958	0.998	1.069	1.167	1.197
1128 (0831)	0.852	0.763	0.646	0.619	0.677	0.761	0.879	0.909
1228 (0832)	0.486	0.431	-	-	0.369	0.450	0.529	0.551
0929	1.261	1.210	1.112	1.062	1.062	1.112	1.210	1.261
0930 (1029)	1.032	0.961	0.843	0.793	0.814	0.885	1.004	1.054
1129 (0931)	0.722	0.641	0.563	0.513	0.503	0.579	0.712	0.761
1030	0.823	0.754	0.620	0.559	0.559	0.620	0.754	0.823
1031 (1130)	0.526	0.459	-	-	-	0.411	0.490	0.545

4.1.2 Problem 3.1.2

4.1.2.1 Description

Figure 9 shows the quarter core geometry for Problem 3.1.2, which is the same as Problem 3.1.1 except Problem 3.1.2 models all rods in (ARI). The goal of this problem is to test the effect of control rods. As boron was not inserted in the graphite as an impurity material, this is the first problem with inserted neutron poisons aside from fission products. The geometry remains ⅛ symmetric. The diagonal dashed line illustrates an axis of reflected symmetry. The following charge-pans are uncontrolled (no control rod present): 0731, 0732, 0830, 0832, 0931, 1028, 1031, 1127, 1129, 1130, 1227, and 1228. Material densities are listed in Table 1.4. Temperatures are listed in Table 10.

4.1.2.2 Reference Solution

Table 4.5 shows the neutron multiplication factor comparison for Shift and MPACT. Timing variables are shown in Table 4.6. The power peaking factors and their difference are shown in Figures 10-11. Note that they are flipped along the x-axis. The power peaking factors are tabulated in Tables 4.7-4.8. The power peaking factors agree well, within 0.007 absolute difference between MPACT and Shift. The largest differences can be seen near the control rod locations and radial edges of the core.

Table 4.5. Neutron multiplication for the reference solution of Problem 3.1.2.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift k_{eff} (1σ)	MPACT k_{eff} (1σ)	Difference [pcm]
0	0.0	0.98085(3)	0.98024	-61(3)

Table 4.6. Timing variables for the reference solution of Problem 3.1.2

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1500	1200	500000	4	48	4.99
MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1.0×10^{-05}	1.0×10^{-05}	0.03	6	32	0.87

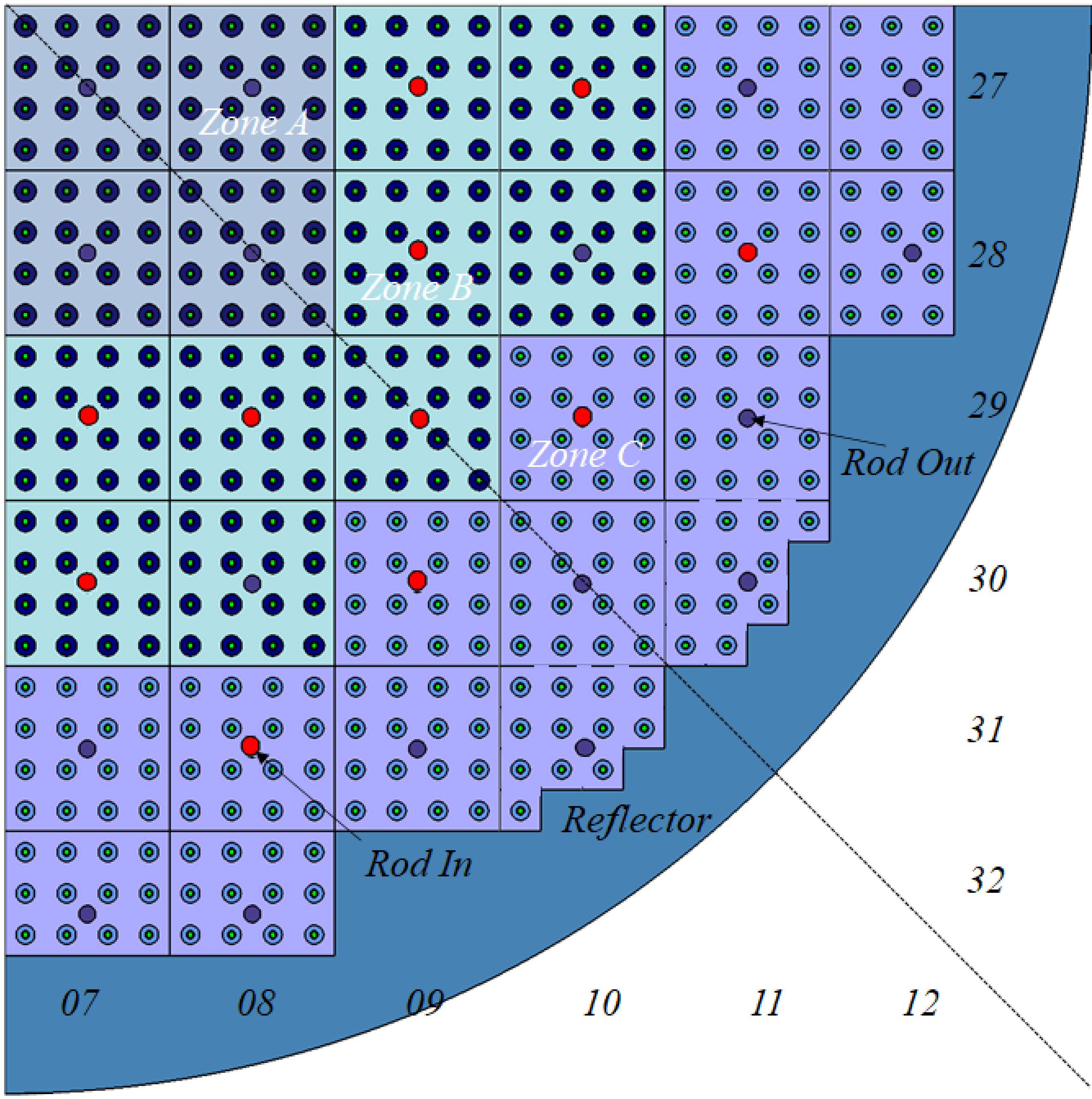
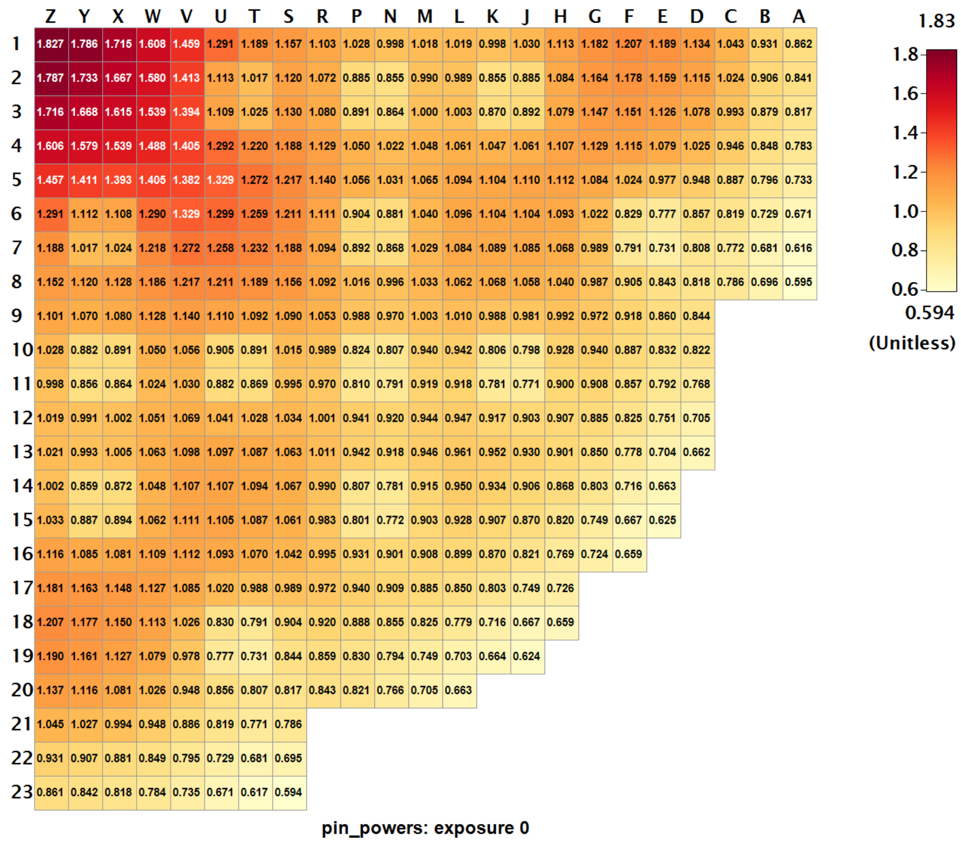


Figure 9. Quarter core 2D with all rods in (ARI), where red denotes the charge-pans with control rods inserted.



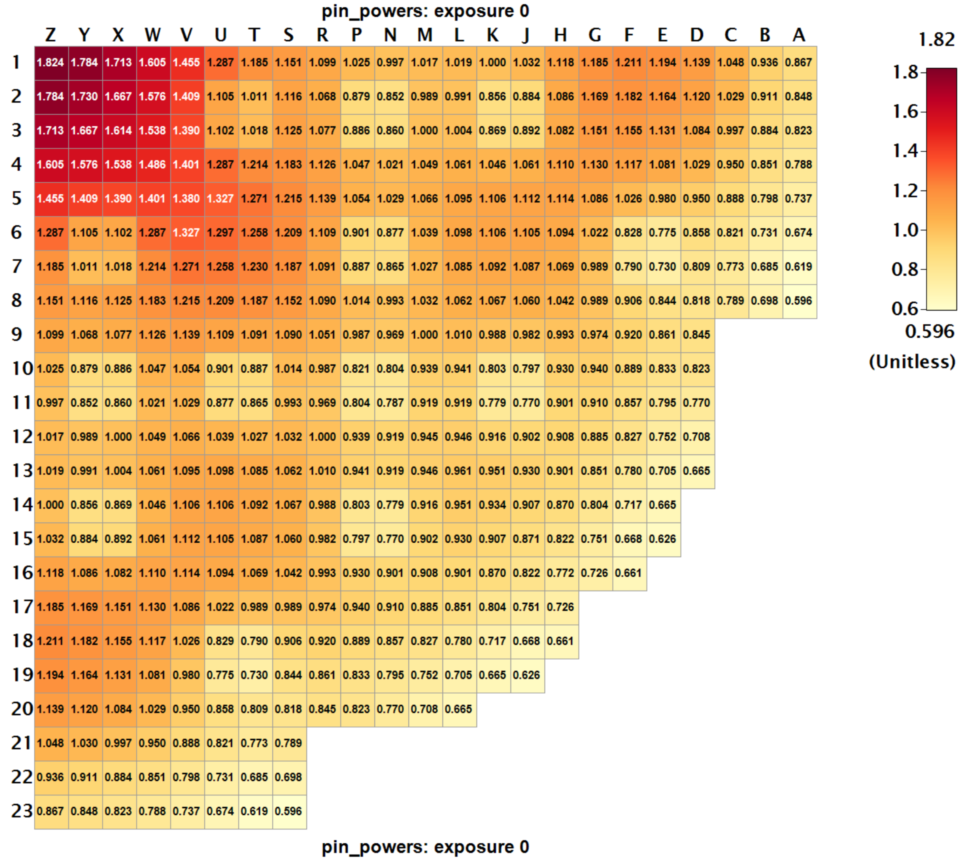


Figure 10. Shift (top) and MPACT (bottom) power peaking factors for Problem 3.1.2

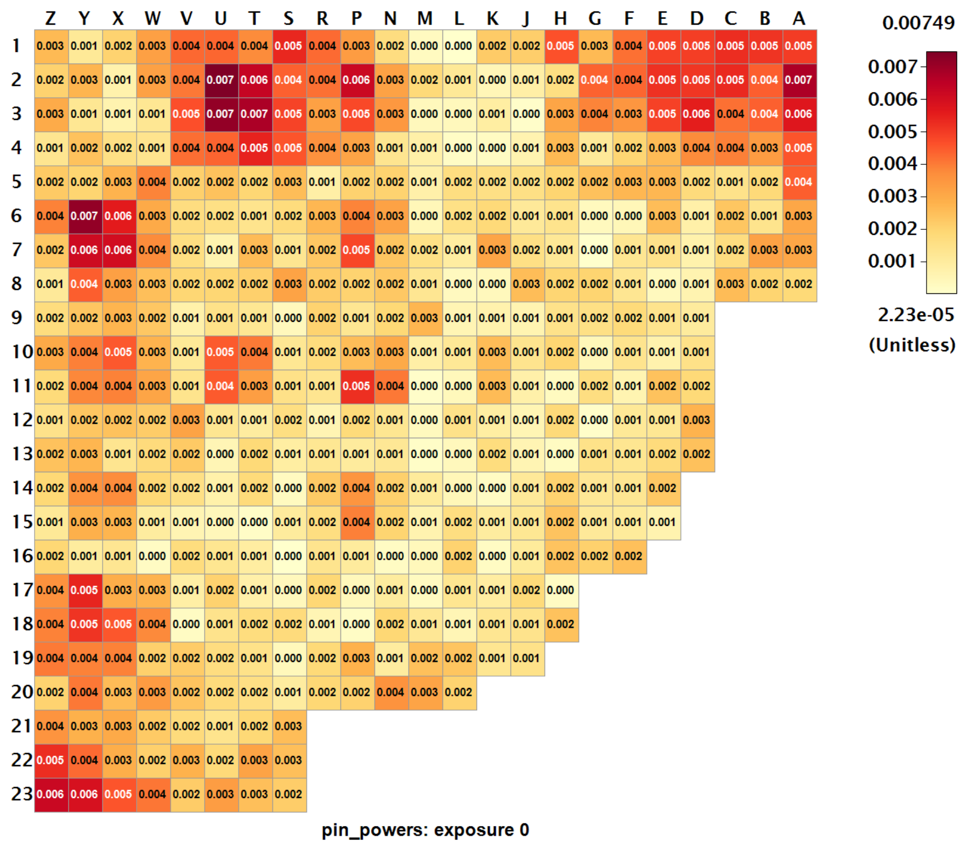


Figure 11. Absolute difference between Shift and MPACT power peaking factors for Problem 3.1.2

Table 4.7. Power peaking factors A–H and P–S of the reference solution of Problem 3.1.2.

Charge Pans	Shift Power Peaking Factors						
	A	B	C	D	P	Q	R	S
	(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0727	1.667	1.615	1.668	1.733	1.827	1.608	1.488	1.606
0827 (0728)	1.017	1.025	1.109	1.113	1.459	1.157	1.188	1.405
0927 (0729)	0.855	0.864	0.891	0.885	1.103	1.018	1.048	1.129
1027 (0730)	0.885	0.892	0.870	0.855	1.019	1.113	1.107	1.061
1127 (0731)	1.159	1.126	1.151	1.178	1.182	1.134	1.025	1.129
1227 (0732)	0.841	0.817	0.879	0.906	1.043	-	-	0.946
0828	1.259	1.232	1.258	1.299	1.382	1.217	1.156	1.217
0928 (0829)	0.881	0.868	0.892	0.904	1.140	1.065	1.033	1.092
1028 (0830)	1.104	1.085	1.089	1.104	1.094	1.112	1.040	1.062
1128 (0831)	0.777	0.731	0.791	0.829	1.084	0.948	0.818	0.987
1228 (0832)	0.671	0.616	0.681	0.729	0.887	-	-	0.786
0929	0.807	0.791	0.810	0.824	1.053	1.003	0.944	1.001
0930 (1029)	0.798	0.771	0.781	0.806	1.010	0.992	0.907	0.947
1129 (0931)	0.832	0.792	0.857	0.887	0.972	0.844	0.705	0.885
1030	0.906	0.870	0.907	0.934	0.961	0.901	0.769	0.899
1031 (1130)	0.663	0.625	0.667	0.716	0.850	0.662	-	0.724
Charge Pans	MPACT Power Peaking Factors							
	A	B	C	D	P	Q	R	S
	(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0727	1.667	1.614	1.667	1.730	1.824	1.605	1.486	1.605
0827 (0728)	1.011	1.018	1.102	1.105	1.455	1.151	1.183	1.401
0927 (0729)	0.852	0.860	0.886	0.879	1.099	1.017	1.049	1.125
1027 (0730)	0.884	0.892	0.869	0.856	1.019	1.118	1.110	1.061
1127 (0731)	1.164	1.131	1.155	1.182	1.185	1.139	1.029	1.130
1227 (0732)	0.848	0.823	0.884	0.911	1.048	-	-	0.950
0828	1.258	1.230	1.258	1.297	1.379	1.215	1.152	1.215
0928 (0829)	0.877	0.865	0.887	0.901	1.139	1.066	1.032	1.090
1028 (0830)	1.105	1.087	1.092	1.106	1.095	1.114	1.042	1.062
1128 (0831)	0.775	0.730	0.790	0.828	1.086	0.950	0.818	0.989
1228 (0832)	0.674	0.619	0.685	0.731	0.888	-	-	0.789
0929	0.804	0.787	0.804	0.821	1.051	1.000	0.945	1.000
0930 (1029)	0.797	0.770	0.779	0.803	1.010	0.993	0.908	0.946
1129 (0931)	0.833	0.795	0.857	0.889	0.974	0.845	0.708	0.885
1030	0.908	0.871	0.908	0.934	0.961	0.901	0.772	0.901
1031 (1130)	0.665	0.626	0.668	0.717	0.852	0.665	-	0.726

Table 4.8. Power peaking factors E–M of the reference solution of Problem 3.1.2.

Charge Pans	Shift Power Peaking Factors							
	E (H)	F (G)	G (F)	H (E)	J (M)	K (L)	L (K)	M (J)
0727	1.786	1.715	1.580	1.539	1.539	1.579	1.716	1.787
0827 (0728)	1.291	1.189	1.120	1.130	1.220	1.292	1.394	1.413
0927 (0729)	1.028	0.998	0.990	1.000	1.022	1.050	1.080	1.072
1027 (0730)	0.998	1.030	1.084	1.079	1.061	1.047	1.003	0.989
1127 (0731)	1.207	1.189	1.115	1.078	1.079	1.115	1.147	1.164
1227 (0732)	0.931	0.862	-	-	0.783	0.848	0.993	1.024
0828	1.329	1.272	1.211	1.188	1.189	1.211	1.272	1.329
0928 (0829)	1.056	1.031	1.040	1.029	0.996	1.016	1.094	1.111
1028 (0830)	1.104	1.110	1.093	1.068	1.058	1.068	1.084	1.096
1128 (0831)	1.024	0.977	0.857	0.808	0.843	0.905	0.989	1.022
1228 (0832)	0.796	0.733	-	-	0.595	0.696	0.772	0.819
0929	0.988	0.970	0.940	0.919	0.920	0.941	0.970	0.989
0930 (1029)	0.988	0.981	0.928	0.900	0.903	0.917	0.918	0.942
1129 (0931)	0.918	0.860	0.822	0.768	0.751	0.825	0.908	0.940
1030	0.952	0.930	0.868	0.820	0.821	0.870	0.928	0.950
1031 (1130)	0.778	0.704	-	-	-	0.659	0.749	0.803
Charge Pans	MPACT Power Peaking Factors							
	E (H)	F (G)	G (F)	H (E)	J (M)	K (L)	L (K)	M (J)
0727	1.784	1.713	1.576	1.538	1.538	1.576	1.713	1.784
0827 (0728)	1.287	1.185	1.116	1.125	1.214	1.287	1.390	1.409
0927 (0729)	1.025	0.997	0.989	1.000	1.021	1.047	1.077	1.068
1027 (0730)	1.000	1.032	1.086	1.082	1.061	1.046	1.004	0.990
1127 (0731)	1.211	1.194	1.120	1.084	1.081	1.117	1.151	1.169
1227 (0732)	0.936	0.867	-	-	0.788	0.851	0.997	1.030
0828	1.327	1.270	1.209	1.187	1.187	1.209	1.270	1.327
0928 (0829)	1.054	1.029	1.039	1.027	0.993	1.014	1.091	1.109
1028 (0830)	1.106	1.112	1.094	1.069	1.060	1.067	1.085	1.097
1128 (0831)	1.026	0.980	0.858	0.809	0.844	0.906	0.989	1.022
1228 (0832)	0.798	0.737	-	-	0.596	0.698	0.773	0.821
0929	0.987	0.968	0.939	0.919	0.919	0.939	0.968	0.987
0930 (1029)	0.988	0.982	0.930	0.901	0.902	0.916	0.919	0.941
1129 (0931)	0.920	0.861	0.823	0.770	0.752	0.827	0.910	0.940
1030	0.951	0.930	0.870	0.822	0.822	0.870	0.930	0.951
1031 (1130)	0.780	0.705	-	-	-	0.661	0.751	0.804

4.2 DEPLETION

4.2.1 Problem 3.2.1

4.2.1.1 Description

Figure 12 shows the quarter core geometry for Problem 3.1.1, which models the depletion with no control rods inserted. The geometry remains 1/8 symmetric. The diagonal dashed line illustrates an axis of reflected symmetry. The main control bank is inserted in the following charge-pans: 0729, 0730, 0927, 0929, and 1027. Material densities are listed in Table1.4. Temperatures are listed in Table 10. Burnup states used for comparison are listed in Table 1.5 and the total system specific power is listed in Table 1.6.

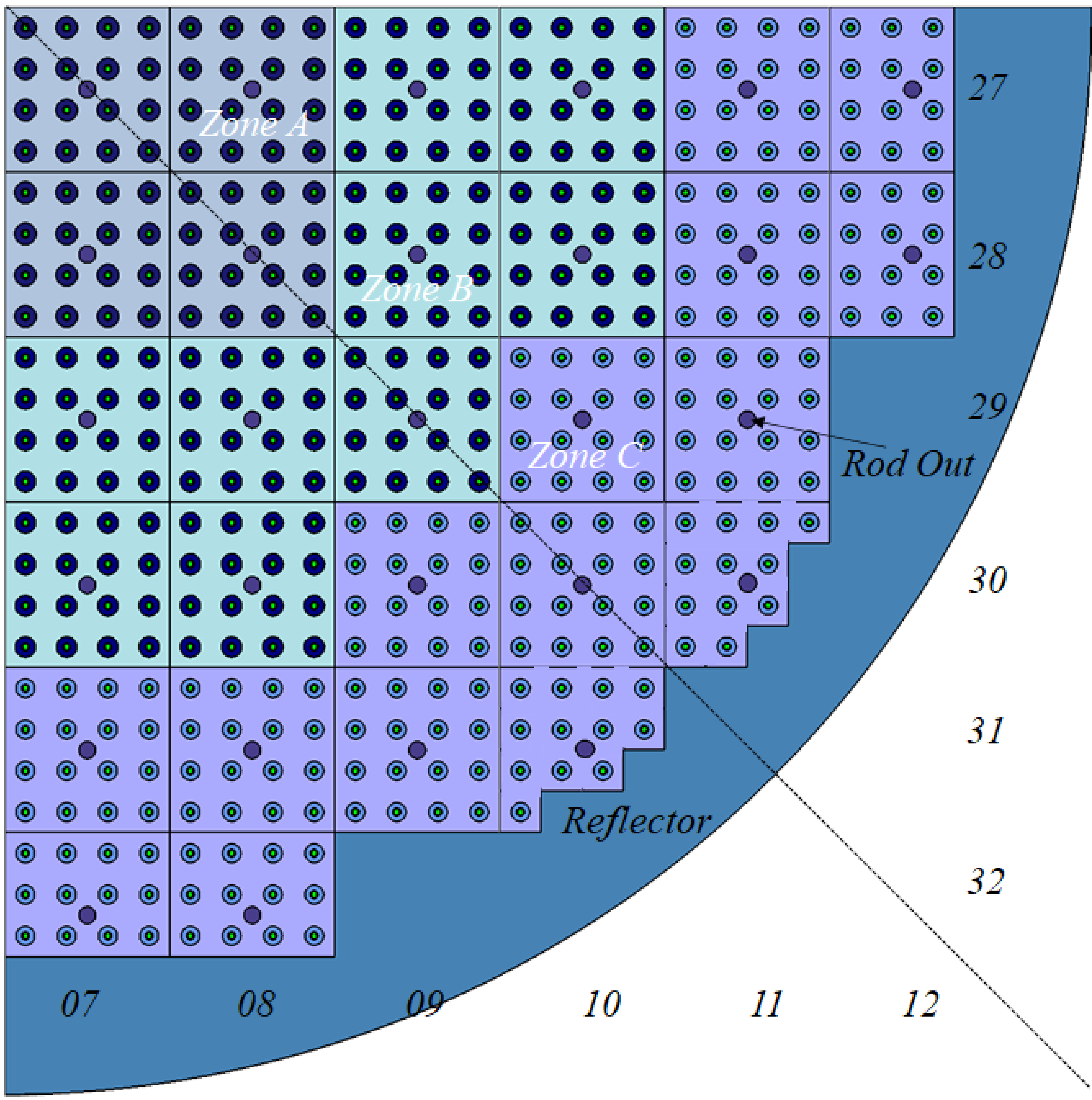


Figure 12. Quarter core 2D with all rods out (ARO).

4.2.1.2 Reference Solution

The neutron multiplication factor results are shown in Table 4.9. The timing variables for Shift and MPACT are shown in Table 4.11. Power peaking factors are displayed for BOC and EOC in Figures 13-14 and fully tabulated for all time steps in Tables 4.23-4.39.

The neutron multiplication factor results agree decently well over the whole cycle. The peak difference is after the first time step and decreases throughout the cycle. The MPACT power peaking factors appear nearly perfectly symmetric. The Shift results are slightly asymmetric, despite high statistics, i.e., less than 10 pcm statistical error and 0.3% or less relative error for tallies in each fuel region.

Table 4.9. Neutron multiplication factor for the reference solution of Problem 3.2.1.

Step	Burnup	Shift	MPACT	Difference
	$\left[\frac{MWd}{MtU}\right]$	k_{eff} (1σ)	k_{eff} (1σ)	[pcm]
0	0.0	1.05248(7)	1.05031(1)	-217(7)
1	25.0	1.03862(7)	1.03401(1)	-461(7)
2	50.0	1.03837(7)	1.03414(1)	-424(7)
3	100.0	1.03906(7)	1.03599(1)	-307(7)
4	200.0	1.04161(7)	1.04054(1)	-107(7)
5	300.0	1.04411(8)	1.04432(1)	22(8)
6	400.0	1.04639(7)	1.04722(1)	84(7)
7	500.0	1.04823(8)	1.04939(1)	117(8)
8	600.0	1.04983(7)	1.05097(1)	114(7)
9	700.0	1.05098(8)	1.05207(1)	109(8)
10	800.0	1.05194(7)	1.0528(1)	86(8)
11	900.0	1.0525(8)	1.05321(1)	71(8)
12	1000.0	1.05306(8)	1.05337(1)	30(8)
13	1100.0	1.05359(8)	1.05331(1)	-28(8)
14	1200.0	1.05373(8)	1.05308(1)	-65(8)
15	1300.0	1.05386(8)	1.0527(1)	-116(8)

	Z	Y	X	W	V	U	T	S	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1	1.682	1.673	1.660	1.648	1.629	1.594	1.565	1.536	1.498	1.451	1.398	1.342	1.275	1.206	1.137	1.065	0.988	0.904	0.813	0.723	0.623	0.534	0.477
2	1.672	1.644	1.639	1.636	1.617	1.572	1.542	1.529	1.490	1.431	1.377	1.329	1.268	1.186	1.120	1.062	0.981	0.886	0.801	0.718	0.620	0.522	0.472
3	1.656	1.638	1.629	1.626	1.609	1.564	1.536	1.514	1.478	1.417	1.366	1.324	1.258	1.177	1.110	1.049	0.969	0.876	0.792	0.707	0.608	0.515	0.462
4	1.645	1.635	1.628	1.617	1.594	1.562	1.532	1.503	1.465	1.418	1.366	1.308	1.243	1.175	1.102	1.033	0.958	0.874	0.786	0.692	0.598	0.505	0.448
5	1.630	1.620	1.609	1.598	1.568	1.542	1.511	1.484	1.442	1.395	1.346	1.284	1.223	1.151	1.083	1.014	0.937	0.850	0.764	0.673	0.574	0.484	0.430
6	1.596	1.576	1.566	1.566	1.543	1.500	1.470	1.453	1.414	1.353	1.304	1.257	1.193	1.115	1.049	0.986	0.911	0.815	0.732	0.646	0.551	0.454	0.401
7	1.566	1.545	1.537	1.539	1.513	1.474	1.445	1.423	1.382	1.324	1.274	1.229	1.166	1.087	1.021	0.959	0.877	0.787	0.702	0.616	0.528	0.433	0.375
8	1.537	1.528	1.518	1.511	1.484	1.457	1.425	1.393	1.354	1.305	1.249	1.197	1.135	1.067	0.998	0.925	0.844	0.758	0.677	0.599	0.533	0.450	0.369
9	1.499	1.491	1.486	1.470	1.445	1.418	1.384	1.351	1.307	1.261	1.211	1.160	1.098	1.028	0.957	0.891	0.804	0.720	0.638	0.593			
10	1.455	1.437	1.425	1.422	1.399	1.358	1.328	1.307	1.261	1.201	1.153	1.116	1.052	0.977	0.909	0.839	0.760	0.669	0.594	0.562			
11	1.407	1.384	1.374	1.370	1.352	1.310	1.283	1.252	1.213	1.154	1.103	1.062	1.005	0.931	0.861	0.792	0.715	0.620	0.548	0.513			
12	1.351	1.338	1.327	1.317	1.295	1.264	1.232	1.198	1.156	1.114	1.063	1.009	0.949	0.886	0.812	0.737	0.658	0.576	0.502	0.458			
13	1.283	1.276	1.267	1.249	1.229	1.198	1.167	1.137	1.099	1.054	1.002	0.947	0.891	0.824	0.751	0.678	0.601	0.524	0.457	0.420			
14	1.212	1.195	1.180	1.177	1.160	1.118	1.083	1.065	1.031	0.977	0.929	0.882	0.823	0.747	0.681	0.618	0.542	0.464	0.418				
15	1.144	1.125	1.116	1.105	1.086	1.047	1.021	0.996	0.960	0.908	0.859	0.813	0.753	0.684	0.621	0.557	0.487	0.420	0.389				
16	1.066	1.064	1.051	1.037	1.018	0.988	0.957	0.926	0.885	0.839	0.792	0.741	0.682	0.618	0.556	0.503	0.459	0.409					
17	0.992	0.984	0.973	0.959	0.937	0.910	0.882	0.843	0.805	0.758	0.711	0.657	0.602	0.545	0.489	0.457							
18	0.906	0.887	0.877	0.874	0.855	0.815	0.785	0.759	0.722	0.664	0.622	0.577	0.524	0.467	0.421	0.407							
19	0.812	0.801	0.793	0.782	0.763	0.730	0.704	0.676	0.641	0.591	0.548	0.502	0.458	0.420	0.386								
20	0.721	0.714	0.704	0.691	0.670	0.646	0.619	0.600	0.594	0.559	0.510	0.458	0.422										
21	0.625	0.617	0.609	0.595	0.573	0.552	0.527	0.536															
22	0.533	0.519	0.513	0.505	0.485	0.456	0.436	0.450															
23	0.477	0.471	0.462	0.451	0.429	0.402	0.375	0.369															

1.75
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.339
(Unitless)

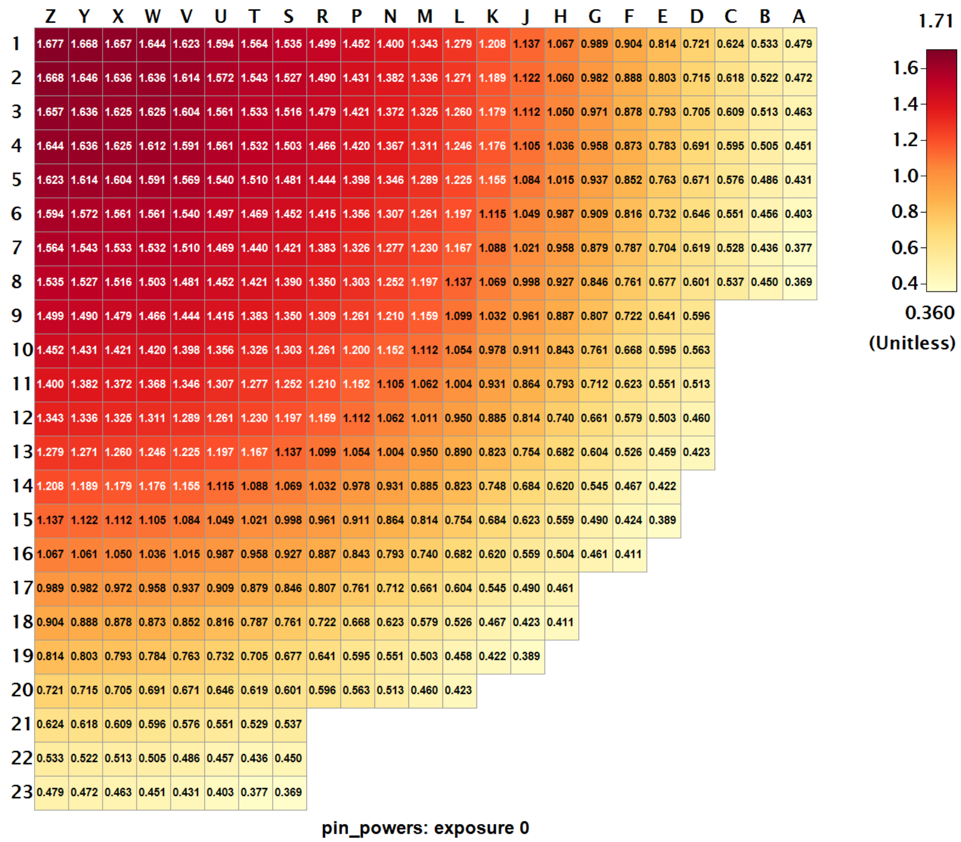
pin_powers: exposure 0

	Z	Y	X	W	V	U	T	S	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1	1.747	1.734	1.723	1.704	1.686	1.654	1.625	1.600	1.561	1.516	1.463	1.406	1.341	1.267	1.189	1.112	1.041	0.954	0.860	0.760	0.657	0.562	0.505
2	1.741	1.716	1.707	1.706	1.682	1.636	1.606	1.596	1.558	1.496	1.445	1.402	1.336	1.247	1.178	1.110	1.040	0.940	0.848	0.759	0.655	0.551	0.500
3	1.687	1.651	1.654	1.639	1.654	1.611	1.583	1.571	1.535	1.477	1.426	1.381	1.313	1.226	1.159	1.093	1.033	0.934	0.844	0.751	0.642	0.546	0.493
4	1.688	1.669	1.649	1.647	1.641	1.609	1.582	1.550	1.514	1.469	1.419	1.370	1.297	1.226	1.151	1.085	1.001	0.910	0.811	0.719	0.631	0.537	0.480
5	1.669	1.657	1.642	1.605	1.625	1.594	1.559	1.527	1.494	1.450	1.400	1.343	1.281	1.210	1.140	1.071	0.992	0.906	0.810	0.712	0.607	0.513	0.451
6	1.623	1.599	1.582	1.571	1.593	1.543	1.513	1.494	1.453	1.389	1.346	1.302	1.243	1.162	1.097	1.034	0.955	0.860	0.773	0.680	0.584	0.480	0.432
7	1.592	1.563	1.558	1.549	1.523	1.474	1.439	1.402	1.403	1.343	1.299	1.256	1.200	1.123	1.057	0.998	0.919	0.827	0.741	0.651	0.554	0.460	0.402
8	1.557	1.545	1.536	1.515	1.487	1.447	1.409	1.364	1.361	1.310	1.262	1.216	1.161	1.098	1.030	0.964	0.883	0.799	0.710	0.630	0.566	0.477	0.394
9	1.483	1.470	1.446	1.447	1.452	1.416	1.385	1.346	1.311	1.265	1.214	1.169	1.114	1.053	0.986	0.917	0.841	0.750	0.671	0.627			
10	1.442	1.416	1.404	1.391	1.393	1.348	1.313	1.285	1.248	1.185	1.141	1.116	1.058	0.989	0.924	0.861	0.782	0.689	0.617	0.588			
11	1.373	1.353	1.345	1.336	1.288	1.258	1.218	1.183	1.190	1.130	1.083	1.045	0.995	0.927	0.871	0.801	0.725	0.641	0.570	0.534			
12	1.298	1.293	1.281	1.263	1.229	1.194	1.177	1.134	1.132	1.080	1.037	0.991	0.936	0.877	0.814	0.745	0.670	0.594	0.521	0.477			
13	1.229	1.227	1.214	1.200	1.184	1.162	1.130	1.102	1.060	1.021	0.971	0.927	0.873	0.813	0.750	0.679	0.607	0.535	0.466	0.434			
14	1.152	1.132	1.124	1.121	1.100	1.059	1.033	1.021	0.988	0.938	0.895	0.857	0.801	0.735	0.675	0.616	0.548	0.473	0.432				
15	1.048	1.046	1.029	1.011	1.022	0.988	0.961	0.944	0.911	0.870	0.827	0.783	0.736	0.668	0.614	0.553	0.488	0.425	0.399				
16	0.984	0.968	0.972	0.952	0.952	0.922	0.895	0.870	0.840	0.802	0.760	0.713	0.664	0.607	0.551	0.499	0.462	0.419					
17	0.918	0.917	0.903	0.890	0.866	0.839	0.816	0.788	0.754	0.718	0.673	0.628	0.577	0.522	0.469	0.450							
18	0.828	0.814	0.801	0.799	0.783	0.749	0.726	0.705	0.674	0.629	0.588	0.550	0.510	0.457	0.413	0.410							
19	0.737	0.729	0.722	0.714	0.697	0.671	0.646	0.627	0.601	0.559	0.521	0.480	0.439	0.408	0.380								
20	0.645	0.640	0.636	0.623	0.607	0.584	0.564	0.553	0.555	0.529	0.488	0.442	0.406										
21	0.551	0.550	0.542	0.531	0.516	0.499	0.478	0.496															
22	0.470	0.462	0.457	0.449	0.435	0.408	0.395	0.412															
23	0.424	0.419	0.413	0.402	0.385	0.361	0.339	0.339															

1.75
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.339
(Unitless)

pin_powers: exposure 1.3

Figure 13. Shift power peaking factors for Problem 3.2.1 at BOC (top) and EOC (bottom)



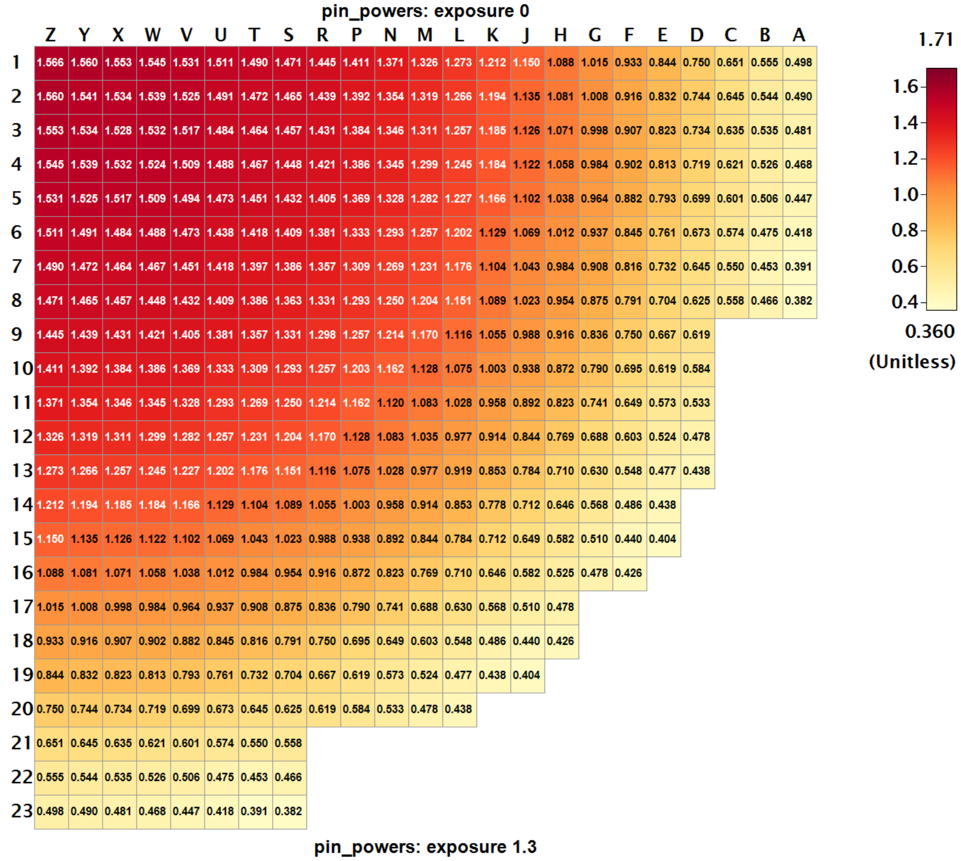


Figure 14. MPACT power peaking factors for Problem 3.2.1 at BOC (top) and EOC (bottom)

Table 4.10. Timing variables for the reference solution of Problem 3.2.1

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1500	1200	500000	2	48	9.64
MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1.0×10^{-04}	1.0×10^{-04}	0.01	3	128	5.30

Table 4.11. Timing variables for the reference solution of Problem 3.2.1

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
15	1500	1200	100000	8	48	13.91
MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
15	1.0×10^{-04}	1.0×10^{-04}	0.03	3	128	21.09

Charge-Pan 0727

Table 4.12. Power peaking factors for charge-pan 0727 of the reference solution of Problem 3.2.1.

Step	Burnup	Shift Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	1.620	1.627	1.637	1.619	1.628	1.653	1.662	1.607	1.637	1.673
1	25.0	1.669	1.677	1.688	1.666	1.677	1.698	1.710	1.654	1.684	1.719
2	50.0	1.668	1.675	1.689	1.665	1.676	1.698	1.711	1.648	1.686	1.720
3	100.0	1.649	1.666	1.676	1.648	1.664	1.686	1.694	1.634	1.672	1.703
4	200.0	1.616	1.642	1.654	1.621	1.643	1.660	1.671	1.606	1.649	1.680
5	300.0	1.601	1.628	1.641	1.603	1.632	1.644	1.655	1.586	1.634	1.666
6	400.0	1.585	1.626	1.632	1.588	1.625	1.636	1.648	1.575	1.624	1.654
7	500.0	1.586	1.629	1.638	1.592	1.628	1.642	1.651	1.572	1.629	1.660
8	600.0	1.589	1.636	1.648	1.597	1.638	1.649	1.660	1.576	1.640	1.669
9	700.0	1.590	1.640	1.651	1.596	1.643	1.653	1.664	1.576	1.643	1.671
10	800.0	1.600	1.661	1.670	1.612	1.663	1.674	1.685	1.589	1.659	1.693
11	900.0	1.603	1.664	1.672	1.614	1.665	1.675	1.687	1.588	1.667	1.695
12	1000.0	1.613	1.676	1.681	1.623	1.677	1.689	1.700	1.597	1.678	1.706
13	1100.0	1.622	1.685	1.695	1.636	1.691	1.703	1.710	1.604	1.692	1.719
14	1200.0	1.629	1.698	1.706	1.645	1.700	1.715	1.722	1.614	1.704	1.729
15	1300.0	1.640	1.708	1.715	1.654	1.714	1.724	1.737	1.619	1.713	1.743
Step	Burnup	MPACT Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	1.625	1.636	1.646	1.625	1.636	1.657	1.668	1.612	1.644	1.677
1	25.0	1.537	1.544	1.552	1.539	1.548	1.564	1.572	1.530	1.555	1.579
2	50.0	1.554	1.562	1.570	1.556	1.565	1.583	1.591	1.546	1.572	1.598
3	100.0	1.585	1.594	1.603	1.586	1.596	1.615	1.624	1.574	1.603	1.632
4	200.0	1.626	1.636	1.646	1.626	1.636	1.658	1.669	1.612	1.645	1.677
5	300.0	1.644	1.655	1.666	1.644	1.655	1.678	1.689	1.630	1.664	1.698
6	400.0	1.651	1.662	1.673	1.651	1.662	1.685	1.696	1.637	1.671	1.705
7	500.0	1.650	1.660	1.671	1.650	1.661	1.683	1.694	1.636	1.669	1.703
8	600.0	1.642	1.653	1.663	1.643	1.653	1.675	1.686	1.629	1.662	1.695
9	700.0	1.631	1.641	1.650	1.631	1.642	1.663	1.673	1.618	1.650	1.681
10	800.0	1.616	1.626	1.635	1.618	1.628	1.647	1.657	1.605	1.635	1.665
11	900.0	1.600	1.609	1.618	1.602	1.611	1.630	1.639	1.591	1.619	1.647
12	1000.0	1.583	1.591	1.599	1.585	1.594	1.612	1.620	1.575	1.601	1.628
13	1100.0	1.565	1.572	1.580	1.568	1.576	1.592	1.600	1.558	1.583	1.607
14	1200.0	1.546	1.553	1.560	1.550	1.557	1.572	1.580	1.541	1.564	1.586
15	1300.0	1.528	1.534	1.541	1.532	1.539	1.553	1.560	1.524	1.545	1.566

Charge-Pans 0827 and 0728

Table 4.13. Problem 3.2.1 reference solution power peaking factors for charge-pans 0827 and 0728.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	1.527	1.536	1.566	1.554	1.586	1.497	1.533	1.615
1	25.0	1.566	1.579	1.607	1.598	1.624	1.531	1.572	1.662
2	50.0	1.568	1.582	1.611	1.597	1.626	1.530	1.574	1.665
3	100.0	1.554	1.566	1.598	1.586	1.613	1.521	1.560	1.649
4	200.0	1.531	1.546	1.574	1.559	1.590	1.503	1.537	1.627
5	300.0	1.521	1.534	1.560	1.548	1.583	1.491	1.526	1.607
6	400.0	1.508	1.525	1.555	1.539	1.570	1.485	1.519	1.600
7	500.0	1.518	1.536	1.563	1.545	1.577	1.492	1.528	1.601
8	600.0	1.525	1.545	1.569	1.552	1.584	1.501	1.535	1.613
9	700.0	1.529	1.550	1.572	1.555	1.587	1.504	1.542	1.614
10	800.0	1.542	1.565	1.589	1.568	1.605	1.514	1.552	1.631
11	900.0	1.546	1.567	1.594	1.572	1.606	1.517	1.563	1.637
12	1000.0	1.557	1.584	1.607	1.584	1.618	1.531	1.577	1.649
13	1100.0	1.572	1.596	1.621	1.598	1.627	1.543	1.589	1.668
14	1200.0	1.580	1.603	1.632	1.606	1.636	1.548	1.599	1.677
15	1300.0	1.592	1.616	1.643	1.614	1.644	1.557	1.608	1.688
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	1.533	1.543	1.572	1.561	1.591	1.503	1.535	1.623
1	25.0	1.466	1.474	1.495	1.487	1.513	1.446	1.472	1.538
2	50.0	1.479	1.487	1.510	1.502	1.528	1.456	1.484	1.555
3	100.0	1.502	1.511	1.536	1.527	1.555	1.476	1.505	1.584
4	200.0	1.533	1.543	1.571	1.561	1.591	1.502	1.535	1.623
5	300.0	1.547	1.558	1.588	1.577	1.607	1.515	1.549	1.641
6	400.0	1.553	1.564	1.594	1.583	1.614	1.520	1.555	1.648
7	500.0	1.553	1.564	1.593	1.583	1.613	1.521	1.555	1.647
8	600.0	1.548	1.558	1.587	1.577	1.607	1.517	1.550	1.640
9	700.0	1.540	1.550	1.578	1.568	1.597	1.510	1.543	1.629
10	800.0	1.530	1.539	1.566	1.557	1.585	1.502	1.533	1.616
11	900.0	1.518	1.527	1.552	1.544	1.572	1.493	1.522	1.600
12	1000.0	1.505	1.514	1.538	1.529	1.557	1.482	1.510	1.584
13	1100.0	1.492	1.500	1.523	1.515	1.541	1.471	1.498	1.566
14	1200.0	1.478	1.486	1.507	1.499	1.525	1.459	1.484	1.548
15	1300.0	1.464	1.472	1.491	1.484	1.509	1.448	1.471	1.531

Table 4.14. Problem 3.2.1 reference solution power peaking factors for charge-pans 0827 and 0728.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	1.557	1.526	1.510	1.521	1.559	1.590	1.605	1.597
1	25.0	1.593	1.558	1.550	1.563	1.600	1.632	1.656	1.643
2	50.0	1.592	1.562	1.549	1.567	1.602	1.635	1.654	1.641
3	100.0	1.580	1.547	1.537	1.550	1.587	1.619	1.642	1.630
4	200.0	1.562	1.529	1.516	1.533	1.564	1.594	1.618	1.603
5	300.0	1.549	1.520	1.507	1.523	1.553	1.579	1.603	1.589
6	400.0	1.543	1.509	1.495	1.512	1.541	1.572	1.595	1.580
7	500.0	1.549	1.519	1.501	1.522	1.553	1.578	1.601	1.583
8	600.0	1.552	1.526	1.509	1.532	1.562	1.590	1.609	1.593
9	700.0	1.557	1.530	1.513	1.537	1.567	1.593	1.615	1.599
10	800.0	1.570	1.543	1.526	1.549	1.581	1.608	1.633	1.614
11	900.0	1.575	1.547	1.531	1.556	1.585	1.613	1.635	1.615
12	1000.0	1.586	1.559	1.548	1.574	1.600	1.629	1.650	1.629
13	1100.0	1.597	1.568	1.557	1.588	1.615	1.643	1.666	1.643
14	1200.0	1.605	1.574	1.567	1.597	1.625	1.653	1.673	1.657
15	1300.0	1.615	1.582	1.578	1.603	1.633	1.663	1.685	1.661
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	1.561	1.532	1.516	1.527	1.564	1.594	1.614	1.604
1	25.0	1.490	1.467	1.456	1.465	1.492	1.515	1.531	1.523
2	50.0	1.504	1.479	1.468	1.477	1.506	1.531	1.548	1.539
3	100.0	1.528	1.501	1.488	1.498	1.531	1.558	1.576	1.567
4	200.0	1.561	1.531	1.516	1.527	1.564	1.594	1.615	1.604
5	300.0	1.577	1.546	1.530	1.541	1.579	1.611	1.633	1.621
6	400.0	1.583	1.551	1.535	1.546	1.585	1.617	1.639	1.628
7	500.0	1.583	1.551	1.535	1.546	1.585	1.616	1.638	1.627
8	600.0	1.577	1.547	1.531	1.542	1.580	1.610	1.631	1.621
9	700.0	1.569	1.539	1.524	1.535	1.571	1.600	1.621	1.610
10	800.0	1.558	1.529	1.515	1.525	1.560	1.588	1.608	1.598
11	900.0	1.545	1.518	1.505	1.515	1.547	1.574	1.592	1.583
12	1000.0	1.532	1.506	1.494	1.503	1.534	1.559	1.576	1.567
13	1100.0	1.518	1.493	1.482	1.491	1.519	1.543	1.559	1.551
14	1200.0	1.503	1.480	1.470	1.478	1.505	1.527	1.542	1.534
15	1300.0	1.488	1.467	1.457	1.465	1.490	1.511	1.525	1.517

Charge-Pans 0927 and 0729

Table 4.15. Problem 3.2.1 reference solution power peaking factors for charge-pans 0927 and 0729.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A (A)	B (D)	C (C)	D (B)	P (R)	Q (Q)	R (P)	S (S)
0	0.0	1.369	1.381	1.429	1.419	1.461	1.307	1.345	1.495
1	25.0	1.406	1.420	1.470	1.455	1.494	1.339	1.386	1.539
2	50.0	1.411	1.422	1.471	1.461	1.495	1.344	1.390	1.540
3	100.0	1.396	1.410	1.456	1.443	1.481	1.330	1.377	1.524
4	200.0	1.375	1.387	1.434	1.421	1.462	1.313	1.352	1.500
5	300.0	1.362	1.375	1.421	1.410	1.452	1.304	1.334	1.484
6	400.0	1.354	1.365	1.413	1.400	1.442	1.300	1.330	1.475
7	500.0	1.359	1.372	1.422	1.407	1.452	1.303	1.334	1.480
8	600.0	1.362	1.378	1.427	1.413	1.456	1.309	1.341	1.486
9	700.0	1.370	1.384	1.434	1.414	1.461	1.311	1.345	1.490
10	800.0	1.375	1.390	1.441	1.425	1.473	1.318	1.352	1.503
11	900.0	1.384	1.400	1.453	1.432	1.477	1.329	1.365	1.511
12	1000.0	1.400	1.419	1.467	1.447	1.489	1.339	1.379	1.527
13	1100.0	1.410	1.431	1.479	1.456	1.499	1.351	1.393	1.537
14	1200.0	1.419	1.442	1.492	1.463	1.508	1.360	1.407	1.551
15	1300.0	1.430	1.447	1.498	1.476	1.515	1.366	1.414	1.559
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A (A)	B (D)	C (C)	D (B)	P (R)	Q (Q)	R (P)	S (S)
0	0.0	1.372	1.382	1.431	1.421	1.466	1.311	1.343	1.499
1	25.0	1.339	1.347	1.387	1.379	1.417	1.290	1.317	1.443
2	50.0	1.344	1.353	1.395	1.386	1.426	1.293	1.322	1.454
3	100.0	1.355	1.364	1.410	1.400	1.443	1.300	1.330	1.472
4	200.0	1.370	1.381	1.430	1.420	1.465	1.310	1.342	1.498
5	300.0	1.378	1.389	1.440	1.430	1.476	1.315	1.349	1.510
6	400.0	1.382	1.392	1.445	1.434	1.481	1.318	1.352	1.516
7	500.0	1.383	1.393	1.445	1.434	1.481	1.319	1.353	1.516
8	600.0	1.381	1.392	1.443	1.432	1.479	1.319	1.352	1.512
9	700.0	1.378	1.389	1.438	1.428	1.474	1.317	1.350	1.506
10	800.0	1.374	1.384	1.432	1.422	1.467	1.316	1.347	1.498
11	900.0	1.370	1.379	1.425	1.416	1.459	1.313	1.344	1.489
12	1000.0	1.364	1.373	1.418	1.409	1.450	1.310	1.340	1.479
13	1100.0	1.358	1.367	1.409	1.401	1.441	1.307	1.335	1.468
14	1200.0	1.352	1.360	1.401	1.393	1.431	1.303	1.331	1.457
15	1300.0	1.346	1.354	1.392	1.384	1.421	1.299	1.326	1.445

Table 4.16. Problem 3.2.1 reference solution power peaking factors for charge-pans 0927 and 0729.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Shift Power Peaking Factors E (H)	F (G)	G (F)	H (E)	J (M)	K (L)	L (K)	M (J)
0	0.0	1.414	1.366	1.325	1.336	1.399	1.451	1.488	1.476
1	25.0	1.448	1.396	1.362	1.378	1.440	1.496	1.527	1.517
2	50.0	1.450	1.400	1.367	1.381	1.441	1.494	1.529	1.515
3	100.0	1.437	1.387	1.352	1.367	1.428	1.478	1.514	1.499
4	200.0	1.417	1.371	1.328	1.341	1.405	1.456	1.491	1.477
5	300.0	1.412	1.358	1.317	1.333	1.389	1.441	1.477	1.465
6	400.0	1.401	1.352	1.310	1.325	1.384	1.432	1.468	1.455
7	500.0	1.406	1.359	1.314	1.330	1.389	1.440	1.478	1.459
8	600.0	1.416	1.363	1.322	1.338	1.394	1.444	1.484	1.467
9	700.0	1.417	1.367	1.323	1.343	1.396	1.452	1.486	1.470
10	800.0	1.426	1.375	1.333	1.349	1.407	1.458	1.498	1.481
11	900.0	1.435	1.383	1.343	1.363	1.418	1.471	1.506	1.488
12	1000.0	1.446	1.394	1.356	1.374	1.431	1.484	1.527	1.502
13	1100.0	1.456	1.406	1.368	1.394	1.449	1.502	1.538	1.513
14	1200.0	1.465	1.414	1.378	1.398	1.460	1.511	1.544	1.522
15	1300.0	1.471	1.420	1.388	1.407	1.466	1.521	1.555	1.531
Step	Burnup $\left[\frac{MWd}{MtU}\right]$	MPACT Power Peaking Factors E (H)	F (G)	G (F)	H (E)	J (M)	K (L)	L (K)	M (J)
0	0.0	1.420	1.367	1.325	1.336	1.400	1.452	1.490	1.479
1	25.0	1.380	1.337	1.302	1.311	1.364	1.407	1.436	1.428
2	50.0	1.387	1.342	1.305	1.315	1.370	1.415	1.446	1.437
3	100.0	1.401	1.352	1.313	1.323	1.382	1.430	1.465	1.455
4	200.0	1.419	1.367	1.324	1.335	1.399	1.452	1.490	1.479
5	300.0	1.428	1.374	1.330	1.341	1.407	1.462	1.502	1.491
6	400.0	1.432	1.377	1.333	1.344	1.411	1.467	1.507	1.496
7	500.0	1.433	1.378	1.334	1.345	1.412	1.467	1.507	1.496
8	600.0	1.431	1.377	1.333	1.344	1.411	1.465	1.504	1.493
9	700.0	1.427	1.375	1.332	1.343	1.407	1.460	1.498	1.487
10	800.0	1.422	1.371	1.329	1.340	1.403	1.454	1.490	1.480
11	900.0	1.416	1.367	1.326	1.337	1.397	1.446	1.481	1.471
12	1000.0	1.409	1.362	1.323	1.333	1.391	1.438	1.471	1.462
13	1100.0	1.402	1.357	1.319	1.329	1.385	1.430	1.461	1.452
14	1200.0	1.394	1.351	1.315	1.324	1.378	1.420	1.450	1.441
15	1300.0	1.386	1.345	1.311	1.319	1.371	1.411	1.439	1.431

Charge-Pans 1027 and (0730)

Table 4.17. Problem 3.2.1 reference solution power peaking factors for charge-pans 1027 and 0730.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	1.113	1.123	1.189	1.179	1.247	1.037	1.067	1.278
1	25.0	1.157	1.171	1.239	1.222	1.283	1.074	1.118	1.331
2	50.0	1.156	1.171	1.235	1.223	1.282	1.076	1.119	1.330
3	100.0	1.142	1.158	1.222	1.207	1.268	1.062	1.105	1.312
4	200.0	1.119	1.127	1.195	1.182	1.251	1.042	1.075	1.281
5	300.0	1.099	1.112	1.179	1.165	1.235	1.027	1.059	1.262
6	400.0	1.094	1.105	1.169	1.154	1.225	1.025	1.053	1.251
7	500.0	1.097	1.111	1.171	1.163	1.229	1.026	1.052	1.250
8	600.0	1.099	1.114	1.179	1.164	1.234	1.033	1.058	1.256
9	700.0	1.101	1.118	1.184	1.167	1.234	1.036	1.063	1.262
10	800.0	1.105	1.121	1.185	1.170	1.242	1.037	1.063	1.262
11	900.0	1.117	1.136	1.200	1.184	1.251	1.054	1.083	1.272
12	1000.0	1.127	1.144	1.210	1.191	1.260	1.058	1.087	1.285
13	1100.0	1.139	1.158	1.225	1.204	1.272	1.071	1.103	1.298
14	1200.0	1.149	1.169	1.232	1.213	1.281	1.080	1.114	1.310
15	1300.0	1.153	1.179	1.243	1.220	1.287	1.087	1.122	1.316
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	1.112	1.122	1.189	1.179	1.246	1.036	1.067	1.279
1	25.0	1.117	1.126	1.184	1.175	1.236	1.050	1.079	1.263
2	50.0	1.115	1.124	1.184	1.175	1.237	1.047	1.076	1.265
3	100.0	1.113	1.122	1.185	1.176	1.240	1.042	1.072	1.270
4	200.0	1.111	1.121	1.188	1.178	1.245	1.035	1.067	1.278
5	300.0	1.111	1.121	1.189	1.179	1.249	1.033	1.065	1.282
6	400.0	1.111	1.121	1.191	1.180	1.251	1.032	1.065	1.284
7	500.0	1.112	1.122	1.192	1.182	1.252	1.033	1.066	1.285
8	600.0	1.114	1.124	1.193	1.183	1.252	1.035	1.067	1.285
9	700.0	1.115	1.126	1.194	1.183	1.252	1.038	1.070	1.285
10	800.0	1.117	1.127	1.194	1.184	1.252	1.041	1.073	1.284
11	900.0	1.119	1.129	1.194	1.185	1.251	1.044	1.076	1.282
12	1000.0	1.121	1.131	1.195	1.185	1.250	1.048	1.079	1.280
13	1100.0	1.123	1.132	1.195	1.185	1.249	1.051	1.082	1.278
14	1200.0	1.125	1.134	1.194	1.185	1.247	1.055	1.085	1.275
15	1300.0	1.126	1.135	1.194	1.185	1.245	1.058	1.088	1.273

Table 4.18. Problem 3.2.1 reference solution power peaking factors for charge-pans 1027 and 0730.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	1.176	1.108	1.049	1.060	1.137	1.211	1.271	1.261
1	25.0	1.213	1.144	1.096	1.111	1.191	1.260	1.316	1.301
2	50.0	1.212	1.145	1.097	1.108	1.188	1.260	1.318	1.303
3	100.0	1.203	1.130	1.080	1.097	1.175	1.244	1.303	1.291
4	200.0	1.181	1.115	1.058	1.071	1.144	1.214	1.278	1.262
5	300.0	1.167	1.095	1.039	1.053	1.126	1.196	1.259	1.245
6	400.0	1.162	1.090	1.035	1.046	1.117	1.187	1.250	1.237
7	500.0	1.162	1.093	1.033	1.050	1.119	1.188	1.248	1.237
8	600.0	1.167	1.098	1.042	1.056	1.124	1.192	1.250	1.241
9	700.0	1.170	1.104	1.046	1.061	1.131	1.198	1.257	1.245
10	800.0	1.176	1.102	1.045	1.062	1.128	1.198	1.260	1.247
11	900.0	1.186	1.116	1.060	1.076	1.146	1.214	1.272	1.260
12	1000.0	1.197	1.125	1.066	1.083	1.155	1.225	1.285	1.272
13	1100.0	1.206	1.137	1.083	1.101	1.165	1.236	1.297	1.280
14	1200.0	1.216	1.146	1.091	1.110	1.183	1.248	1.306	1.289
15	1300.0	1.220	1.154	1.096	1.120	1.188	1.256	1.315	1.296
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	1.176	1.105	1.050	1.060	1.137	1.208	1.271	1.260
1	25.0	1.174	1.112	1.063	1.073	1.140	1.202	1.256	1.247
2	50.0	1.174	1.110	1.060	1.070	1.139	1.202	1.258	1.249
3	100.0	1.174	1.108	1.055	1.065	1.137	1.204	1.263	1.253
4	200.0	1.175	1.105	1.050	1.060	1.136	1.207	1.270	1.259
5	300.0	1.176	1.104	1.047	1.058	1.136	1.209	1.274	1.263
6	400.0	1.177	1.104	1.047	1.058	1.137	1.210	1.276	1.265
7	500.0	1.179	1.105	1.048	1.059	1.138	1.212	1.277	1.266
8	600.0	1.180	1.107	1.050	1.060	1.139	1.213	1.277	1.266
9	700.0	1.181	1.109	1.052	1.063	1.141	1.213	1.277	1.266
10	800.0	1.182	1.111	1.055	1.066	1.143	1.214	1.276	1.265
11	900.0	1.183	1.113	1.058	1.069	1.144	1.214	1.275	1.264
12	1000.0	1.183	1.115	1.062	1.072	1.146	1.214	1.273	1.263
13	1100.0	1.184	1.118	1.065	1.075	1.147	1.213	1.271	1.261
14	1200.0	1.184	1.120	1.068	1.078	1.149	1.213	1.268	1.259
15	1300.0	1.185	1.122	1.071	1.081	1.150	1.212	1.266	1.257

Charge-Pans 1127 and (0731)

Table 4.19. Problem 3.2.1 reference solution power peaking factors for charge-pans 1127 and 0731.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.794	0.803	0.888	0.879	0.956	0.693	0.724	0.989
1	25.0	0.835	0.850	0.935	0.923	0.999	0.727	0.766	1.044
2	50.0	0.838	0.850	0.937	0.922	1.000	0.728	0.767	1.041
3	100.0	0.823	0.835	0.921	0.911	0.986	0.716	0.753	1.029
4	200.0	0.801	0.811	0.897	0.886	0.962	0.694	0.728	0.997
5	300.0	0.789	0.796	0.880	0.871	0.942	0.683	0.713	0.978
6	400.0	0.784	0.790	0.876	0.868	0.938	0.676	0.707	0.971
7	500.0	0.784	0.792	0.877	0.868	0.936	0.675	0.709	0.970
8	600.0	0.790	0.795	0.879	0.875	0.941	0.678	0.711	0.974
9	700.0	0.791	0.797	0.882	0.878	0.941	0.681	0.712	0.978
10	800.0	0.792	0.796	0.882	0.878	0.942	0.680	0.710	0.977
11	900.0	0.807	0.813	0.899	0.892	0.958	0.691	0.727	0.992
12	1000.0	0.813	0.820	0.906	0.899	0.961	0.697	0.731	0.997
13	1100.0	0.827	0.835	0.921	0.915	0.974	0.707	0.744	1.015
14	1200.0	0.835	0.842	0.927	0.924	0.980	0.712	0.752	1.026
15	1300.0	0.843	0.850	0.936	0.929	0.987	0.719	0.759	1.036
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.793	0.803	0.888	0.878	0.958	0.691	0.721	0.989
1	25.0	0.823	0.832	0.913	0.904	0.979	0.724	0.753	1.008
2	50.0	0.818	0.827	0.908	0.899	0.975	0.718	0.747	1.004
3	100.0	0.807	0.817	0.899	0.890	0.967	0.707	0.736	0.998
4	200.0	0.794	0.803	0.888	0.878	0.958	0.692	0.721	0.989
5	300.0	0.787	0.797	0.882	0.872	0.953	0.684	0.714	0.985
6	400.0	0.784	0.794	0.880	0.870	0.952	0.681	0.711	0.984
7	500.0	0.784	0.794	0.881	0.871	0.952	0.680	0.710	0.985
8	600.0	0.786	0.796	0.883	0.873	0.954	0.682	0.712	0.987
9	700.0	0.790	0.799	0.886	0.876	0.958	0.685	0.716	0.990
10	800.0	0.794	0.804	0.890	0.880	0.961	0.690	0.720	0.993
11	900.0	0.799	0.809	0.895	0.885	0.966	0.695	0.725	0.997
12	1000.0	0.804	0.814	0.900	0.890	0.970	0.700	0.731	1.001
13	1100.0	0.810	0.820	0.905	0.896	0.975	0.707	0.737	1.006
14	1200.0	0.817	0.826	0.911	0.901	0.980	0.713	0.743	1.010
15	1300.0	0.823	0.832	0.916	0.907	0.984	0.719	0.750	1.015

Table 4.20. Problem 3.2.1 reference solution power peaking factors for charge-pans 1127 and 0731.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\mathrm{MWd}}{\mathrm{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.875	0.786	0.706	0.719	0.816	0.905	0.983	0.973
1	25.0	0.913	0.822	0.742	0.759	0.863	0.955	1.030	1.015
2	50.0	0.915	0.823	0.746	0.757	0.862	0.954	1.030	1.018
3	100.0	0.901	0.810	0.735	0.747	0.847	0.940	1.020	1.006
4	200.0	0.881	0.788	0.714	0.724	0.824	0.914	0.990	0.982
5	300.0	0.861	0.775	0.699	0.708	0.805	0.894	0.973	0.966
6	400.0	0.857	0.769	0.698	0.704	0.799	0.887	0.968	0.959
7	500.0	0.856	0.770	0.697	0.705	0.796	0.888	0.969	0.962
8	600.0	0.859	0.774	0.701	0.707	0.802	0.892	0.973	0.967
9	700.0	0.862	0.775	0.704	0.711	0.806	0.895	0.978	0.972
10	800.0	0.862	0.780	0.705	0.711	0.803	0.891	0.976	0.974
11	900.0	0.878	0.793	0.721	0.725	0.819	0.908	0.993	0.986
12	1000.0	0.880	0.797	0.725	0.731	0.825	0.916	1.000	0.997
13	1100.0	0.896	0.808	0.736	0.744	0.840	0.933	1.016	1.010
14	1200.0	0.902	0.814	0.744	0.751	0.848	0.940	1.023	1.018
15	1300.0	0.909	0.822	0.751	0.759	0.854	0.945	1.032	1.027
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\mathrm{MWd}}{\mathrm{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.873	0.783	0.705	0.715	0.814	0.904	0.982	0.971
1	25.0	0.900	0.814	0.738	0.747	0.844	0.929	1.001	0.992
2	50.0	0.895	0.809	0.732	0.742	0.838	0.924	0.997	0.988
3	100.0	0.885	0.798	0.721	0.731	0.828	0.916	0.991	0.980
4	200.0	0.873	0.784	0.706	0.716	0.814	0.904	0.982	0.971
5	300.0	0.867	0.777	0.698	0.708	0.808	0.899	0.978	0.967
6	400.0	0.865	0.774	0.695	0.705	0.805	0.897	0.977	0.966
7	500.0	0.865	0.774	0.695	0.705	0.805	0.897	0.977	0.967
8	600.0	0.867	0.776	0.696	0.706	0.807	0.899	0.979	0.969
9	700.0	0.871	0.780	0.700	0.710	0.811	0.903	0.982	0.972
10	800.0	0.875	0.784	0.704	0.714	0.815	0.907	0.986	0.975
11	900.0	0.880	0.789	0.709	0.719	0.820	0.911	0.990	0.980
12	1000.0	0.885	0.795	0.715	0.725	0.826	0.916	0.994	0.984
13	1100.0	0.891	0.801	0.721	0.731	0.832	0.922	0.999	0.988
14	1200.0	0.897	0.807	0.727	0.737	0.838	0.927	1.003	0.993
15	1300.0	0.902	0.813	0.734	0.744	0.844	0.933	1.008	0.998

Charge-Pans 1227 and (0732)

Table 4.21. Problem 3.2.1 reference solution power peaking factors for charge-pans 1227 and 0732.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Shift Power Peaking Factors A (A)	B (D)	C (C)	D (B)	P (R)	S (Q)
0	0.0	0.466	0.474	0.525	0.516	0.598	0.626
1	25.0	0.491	0.500	0.556	0.545	0.628	0.664
2	50.0	0.491	0.502	0.555	0.545	0.628	0.665
3	100.0	0.483	0.492	0.548	0.537	0.620	0.652
4	200.0	0.471	0.477	0.530	0.519	0.602	0.631
5	300.0	0.457	0.464	0.516	0.506	0.589	0.617
6	400.0	0.456	0.461	0.513	0.502	0.587	0.612
7	500.0	0.454	0.460	0.512	0.503	0.585	0.608
8	600.0	0.456	0.462	0.516	0.505	0.590	0.612
9	700.0	0.458	0.462	0.518	0.506	0.590	0.615
10	800.0	0.461	0.464	0.518	0.507	0.593	0.614
11	900.0	0.469	0.474	0.530	0.516	0.603	0.626
12	1000.0	0.473	0.475	0.534	0.520	0.607	0.632
13	1100.0	0.481	0.486	0.543	0.529	0.616	0.644
14	1200.0	0.487	0.489	0.549	0.535	0.622	0.649
15	1300.0	0.491	0.492	0.554	0.539	0.627	0.654
Step	Burnup $\left[\frac{MWd}{MtU}\right]$	MPACT Power Peaking Factors A (A)	B (D)	C (C)	D (B)	P (R)	S (Q)
0	0.0	0.463	0.472	0.522	0.513	0.595	0.624
1	25.0	0.494	0.503	0.553	0.545	0.628	0.657
2	50.0	0.489	0.498	0.548	0.539	0.623	0.651
3	100.0	0.479	0.488	0.538	0.529	0.612	0.641
4	200.0	0.465	0.473	0.523	0.514	0.597	0.625
5	300.0	0.457	0.466	0.515	0.507	0.589	0.617
6	400.0	0.453	0.462	0.512	0.503	0.585	0.614
7	500.0	0.452	0.460	0.511	0.502	0.584	0.613
8	600.0	0.452	0.461	0.512	0.503	0.586	0.615
9	700.0	0.455	0.463	0.514	0.505	0.589	0.618
10	800.0	0.458	0.466	0.518	0.509	0.593	0.622
11	900.0	0.461	0.470	0.522	0.513	0.597	0.627
12	1000.0	0.466	0.475	0.527	0.518	0.603	0.632
13	1100.0	0.471	0.480	0.532	0.523	0.608	0.638
14	1200.0	0.476	0.485	0.538	0.529	0.615	0.644
15	1300.0	0.481	0.490	0.544	0.535	0.621	0.651

Table 4.22. Problem 3.2.1 reference solution power peaking factors for charge-pans 1227 and 0732.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Shift Power Peaking Factors E (H)	F (G)	J (F)	K (E)	L (M)	M (L)
0	0.0	0.509	0.454	0.483	0.536	0.620	0.611
1	25.0	0.533	0.478	0.510	0.567	0.655	0.644
2	50.0	0.535	0.476	0.509	0.569	0.654	0.644
3	100.0	0.528	0.471	0.500	0.557	0.647	0.636
4	200.0	0.510	0.456	0.485	0.538	0.627	0.619
5	300.0	0.501	0.446	0.473	0.527	0.612	0.605
6	400.0	0.497	0.445	0.469	0.521	0.610	0.602
7	500.0	0.498	0.444	0.468	0.520	0.609	0.601
8	600.0	0.498	0.446	0.472	0.524	0.608	0.603
9	700.0	0.502	0.450	0.474	0.524	0.612	0.608
10	800.0	0.503	0.451	0.474	0.527	0.613	0.608
11	900.0	0.514	0.461	0.483	0.537	0.625	0.620
12	1000.0	0.517	0.462	0.488	0.542	0.630	0.625
13	1100.0	0.526	0.471	0.495	0.549	0.642	0.636
14	1200.0	0.531	0.477	0.501	0.557	0.649	0.644
15	1300.0	0.537	0.481	0.505	0.561	0.655	0.649
Step	**Burnup $\left[\frac{MWd}{MtU}\right]$**	**MPACT Power Peaking Factors E (H)**	**F (G)**	**J (F)**	**K (E)**	**L (M)**	**M (L)**
0	0.0	0.505	0.451	0.479	0.533	0.618	0.609
1	25.0	0.537	0.481	0.510	0.565	0.651	0.642
2	50.0	0.531	0.476	0.505	0.559	0.645	0.636
3	100.0	0.521	0.466	0.495	0.549	0.635	0.625
4	200.0	0.506	0.452	0.480	0.534	0.619	0.610
5	300.0	0.499	0.445	0.472	0.526	0.611	0.602
6	400.0	0.495	0.441	0.469	0.522	0.608	0.598
7	500.0	0.494	0.440	0.467	0.521	0.607	0.598
8	600.0	0.495	0.440	0.468	0.522	0.609	0.599
9	700.0	0.497	0.442	0.470	0.525	0.612	0.602
10	800.0	0.501	0.445	0.473	0.528	0.616	0.606
11	900.0	0.505	0.449	0.477	0.533	0.620	0.611
12	1000.0	0.510	0.453	0.482	0.538	0.626	0.616
13	1100.0	0.515	0.458	0.487	0.543	0.632	0.622
14	1200.0	0.521	0.463	0.492	0.549	0.638	0.628
15	1300.0	0.526	0.468	0.498	0.555	0.645	0.635

Charge-Pan 0828

Table 4.23. Problem 3.2.1 reference solution power peaking factors for charge-pan 0828.

Step	Burnup	Shift Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	1.436	1.465	1.496	1.415	1.446	1.502	1.536	1.387	1.474	1.566
1	25.0	1.454	1.483	1.513	1.430	1.467	1.530	1.564	1.392	1.500	1.596
2	50.0	1.450	1.484	1.517	1.429	1.466	1.533	1.562	1.393	1.502	1.594
3	100.0	1.444	1.477	1.509	1.423	1.461	1.525	1.559	1.387	1.494	1.590
4	200.0	1.432	1.474	1.503	1.416	1.457	1.513	1.543	1.384	1.484	1.575
5	300.0	1.426	1.471	1.500	1.409	1.457	1.507	1.540	1.379	1.481	1.569
6	400.0	1.418	1.468	1.496	1.403	1.452	1.503	1.532	1.377	1.475	1.563
7	500.0	1.420	1.475	1.501	1.406	1.458	1.511	1.537	1.378	1.484	1.570
8	600.0	1.423	1.479	1.511	1.408	1.464	1.519	1.547	1.381	1.490	1.576
9	700.0	1.423	1.486	1.509	1.411	1.468	1.522	1.552	1.378	1.497	1.583
10	800.0	1.427	1.493	1.519	1.412	1.474	1.535	1.564	1.382	1.503	1.597
11	900.0	1.426	1.494	1.518	1.412	1.477	1.537	1.564	1.380	1.509	1.597
12	1000.0	1.434	1.500	1.531	1.420	1.483	1.544	1.574	1.386	1.519	1.606
13	1100.0	1.436	1.509	1.532	1.423	1.488	1.551	1.583	1.385	1.528	1.616
14	1200.0	1.442	1.513	1.540	1.425	1.491	1.556	1.588	1.385	1.528	1.623
15	1300.0	1.443	1.517	1.541	1.429	1.496	1.563	1.597	1.388	1.539	1.630
Step	Burnup	MPACT Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	1.440	1.469	1.497	1.421	1.452	1.510	1.540	1.390	1.481	1.569
1	25.0	1.392	1.415	1.437	1.380	1.405	1.450	1.473	1.355	1.428	1.497
2	50.0	1.401	1.425	1.448	1.387	1.413	1.461	1.486	1.361	1.438	1.511
3	100.0	1.417	1.443	1.469	1.401	1.429	1.482	1.509	1.373	1.456	1.536
4	200.0	1.439	1.468	1.496	1.420	1.451	1.510	1.540	1.389	1.481	1.569
5	300.0	1.450	1.480	1.510	1.430	1.462	1.523	1.554	1.397	1.493	1.585
6	400.0	1.455	1.485	1.515	1.434	1.467	1.528	1.560	1.401	1.498	1.591
7	500.0	1.455	1.485	1.515	1.435	1.467	1.528	1.560	1.402	1.498	1.591
8	600.0	1.453	1.482	1.511	1.433	1.465	1.524	1.555	1.401	1.495	1.585
9	700.0	1.448	1.476	1.504	1.429	1.460	1.518	1.547	1.398	1.489	1.576
10	800.0	1.441	1.468	1.496	1.424	1.453	1.509	1.537	1.393	1.481	1.565
11	900.0	1.433	1.460	1.486	1.417	1.446	1.499	1.526	1.388	1.473	1.552
12	1000.0	1.425	1.450	1.474	1.410	1.437	1.488	1.513	1.382	1.463	1.539
13	1100.0	1.416	1.439	1.463	1.402	1.428	1.476	1.500	1.376	1.453	1.524
14	1200.0	1.406	1.429	1.451	1.394	1.419	1.464	1.486	1.369	1.442	1.509
15	1300.0	1.397	1.418	1.438	1.386	1.409	1.451	1.473	1.363	1.432	1.494

Charge-Pans 0928 and (0829)

Table 4.24. Problem 3.2.1 reference solution power peaking factors for charge-pans 0928 and 0829.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	1.274	1.301	1.349	1.322	1.345	1.194	1.289	1.436
1	25.0	1.280	1.317	1.365	1.329	1.349	1.193	1.308	1.463
2	50.0	1.284	1.320	1.368	1.329	1.349	1.196	1.315	1.462
3	100.0	1.276	1.314	1.364	1.326	1.346	1.196	1.305	1.456
4	200.0	1.276	1.310	1.356	1.324	1.349	1.199	1.299	1.448
5	300.0	1.273	1.305	1.354	1.320	1.350	1.197	1.290	1.441
6	400.0	1.270	1.305	1.349	1.319	1.349	1.199	1.289	1.440
7	500.0	1.276	1.310	1.360	1.326	1.354	1.202	1.296	1.444
8	600.0	1.280	1.316	1.366	1.329	1.355	1.205	1.303	1.449
9	700.0	1.283	1.320	1.368	1.330	1.358	1.209	1.305	1.454
10	800.0	1.286	1.323	1.372	1.335	1.359	1.209	1.312	1.462
11	900.0	1.286	1.326	1.376	1.336	1.356	1.210	1.318	1.467
12	1000.0	1.292	1.336	1.385	1.342	1.361	1.214	1.330	1.476
13	1100.0	1.297	1.342	1.390	1.344	1.363	1.217	1.339	1.485
14	1200.0	1.297	1.342	1.391	1.345	1.363	1.219	1.342	1.491
15	1300.0	1.298	1.349	1.397	1.345	1.360	1.214	1.348	1.496
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	1.277	1.307	1.356	1.326	1.350	1.197	1.289	1.444
1	25.0	1.260	1.284	1.325	1.301	1.322	1.194	1.272	1.400
2	50.0	1.262	1.288	1.330	1.305	1.327	1.194	1.275	1.408
3	100.0	1.268	1.295	1.340	1.313	1.336	1.194	1.280	1.423
4	200.0	1.276	1.305	1.355	1.325	1.349	1.197	1.288	1.443
5	300.0	1.280	1.311	1.362	1.331	1.356	1.198	1.293	1.454
6	400.0	1.283	1.314	1.365	1.334	1.359	1.199	1.295	1.458
7	500.0	1.284	1.315	1.366	1.335	1.360	1.201	1.296	1.459
8	600.0	1.284	1.314	1.365	1.334	1.359	1.202	1.296	1.456
9	700.0	1.283	1.313	1.363	1.333	1.357	1.202	1.296	1.452
10	800.0	1.282	1.311	1.359	1.330	1.354	1.203	1.294	1.446
11	900.0	1.280	1.308	1.355	1.327	1.350	1.204	1.292	1.439
12	1000.0	1.278	1.305	1.350	1.323	1.346	1.204	1.290	1.431
13	1100.0	1.275	1.301	1.345	1.319	1.341	1.204	1.288	1.422
14	1200.0	1.272	1.298	1.339	1.314	1.336	1.204	1.285	1.414
15	1300.0	1.269	1.293	1.333	1.309	1.331	1.204	1.282	1.405

Table 4.25. Problem 3.2.1 reference solution power peaking factors for charge-pans 0928 and 0829.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	1.298	1.248	1.229	1.261	1.343	1.394	1.409	1.379
1	25.0	1.298	1.246	1.234	1.272	1.362	1.416	1.424	1.387
2	50.0	1.301	1.250	1.238	1.277	1.368	1.420	1.431	1.389
3	100.0	1.296	1.248	1.234	1.274	1.361	1.413	1.422	1.385
4	200.0	1.305	1.252	1.231	1.265	1.350	1.403	1.418	1.386
5	300.0	1.303	1.251	1.230	1.262	1.345	1.397	1.412	1.382
6	400.0	1.302	1.252	1.227	1.259	1.342	1.392	1.409	1.378
7	500.0	1.307	1.257	1.231	1.265	1.350	1.399	1.417	1.383
8	600.0	1.309	1.258	1.236	1.271	1.356	1.406	1.422	1.387
9	700.0	1.310	1.259	1.238	1.273	1.360	1.411	1.424	1.390
10	800.0	1.311	1.259	1.242	1.282	1.366	1.418	1.432	1.391
11	900.0	1.310	1.262	1.243	1.288	1.372	1.424	1.431	1.392
12	1000.0	1.314	1.263	1.250	1.292	1.384	1.435	1.440	1.398
13	1100.0	1.316	1.268	1.254	1.299	1.394	1.445	1.446	1.400
14	1200.0	1.313	1.262	1.258	1.303	1.398	1.449	1.449	1.401
15	1300.0	1.313	1.262	1.257	1.305	1.405	1.455	1.453	1.404
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	1.303	1.252	1.230	1.261	1.346	1.398	1.415	1.383
1	25.0	1.283	1.240	1.221	1.247	1.319	1.362	1.375	1.349
2	50.0	1.286	1.241	1.222	1.249	1.324	1.368	1.382	1.355
3	100.0	1.293	1.245	1.225	1.253	1.332	1.380	1.395	1.367
4	200.0	1.302	1.251	1.229	1.260	1.345	1.397	1.414	1.382
5	300.0	1.307	1.254	1.232	1.263	1.351	1.406	1.423	1.390
6	400.0	1.310	1.256	1.234	1.266	1.355	1.409	1.427	1.394
7	500.0	1.311	1.257	1.235	1.267	1.355	1.410	1.428	1.395
8	600.0	1.311	1.258	1.236	1.267	1.355	1.409	1.426	1.394
9	700.0	1.310	1.258	1.236	1.267	1.353	1.405	1.422	1.391
10	800.0	1.308	1.257	1.236	1.266	1.350	1.401	1.417	1.387
11	900.0	1.306	1.256	1.235	1.265	1.346	1.396	1.411	1.382
12	1000.0	1.303	1.255	1.235	1.264	1.342	1.390	1.404	1.376
13	1100.0	1.300	1.253	1.234	1.262	1.338	1.383	1.397	1.370
14	1200.0	1.296	1.252	1.233	1.260	1.333	1.376	1.389	1.364
15	1300.0	1.293	1.250	1.231	1.257	1.328	1.369	1.381	1.357

Charge-Pans 1028 and (0830)

Table 4.26. Problem 3.2.1 reference solution power peaking factors for charge-pans 1028 and 0830.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	1.021	1.047	1.115	1.090	1.137	0.929	1.016	1.226
1	25.0	1.031	1.067	1.131	1.099	1.137	0.932	1.042	1.249
2	50.0	1.037	1.069	1.134	1.097	1.136	0.937	1.044	1.251
3	100.0	1.031	1.065	1.130	1.095	1.137	0.937	1.037	1.241
4	200.0	1.026	1.057	1.123	1.090	1.137	0.932	1.024	1.230
5	300.0	1.020	1.048	1.110	1.083	1.134	0.927	1.016	1.220
6	400.0	1.018	1.045	1.111	1.083	1.135	0.927	1.012	1.217
7	500.0	1.021	1.050	1.114	1.086	1.141	0.931	1.016	1.222
8	600.0	1.026	1.052	1.119	1.092	1.140	0.936	1.023	1.226
9	700.0	1.031	1.059	1.124	1.095	1.146	0.938	1.028	1.231
10	800.0	1.030	1.062	1.130	1.097	1.147	0.940	1.028	1.238
11	900.0	1.039	1.071	1.136	1.103	1.152	0.947	1.042	1.246
12	1000.0	1.045	1.077	1.141	1.109	1.157	0.952	1.046	1.255
13	1100.0	1.051	1.085	1.150	1.114	1.156	0.958	1.058	1.266
14	1200.0	1.054	1.092	1.154	1.120	1.160	0.960	1.066	1.272
15	1300.0	1.061	1.096	1.160	1.124	1.161	0.964	1.074	1.277
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	1.021	1.049	1.115	1.088	1.137	0.927	1.015	1.225
1	25.0	1.035	1.060	1.120	1.095	1.141	0.950	1.031	1.217
2	50.0	1.032	1.058	1.118	1.093	1.140	0.945	1.028	1.218
3	100.0	1.027	1.053	1.116	1.090	1.138	0.937	1.022	1.220
4	200.0	1.021	1.048	1.114	1.087	1.137	0.926	1.014	1.224
5	300.0	1.018	1.046	1.114	1.086	1.137	0.922	1.011	1.227
6	400.0	1.017	1.046	1.115	1.086	1.137	0.920	1.010	1.228
7	500.0	1.018	1.047	1.116	1.087	1.138	0.920	1.011	1.230
8	600.0	1.020	1.049	1.117	1.089	1.140	0.923	1.013	1.230
9	700.0	1.023	1.051	1.119	1.091	1.141	0.926	1.016	1.231
10	800.0	1.026	1.054	1.121	1.093	1.143	0.930	1.019	1.231
11	900.0	1.029	1.057	1.123	1.095	1.145	0.934	1.023	1.231
12	1000.0	1.032	1.060	1.124	1.097	1.147	0.939	1.027	1.230
13	1100.0	1.036	1.063	1.126	1.100	1.148	0.944	1.031	1.229
14	1200.0	1.039	1.066	1.128	1.102	1.150	0.949	1.035	1.228
15	1300.0	1.043	1.069	1.129	1.104	1.151	0.954	1.038	1.227

Table 4.27. Problem 3.2.1 reference solution power peaking factors for charge-pans 1028 and 0830.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	1.069	1.001	0.959	0.990	1.086	1.157	1.195	1.167
1	25.0	1.073	1.003	0.971	1.008	1.114	1.179	1.213	1.174
2	50.0	1.071	1.003	0.973	1.012	1.113	1.182	1.214	1.174
3	100.0	1.071	1.004	0.969	1.003	1.106	1.172	1.208	1.169
4	200.0	1.071	1.001	0.964	0.997	1.094	1.163	1.200	1.165
5	300.0	1.071	1.000	0.957	0.986	1.083	1.151	1.191	1.162
6	400.0	1.070	0.998	0.957	0.987	1.080	1.152	1.192	1.161
7	500.0	1.073	1.001	0.958	0.988	1.083	1.152	1.193	1.166
8	600.0	1.076	1.008	0.963	0.998	1.088	1.161	1.200	1.171
9	700.0	1.082	1.011	0.970	1.001	1.094	1.163	1.205	1.173
10	800.0	1.079	1.008	0.969	1.001	1.098	1.168	1.208	1.177
11	900.0	1.088	1.016	0.978	1.010	1.110	1.180	1.215	1.180
12	1000.0	1.093	1.022	0.982	1.018	1.116	1.186	1.226	1.186
13	1100.0	1.094	1.026	0.991	1.027	1.128	1.197	1.226	1.191
14	1200.0	1.097	1.030	0.997	1.032	1.134	1.201	1.233	1.196
15	1300.0	1.098	1.035	1.002	1.040	1.140	1.212	1.238	1.198
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	1.069	0.998	0.958	0.987	1.084	1.155	1.197	1.167
1	25.0	1.080	1.016	0.978	1.006	1.093	1.156	1.192	1.166
2	50.0	1.078	1.012	0.974	1.002	1.091	1.155	1.192	1.166
3	100.0	1.073	1.006	0.967	0.995	1.087	1.154	1.193	1.165
4	200.0	1.069	0.998	0.957	0.987	1.084	1.154	1.196	1.166
5	300.0	1.067	0.995	0.953	0.983	1.082	1.154	1.197	1.167
6	400.0	1.066	0.994	0.952	0.982	1.082	1.155	1.199	1.168
7	500.0	1.067	0.994	0.952	0.983	1.083	1.156	1.200	1.169
8	600.0	1.069	0.996	0.955	0.985	1.085	1.158	1.201	1.170
9	700.0	1.072	0.999	0.958	0.988	1.087	1.159	1.202	1.171
10	800.0	1.074	1.003	0.961	0.992	1.090	1.161	1.202	1.172
11	900.0	1.077	1.006	0.966	0.996	1.092	1.162	1.203	1.174
12	1000.0	1.080	1.010	0.970	1.000	1.095	1.163	1.203	1.174
13	1100.0	1.083	1.015	0.975	1.004	1.097	1.164	1.203	1.175
14	1200.0	1.086	1.019	0.979	1.008	1.100	1.165	1.203	1.176
15	1300.0	1.089	1.023	0.984	1.012	1.102	1.166	1.202	1.176

Charge-Pans 1128 and (0831)

Table 4.28. Problem 3.2.1 reference solution power peaking factors for charge-pans 1128 and 0831.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.706	0.735	0.816	0.786	0.844	0.603	0.672	0.937
1	25.0	0.724	0.758	0.840	0.807	0.857	0.613	0.701	0.967
2	50.0	0.721	0.758	0.841	0.805	0.855	0.613	0.701	0.970
3	100.0	0.720	0.753	0.835	0.800	0.853	0.613	0.694	0.960
4	200.0	0.710	0.739	0.823	0.794	0.849	0.605	0.679	0.943
5	300.0	0.700	0.729	0.811	0.784	0.844	0.600	0.667	0.930
6	400.0	0.702	0.729	0.812	0.784	0.845	0.602	0.668	0.927
7	500.0	0.702	0.728	0.811	0.784	0.843	0.601	0.667	0.928
8	600.0	0.705	0.734	0.816	0.787	0.849	0.605	0.672	0.933
9	700.0	0.709	0.737	0.818	0.791	0.853	0.610	0.675	0.938
10	800.0	0.709	0.736	0.821	0.794	0.854	0.609	0.676	0.937
11	900.0	0.722	0.748	0.833	0.803	0.860	0.618	0.689	0.951
12	1000.0	0.726	0.753	0.841	0.807	0.865	0.621	0.694	0.957
13	1100.0	0.733	0.764	0.847	0.818	0.871	0.627	0.705	0.968
14	1200.0	0.737	0.771	0.853	0.821	0.873	0.631	0.711	0.976
15	1300.0	0.741	0.774	0.859	0.824	0.878	0.636	0.717	0.983
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.704	0.732	0.816	0.787	0.846	0.601	0.671	0.937
1	25.0	0.736	0.763	0.844	0.817	0.874	0.634	0.704	0.960
2	50.0	0.730	0.758	0.839	0.811	0.868	0.628	0.698	0.955
3	100.0	0.720	0.747	0.829	0.801	0.859	0.617	0.687	0.947
4	200.0	0.705	0.732	0.816	0.787	0.846	0.601	0.672	0.937
5	300.0	0.698	0.725	0.810	0.781	0.840	0.593	0.664	0.932
6	400.0	0.694	0.722	0.807	0.778	0.838	0.590	0.661	0.930
7	500.0	0.694	0.722	0.807	0.778	0.838	0.589	0.660	0.931
8	600.0	0.696	0.724	0.809	0.780	0.840	0.590	0.662	0.933
9	700.0	0.699	0.727	0.812	0.783	0.843	0.593	0.665	0.936
10	800.0	0.703	0.731	0.817	0.788	0.847	0.597	0.669	0.940
11	900.0	0.708	0.736	0.822	0.793	0.852	0.602	0.674	0.944
12	1000.0	0.714	0.742	0.827	0.798	0.858	0.607	0.680	0.949
13	1100.0	0.720	0.748	0.833	0.804	0.863	0.613	0.686	0.954
14	1200.0	0.726	0.754	0.839	0.810	0.869	0.619	0.692	0.959
15	1300.0	0.732	0.761	0.845	0.816	0.875	0.625	0.699	0.964

Table 4.29. Problem 3.2.1 reference solution power peaking factors for charge-pans 1128 and 0831.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.763	0.677	0.622	0.648	0.763	0.852	0.909	0.877
1	25.0	0.773	0.691	0.636	0.669	0.795	0.885	0.933	0.895
2	50.0	0.772	0.687	0.637	0.671	0.794	0.886	0.935	0.897
3	100.0	0.772	0.689	0.635	0.666	0.789	0.876	0.926	0.890
4	200.0	0.766	0.680	0.626	0.656	0.769	0.862	0.914	0.880
5	300.0	0.759	0.674	0.616	0.644	0.760	0.847	0.904	0.874
6	400.0	0.759	0.674	0.618	0.644	0.759	0.846	0.901	0.874
7	500.0	0.760	0.677	0.617	0.643	0.756	0.847	0.900	0.874
8	600.0	0.767	0.680	0.620	0.649	0.762	0.852	0.906	0.879
9	700.0	0.770	0.684	0.625	0.651	0.765	0.853	0.910	0.883
10	800.0	0.770	0.684	0.626	0.650	0.768	0.857	0.912	0.885
11	900.0	0.780	0.695	0.637	0.663	0.781	0.871	0.921	0.892
12	1000.0	0.784	0.697	0.639	0.666	0.788	0.876	0.926	0.897
13	1100.0	0.789	0.704	0.647	0.676	0.798	0.886	0.938	0.906
14	1200.0	0.795	0.709	0.652	0.681	0.803	0.894	0.944	0.911
15	1300.0	0.797	0.710	0.655	0.687	0.812	0.900	0.951	0.917
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.761	0.677	0.619	0.646	0.763	0.852	0.909	0.879
1	25.0	0.792	0.709	0.652	0.678	0.794	0.880	0.933	0.905
2	50.0	0.787	0.703	0.646	0.673	0.788	0.875	0.929	0.900
3	100.0	0.776	0.692	0.635	0.662	0.778	0.865	0.920	0.891
4	200.0	0.762	0.677	0.620	0.646	0.763	0.852	0.909	0.879
5	300.0	0.755	0.670	0.612	0.639	0.756	0.846	0.904	0.873
6	400.0	0.752	0.666	0.609	0.635	0.753	0.844	0.902	0.871
7	500.0	0.752	0.666	0.608	0.635	0.753	0.844	0.902	0.872
8	600.0	0.754	0.667	0.609	0.636	0.755	0.846	0.905	0.874
9	700.0	0.757	0.670	0.612	0.639	0.759	0.849	0.908	0.877
10	800.0	0.761	0.675	0.616	0.643	0.763	0.854	0.912	0.881
11	900.0	0.766	0.680	0.621	0.648	0.768	0.859	0.917	0.886
12	1000.0	0.772	0.685	0.626	0.654	0.774	0.864	0.921	0.891
13	1100.0	0.778	0.691	0.632	0.660	0.780	0.870	0.927	0.896
14	1200.0	0.784	0.697	0.638	0.666	0.786	0.876	0.932	0.902
15	1300.0	0.791	0.704	0.645	0.673	0.793	0.882	0.937	0.908

Charge-Pans 1228 and (0832)

Table 4.30. Problem 3.2.1 reference solution power peaking factors for charge-pans 1228 and 0832.

Step	Burnup	Shift Power Peaking Factors					
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	S
		(A)	(D)	(C)	(B)	(R)	(Q)
0	0.0	0.380	0.405	0.460	0.438	0.540	0.579
1	25.0	0.393	0.423	0.477	0.453	0.551	0.603
2	50.0	0.392	0.420	0.478	0.452	0.550	0.604
3	100.0	0.388	0.416	0.473	0.448	0.549	0.597
4	200.0	0.382	0.407	0.462	0.439	0.541	0.579
5	300.0	0.376	0.398	0.454	0.433	0.534	0.569
6	400.0	0.375	0.397	0.453	0.431	0.535	0.568
7	500.0	0.375	0.395	0.454	0.431	0.533	0.566
8	600.0	0.375	0.395	0.455	0.433	0.534	0.569
9	700.0	0.378	0.399	0.459	0.434	0.540	0.572
10	800.0	0.379	0.398	0.460	0.434	0.539	0.572
11	900.0	0.386	0.406	0.470	0.444	0.549	0.582
12	1000.0	0.390	0.409	0.473	0.445	0.550	0.585
13	1100.0	0.394	0.414	0.480	0.450	0.556	0.595
14	1200.0	0.397	0.417	0.482	0.452	0.558	0.600
15	1300.0	0.401	0.422	0.486	0.458	0.563	0.606
Step	Burnup	MPACT Power Peaking Factors					
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	S
		(A)	(D)	(C)	(B)	(R)	(Q)
0	0.0	0.377	0.403	0.456	0.436	0.537	0.576
1	25.0	0.404	0.431	0.486	0.464	0.569	0.609
2	50.0	0.400	0.427	0.481	0.460	0.564	0.603
3	100.0	0.391	0.418	0.472	0.450	0.553	0.592
4	200.0	0.379	0.404	0.458	0.437	0.538	0.577
5	300.0	0.372	0.397	0.450	0.430	0.530	0.569
6	400.0	0.369	0.394	0.447	0.426	0.526	0.566
7	500.0	0.367	0.393	0.446	0.425	0.525	0.565
8	600.0	0.368	0.393	0.446	0.426	0.526	0.566
9	700.0	0.369	0.395	0.448	0.427	0.528	0.569
10	800.0	0.372	0.397	0.452	0.430	0.532	0.573
11	900.0	0.375	0.401	0.455	0.434	0.536	0.577
12	1000.0	0.378	0.405	0.460	0.438	0.541	0.583
13	1100.0	0.382	0.409	0.464	0.443	0.546	0.588
14	1200.0	0.387	0.413	0.470	0.448	0.552	0.594
15	1300.0	0.391	0.418	0.475	0.453	0.558	0.601

Table 4.31. Problem 3.2.1 reference solution power peaking factors for charge-pans 1228 and 0832.

Step	Burnup	Shift Power Peaking Factors					
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)
0	0.0	0.451	0.372	0.433	0.488	0.555	0.531
1	25.0	0.465	0.382	0.452	0.510	0.574	0.548
2	50.0	0.462	0.382	0.452	0.509	0.574	0.545
3	100.0	0.461	0.380	0.448	0.506	0.569	0.544
4	200.0	0.455	0.374	0.436	0.492	0.556	0.535
5	300.0	0.447	0.371	0.428	0.481	0.547	0.525
6	400.0	0.449	0.370	0.427	0.480	0.546	0.527
7	500.0	0.450	0.371	0.425	0.481	0.546	0.526
8	600.0	0.449	0.371	0.428	0.481	0.548	0.527
9	700.0	0.453	0.373	0.431	0.482	0.552	0.533
10	800.0	0.453	0.374	0.433	0.485	0.553	0.533
11	900.0	0.462	0.382	0.441	0.495	0.562	0.544
12	1000.0	0.467	0.387	0.445	0.498	0.566	0.546
13	1100.0	0.469	0.390	0.452	0.507	0.576	0.553
14	1200.0	0.473	0.392	0.455	0.511	0.579	0.557
15	1300.0	0.477	0.396	0.460	0.515	0.583	0.560
Step	Burnup	MPACT Power Peaking Factors					
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)
0	0.0	0.450	0.369	0.431	0.486	0.551	0.529
1	25.0	0.479	0.396	0.460	0.517	0.583	0.560
2	50.0	0.475	0.392	0.455	0.512	0.578	0.555
3	100.0	0.465	0.384	0.446	0.502	0.567	0.544
4	200.0	0.451	0.371	0.432	0.487	0.552	0.529
5	300.0	0.443	0.365	0.425	0.480	0.544	0.522
6	400.0	0.440	0.361	0.421	0.476	0.541	0.518
7	500.0	0.438	0.360	0.420	0.475	0.540	0.517
8	600.0	0.439	0.360	0.420	0.476	0.541	0.518
9	700.0	0.441	0.362	0.422	0.478	0.544	0.521
10	800.0	0.444	0.364	0.425	0.481	0.547	0.524
11	900.0	0.447	0.367	0.428	0.485	0.552	0.528
12	1000.0	0.452	0.370	0.433	0.490	0.557	0.533
13	1100.0	0.456	0.374	0.437	0.495	0.562	0.539
14	1200.0	0.461	0.378	0.442	0.501	0.568	0.544
15	1300.0	0.466	0.382	0.447	0.506	0.574	0.550

Charge-Pan 0929

Table 4.32. Problem 3.2.1 reference solution power peaking factors for charge-pan 0929.

Step	Burnup	Shift Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	1.104	1.156	1.197	1.062	1.113	1.208	1.258	1.011	1.159	1.307
1	25.0	1.081	1.133	1.182	1.041	1.098	1.195	1.248	0.988	1.148	1.297
2	50.0	1.084	1.135	1.183	1.042	1.098	1.199	1.250	0.987	1.149	1.301
3	100.0	1.090	1.146	1.187	1.050	1.103	1.203	1.254	0.996	1.153	1.302
4	200.0	1.104	1.160	1.199	1.063	1.115	1.212	1.262	1.008	1.163	1.312
5	300.0	1.108	1.170	1.206	1.066	1.119	1.215	1.267	1.018	1.164	1.313
6	400.0	1.110	1.173	1.208	1.071	1.119	1.218	1.265	1.023	1.166	1.313
7	500.0	1.113	1.172	1.210	1.073	1.126	1.220	1.270	1.025	1.170	1.318
8	600.0	1.108	1.171	1.208	1.072	1.126	1.220	1.269	1.022	1.173	1.318
9	700.0	1.111	1.168	1.209	1.070	1.126	1.222	1.272	1.021	1.174	1.317
10	800.0	1.105	1.163	1.204	1.066	1.122	1.225	1.271	1.015	1.174	1.318
11	900.0	1.102	1.157	1.203	1.066	1.123	1.223	1.271	1.013	1.173	1.317
12	1000.0	1.100	1.152	1.201	1.065	1.122	1.221	1.270	1.007	1.173	1.316
13	1100.0	1.093	1.146	1.198	1.058	1.121	1.221	1.269	0.999	1.174	1.316
14	1200.0	1.089	1.138	1.194	1.053	1.119	1.219	1.267	0.998	1.173	1.313
15	1300.0	1.085	1.132	1.191	1.050	1.114	1.216	1.264	0.992	1.169	1.310
Step	Burnup	MPACT Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	1.105	1.159	1.200	1.062	1.112	1.210	1.261	1.011	1.159	1.309
1	25.0	1.111	1.161	1.193	1.074	1.119	1.204	1.247	1.028	1.161	1.289
2	50.0	1.109	1.160	1.194	1.071	1.117	1.204	1.249	1.025	1.160	1.292
3	100.0	1.107	1.159	1.195	1.067	1.115	1.206	1.253	1.018	1.159	1.299
4	200.0	1.104	1.158	1.199	1.062	1.112	1.209	1.260	1.010	1.158	1.309
5	300.0	1.103	1.159	1.201	1.060	1.111	1.211	1.263	1.007	1.159	1.314
6	400.0	1.104	1.160	1.202	1.059	1.111	1.212	1.266	1.006	1.160	1.317
7	500.0	1.105	1.161	1.203	1.060	1.112	1.214	1.267	1.007	1.161	1.318
8	600.0	1.106	1.162	1.204	1.062	1.114	1.215	1.267	1.009	1.162	1.317
9	700.0	1.108	1.164	1.205	1.064	1.116	1.215	1.267	1.012	1.164	1.316
10	800.0	1.110	1.165	1.205	1.067	1.118	1.216	1.266	1.015	1.165	1.314
11	900.0	1.112	1.166	1.205	1.070	1.120	1.216	1.265	1.019	1.166	1.312
12	1000.0	1.114	1.167	1.205	1.073	1.122	1.216	1.263	1.023	1.167	1.309
13	1100.0	1.116	1.169	1.205	1.076	1.124	1.215	1.262	1.027	1.169	1.306
14	1200.0	1.118	1.170	1.204	1.080	1.126	1.215	1.260	1.031	1.170	1.302
15	1300.0	1.120	1.170	1.203	1.083	1.128	1.214	1.257	1.035	1.170	1.298

Charge-Pans 1029 and (0930)

Table 4.33. Problem 3.2.1 reference solution power peaking factors for charge-pans 1029 and 0930.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.865	0.913	0.980	0.932	0.952	0.742	0.889	1.097
1	25.0	0.850	0.899	0.966	0.916	0.928	0.728	0.887	1.090
2	50.0	0.851	0.902	0.966	0.917	0.928	0.724	0.887	1.092
3	100.0	0.855	0.905	0.972	0.922	0.937	0.732	0.889	1.093
4	200.0	0.863	0.911	0.978	0.930	0.949	0.739	0.891	1.102
5	300.0	0.865	0.913	0.980	0.933	0.955	0.746	0.889	1.099
6	400.0	0.867	0.915	0.982	0.935	0.960	0.748	0.892	1.103
7	500.0	0.871	0.918	0.985	0.938	0.962	0.749	0.895	1.102
8	600.0	0.870	0.919	0.988	0.940	0.961	0.754	0.900	1.105
9	700.0	0.873	0.923	0.989	0.940	0.959	0.755	0.904	1.111
10	800.0	0.871	0.919	0.987	0.937	0.955	0.749	0.903	1.108
11	900.0	0.874	0.927	0.989	0.939	0.954	0.753	0.908	1.110
12	1000.0	0.875	0.926	0.993	0.937	0.950	0.751	0.910	1.112
13	1100.0	0.871	0.926	0.989	0.932	0.945	0.747	0.915	1.113
14	1200.0	0.870	0.927	0.990	0.932	0.942	0.747	0.920	1.114
15	1300.0	0.868	0.924	0.988	0.928	0.936	0.745	0.916	1.113
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.864	0.911	0.978	0.931	0.950	0.740	0.887	1.099
1	25.0	0.891	0.935	0.997	0.953	0.972	0.772	0.913	1.107
2	50.0	0.885	0.930	0.993	0.949	0.968	0.766	0.908	1.105
3	100.0	0.876	0.922	0.986	0.941	0.960	0.755	0.899	1.102
4	200.0	0.864	0.910	0.978	0.930	0.950	0.741	0.887	1.098
5	300.0	0.858	0.905	0.974	0.926	0.945	0.733	0.881	1.097
6	400.0	0.856	0.904	0.972	0.924	0.944	0.730	0.879	1.097
7	500.0	0.856	0.904	0.973	0.924	0.944	0.730	0.880	1.098
8	600.0	0.858	0.906	0.975	0.926	0.946	0.732	0.882	1.099
9	700.0	0.861	0.909	0.978	0.930	0.949	0.735	0.885	1.102
10	800.0	0.865	0.913	0.982	0.934	0.953	0.739	0.889	1.104
11	900.0	0.870	0.918	0.986	0.938	0.958	0.744	0.894	1.106
12	1000.0	0.875	0.923	0.990	0.943	0.962	0.750	0.899	1.109
13	1100.0	0.881	0.928	0.994	0.948	0.967	0.756	0.904	1.111
14	1200.0	0.887	0.933	0.999	0.953	0.972	0.763	0.910	1.114
15	1300.0	0.892	0.938	1.003	0.958	0.977	0.769	0.916	1.116

Table 4.34. Problem 3.2.1 reference solution power peaking factors for charge-pans 1029 and 0930.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.883	0.816	0.796	0.843	0.961	1.035	1.056	1.005
1	25.0	0.866	0.797	0.783	0.836	0.958	1.027	1.039	0.985
2	50.0	0.866	0.798	0.784	0.837	0.956	1.025	1.042	0.988
3	100.0	0.872	0.805	0.788	0.842	0.962	1.030	1.046	0.992
4	200.0	0.884	0.815	0.795	0.845	0.965	1.033	1.055	1.001
5	300.0	0.890	0.818	0.798	0.847	0.963	1.032	1.053	1.008
6	400.0	0.894	0.823	0.799	0.850	0.964	1.034	1.060	1.009
7	500.0	0.895	0.824	0.801	0.851	0.970	1.037	1.058	1.010
8	600.0	0.897	0.827	0.805	0.855	0.972	1.043	1.063	1.012
9	700.0	0.895	0.827	0.808	0.858	0.977	1.045	1.065	1.009
10	800.0	0.894	0.823	0.803	0.855	0.975	1.044	1.061	1.006
11	900.0	0.892	0.826	0.807	0.861	0.980	1.049	1.063	1.007
12	1000.0	0.891	0.822	0.807	0.864	0.983	1.052	1.063	1.007
13	1100.0	0.884	0.817	0.805	0.862	0.985	1.055	1.060	1.000
14	1200.0	0.880	0.819	0.803	0.865	0.987	1.055	1.059	1.002
15	1300.0	0.879	0.815	0.802	0.864	0.988	1.055	1.058	0.996
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.885	0.814	0.793	0.843	0.961	1.032	1.054	1.004
1	25.0	0.911	0.844	0.824	0.871	0.982	1.047	1.067	1.021
2	50.0	0.906	0.839	0.818	0.866	0.978	1.044	1.064	1.018
3	100.0	0.897	0.828	0.808	0.856	0.970	1.039	1.059	1.011
4	200.0	0.885	0.815	0.794	0.843	0.961	1.032	1.053	1.003
5	300.0	0.879	0.808	0.787	0.837	0.957	1.029	1.051	1.000
6	400.0	0.877	0.805	0.784	0.834	0.955	1.028	1.050	0.999
7	500.0	0.877	0.805	0.784	0.834	0.956	1.029	1.051	0.999
8	600.0	0.879	0.807	0.786	0.836	0.958	1.031	1.053	1.001
9	700.0	0.882	0.811	0.789	0.840	0.961	1.034	1.056	1.004
10	800.0	0.887	0.815	0.794	0.844	0.965	1.037	1.059	1.008
11	900.0	0.891	0.820	0.799	0.849	0.969	1.040	1.062	1.012
12	1000.0	0.897	0.826	0.804	0.854	0.973	1.044	1.065	1.016
13	1100.0	0.902	0.832	0.810	0.860	0.978	1.048	1.068	1.020
14	1200.0	0.908	0.838	0.817	0.866	0.983	1.051	1.072	1.024
15	1300.0	0.914	0.844	0.823	0.872	0.988	1.055	1.075	1.028

Charge-Pans 1129 and (0931)

Table 4.35. Problem 3.2.1 reference solution power peaking factors for charge-pans 1129 and 0931.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.552	0.598	0.671	0.624	0.663	0.463	0.598	0.811
1	25.0	0.549	0.596	0.668	0.621	0.653	0.458	0.605	0.809
2	50.0	0.548	0.597	0.668	0.618	0.651	0.458	0.601	0.810
3	100.0	0.550	0.600	0.670	0.620	0.654	0.460	0.604	0.812
4	200.0	0.551	0.594	0.667	0.624	0.661	0.463	0.600	0.808
5	300.0	0.553	0.598	0.669	0.627	0.663	0.465	0.596	0.806
6	400.0	0.553	0.597	0.670	0.627	0.667	0.467	0.598	0.804
7	500.0	0.554	0.597	0.672	0.629	0.668	0.467	0.599	0.807
8	600.0	0.555	0.600	0.673	0.629	0.667	0.469	0.601	0.810
9	700.0	0.558	0.602	0.675	0.633	0.671	0.471	0.604	0.813
10	800.0	0.558	0.604	0.676	0.631	0.667	0.472	0.606	0.813
11	900.0	0.564	0.610	0.682	0.636	0.675	0.476	0.615	0.821
12	1000.0	0.564	0.611	0.684	0.636	0.671	0.476	0.617	0.824
13	1100.0	0.567	0.614	0.686	0.639	0.672	0.478	0.621	0.828
14	1200.0	0.567	0.616	0.689	0.641	0.671	0.479	0.625	0.830
15	1300.0	0.569	0.618	0.689	0.640	0.674	0.479	0.629	0.833
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.551	0.595	0.668	0.623	0.661	0.460	0.596	0.807
1	25.0	0.582	0.627	0.700	0.655	0.694	0.491	0.629	0.836
2	50.0	0.576	0.621	0.694	0.650	0.688	0.486	0.623	0.831
3	100.0	0.566	0.610	0.684	0.639	0.677	0.476	0.612	0.821
4	200.0	0.551	0.595	0.669	0.624	0.661	0.462	0.596	0.807
5	300.0	0.543	0.588	0.661	0.616	0.654	0.454	0.588	0.801
6	400.0	0.540	0.584	0.658	0.613	0.650	0.450	0.584	0.798
7	500.0	0.539	0.583	0.657	0.612	0.650	0.449	0.583	0.798
8	600.0	0.540	0.584	0.659	0.613	0.651	0.450	0.584	0.800
9	700.0	0.542	0.587	0.662	0.616	0.654	0.452	0.587	0.803
10	800.0	0.546	0.591	0.666	0.620	0.659	0.455	0.591	0.808
11	900.0	0.551	0.596	0.671	0.625	0.664	0.458	0.595	0.813
12	1000.0	0.555	0.601	0.677	0.630	0.669	0.463	0.601	0.818
13	1100.0	0.561	0.607	0.682	0.636	0.675	0.467	0.606	0.824
14	1200.0	0.567	0.613	0.689	0.642	0.682	0.472	0.612	0.830
15	1300.0	0.573	0.619	0.695	0.649	0.688	0.478	0.619	0.836

Table 4.36. Problem 3.2.1 reference solution power peaking factors for charge-pans 1129 and 0931.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.581	0.505	0.515	0.566	0.643	0.725	0.766	0.713
1	25.0	0.574	0.501	0.513	0.566	0.648	0.728	0.761	0.707
2	50.0	0.572	0.499	0.513	0.567	0.648	0.728	0.759	0.704
3	100.0	0.577	0.501	0.515	0.569	0.648	0.728	0.761	0.709
4	200.0	0.580	0.503	0.514	0.565	0.645	0.723	0.760	0.712
5	300.0	0.582	0.507	0.516	0.566	0.642	0.721	0.760	0.713
6	400.0	0.585	0.508	0.518	0.568	0.641	0.720	0.759	0.715
7	500.0	0.586	0.510	0.520	0.568	0.643	0.725	0.764	0.717
8	600.0	0.587	0.512	0.519	0.569	0.646	0.726	0.763	0.718
9	700.0	0.590	0.511	0.524	0.574	0.648	0.730	0.768	0.722
10	800.0	0.589	0.515	0.524	0.572	0.649	0.731	0.768	0.721
11	900.0	0.594	0.518	0.529	0.582	0.658	0.739	0.775	0.724
12	1000.0	0.593	0.516	0.530	0.582	0.659	0.740	0.773	0.725
13	1100.0	0.594	0.517	0.533	0.585	0.666	0.745	0.777	0.724
14	1200.0	0.595	0.519	0.534	0.589	0.667	0.750	0.779	0.726
15	1300.0	0.592	0.520	0.536	0.590	0.669	0.751	0.777	0.727
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.579	0.503	0.513	0.563	0.641	0.722	0.761	0.712
1	25.0	0.611	0.534	0.545	0.596	0.674	0.753	0.792	0.744
2	50.0	0.606	0.529	0.540	0.591	0.668	0.747	0.786	0.739
3	100.0	0.595	0.519	0.529	0.580	0.657	0.737	0.776	0.728
4	200.0	0.580	0.504	0.514	0.564	0.642	0.722	0.761	0.713
5	300.0	0.572	0.497	0.506	0.555	0.634	0.715	0.754	0.705
6	400.0	0.568	0.493	0.502	0.551	0.630	0.712	0.751	0.702
7	500.0	0.568	0.492	0.501	0.550	0.630	0.711	0.751	0.702
8	600.0	0.569	0.493	0.502	0.551	0.631	0.713	0.753	0.704
9	700.0	0.572	0.495	0.504	0.554	0.634	0.716	0.756	0.707
10	800.0	0.575	0.499	0.507	0.557	0.638	0.721	0.761	0.711
11	900.0	0.580	0.503	0.512	0.562	0.643	0.726	0.766	0.716
12	1000.0	0.585	0.507	0.516	0.567	0.649	0.731	0.771	0.722
13	1100.0	0.591	0.513	0.521	0.573	0.655	0.737	0.777	0.728
14	1200.0	0.597	0.518	0.527	0.578	0.661	0.744	0.784	0.734
15	1300.0	0.603	0.524	0.533	0.584	0.667	0.750	0.790	0.741

Charge-Pan 1030

Table 4.37. Problem 3.2.1 reference solution power peaking factors for charge-pan 1030.

Step	Burnup	Shift Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	0.624	0.681	0.749	0.561	0.621	0.756	0.824	0.505	0.683	0.889
1	25.0	0.603	0.657	0.727	0.541	0.602	0.737	0.801	0.487	0.668	0.866
2	50.0	0.603	0.657	0.725	0.543	0.603	0.734	0.799	0.489	0.667	0.864
3	100.0	0.612	0.665	0.736	0.549	0.611	0.742	0.810	0.493	0.673	0.874
4	200.0	0.621	0.680	0.745	0.556	0.618	0.752	0.822	0.502	0.680	0.885
5	300.0	0.626	0.688	0.753	0.564	0.626	0.758	0.827	0.510	0.687	0.892
6	400.0	0.630	0.696	0.755	0.566	0.626	0.760	0.829	0.513	0.690	0.896
7	500.0	0.633	0.693	0.757	0.570	0.630	0.761	0.830	0.516	0.690	0.897
8	600.0	0.634	0.693	0.756	0.570	0.630	0.763	0.831	0.515	0.692	0.895
9	700.0	0.630	0.688	0.754	0.568	0.629	0.761	0.829	0.515	0.693	0.893
10	800.0	0.628	0.686	0.751	0.565	0.625	0.761	0.829	0.512	0.690	0.890
11	900.0	0.627	0.684	0.750	0.567	0.627	0.761	0.826	0.512	0.693	0.888
12	1000.0	0.625	0.676	0.746	0.561	0.624	0.758	0.825	0.506	0.690	0.886
13	1100.0	0.617	0.669	0.742	0.557	0.621	0.754	0.818	0.504	0.687	0.878
14	1200.0	0.615	0.668	0.737	0.557	0.618	0.752	0.816	0.503	0.687	0.876
15	1300.0	0.612	0.661	0.736	0.553	0.618	0.749	0.813	0.501	0.684	0.872
Step	Burnup	MPACT Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	0.623	0.682	0.748	0.559	0.620	0.754	0.823	0.504	0.682	0.890
1	25.0	0.656	0.715	0.780	0.591	0.653	0.786	0.853	0.536	0.715	0.917
2	50.0	0.650	0.709	0.774	0.586	0.647	0.780	0.847	0.531	0.709	0.911
3	100.0	0.639	0.698	0.764	0.575	0.636	0.769	0.837	0.520	0.698	0.902
4	200.0	0.624	0.682	0.749	0.559	0.621	0.755	0.824	0.505	0.682	0.890
5	300.0	0.616	0.675	0.742	0.552	0.613	0.747	0.817	0.497	0.675	0.885
6	400.0	0.612	0.671	0.739	0.548	0.609	0.744	0.814	0.493	0.671	0.882
7	500.0	0.611	0.671	0.738	0.547	0.608	0.744	0.814	0.492	0.671	0.883
8	600.0	0.613	0.672	0.740	0.548	0.610	0.746	0.816	0.493	0.672	0.885
9	700.0	0.616	0.676	0.744	0.551	0.613	0.749	0.820	0.495	0.676	0.888
10	800.0	0.620	0.680	0.748	0.554	0.617	0.754	0.824	0.499	0.680	0.892
11	900.0	0.625	0.685	0.753	0.559	0.622	0.759	0.829	0.503	0.685	0.897
12	1000.0	0.630	0.691	0.759	0.564	0.627	0.765	0.835	0.508	0.691	0.902
13	1100.0	0.636	0.697	0.765	0.570	0.633	0.771	0.841	0.513	0.697	0.908
14	1200.0	0.642	0.703	0.771	0.576	0.640	0.777	0.847	0.519	0.703	0.914
15	1300.0	0.649	0.710	0.778	0.582	0.646	0.784	0.853	0.525	0.710	0.919

Table 4.38. Problem 3.2.1 reference solution power peaking factors for charge-pans 1130 and 1031.

Step	Burnup	Shift Power Peaking Factors						
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	R	S
		(A)	(D)	(C)	(B)	(R)	(P)	(S)
0	0.0	0.392	0.423	0.468	0.425	0.461	0.426	0.606
1	25.0	0.384	0.414	0.458	0.415	0.448	0.420	0.593
2	50.0	0.382	0.414	0.457	0.412	0.446	0.418	0.592
3	100.0	0.386	0.419	0.463	0.418	0.453	0.423	0.597
4	200.0	0.390	0.423	0.465	0.424	0.458	0.424	0.600
5	300.0	0.393	0.426	0.470	0.429	0.463	0.426	0.605
6	400.0	0.394	0.425	0.471	0.428	0.467	0.428	0.604
7	500.0	0.398	0.429	0.473	0.431	0.467	0.429	0.605
8	600.0	0.397	0.429	0.474	0.432	0.467	0.429	0.606
9	700.0	0.398	0.431	0.476	0.431	0.466	0.431	0.607
10	800.0	0.395	0.429	0.474	0.428	0.465	0.431	0.602
11	900.0	0.398	0.434	0.474	0.433	0.466	0.434	0.606
12	1000.0	0.397	0.432	0.473	0.429	0.461	0.434	0.603
13	1100.0	0.395	0.431	0.472	0.427	0.459	0.434	0.602
14	1200.0	0.395	0.431	0.472	0.428	0.459	0.435	0.604
15	1300.0	0.395	0.430	0.472	0.426	0.458	0.436	0.600
Step	Burnup	MPACT Power Peaking Factors						
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	R	S
		(A)	(D)	(C)	(B)	(R)	(P)	(S)
0	0.0	0.389	0.422	0.467	0.424	0.461	0.423	0.604
1	25.0	0.418	0.451	0.497	0.452	0.491	0.452	0.637
2	50.0	0.413	0.446	0.492	0.448	0.486	0.447	0.632
3	100.0	0.404	0.436	0.482	0.438	0.476	0.438	0.621
4	200.0	0.391	0.423	0.468	0.425	0.461	0.424	0.605
5	300.0	0.384	0.416	0.460	0.417	0.454	0.417	0.597
6	400.0	0.380	0.412	0.457	0.414	0.450	0.413	0.594
7	500.0	0.379	0.411	0.456	0.412	0.448	0.412	0.593
8	600.0	0.379	0.411	0.456	0.413	0.449	0.412	0.594
9	700.0	0.381	0.413	0.459	0.415	0.451	0.414	0.597
10	800.0	0.384	0.416	0.462	0.418	0.454	0.417	0.601
11	900.0	0.387	0.419	0.466	0.421	0.458	0.420	0.606
12	1000.0	0.391	0.423	0.470	0.425	0.463	0.424	0.611
13	1100.0	0.395	0.428	0.475	0.430	0.468	0.429	0.617
14	1200.0	0.399	0.433	0.480	0.435	0.473	0.433	0.624
15	1300.0	0.404	0.438	0.486	0.440	0.478	0.438	0.630

Table 4.39. Problem 3.2.1 reference solution power peaking factors for charge-pans 1130 and 1031.

Step	Burnup	Shift Power Peaking Factors				
	$\left[\frac{MWd}{MtU}\right]$	E	J	K	L	M
		(H)	(M)	(L)	(K)	(J)
0	0.0	0.412	0.463	0.529	0.548	0.491
1	25.0	0.401	0.453	0.518	0.533	0.478
2	50.0	0.400	0.451	0.517	0.530	0.475
3	100.0	0.405	0.455	0.521	0.539	0.483
4	200.0	0.409	0.459	0.523	0.544	0.489
5	300.0	0.415	0.461	0.526	0.547	0.495
6	400.0	0.418	0.462	0.527	0.549	0.496
7	500.0	0.419	0.462	0.528	0.550	0.497
8	600.0	0.421	0.462	0.530	0.551	0.497
9	700.0	0.419	0.463	0.530	0.552	0.499
10	800.0	0.418	0.463	0.527	0.550	0.497
11	900.0	0.418	0.467	0.531	0.553	0.497
12	1000.0	0.417	0.464	0.531	0.549	0.494
13	1100.0	0.415	0.465	0.530	0.549	0.491
14	1200.0	0.416	0.465	0.530	0.548	0.490
15	1300.0	0.412	0.466	0.531	0.546	0.489
Step	Burnup	MPACT Power Peaking Factors				
	$\left[\frac{MWd}{MtU}\right]$	E	J	K	L	M
		(H)	(M)	(L)	(K)	(J)
0	0.0	0.411	0.459	0.526	0.545	0.490
1	25.0	0.440	0.488	0.557	0.577	0.521
2	50.0	0.435	0.483	0.552	0.572	0.516
3	100.0	0.426	0.474	0.542	0.561	0.506
4	200.0	0.412	0.460	0.527	0.546	0.491
5	300.0	0.405	0.452	0.519	0.538	0.483
6	400.0	0.401	0.448	0.515	0.534	0.479
7	500.0	0.399	0.447	0.514	0.533	0.478
8	600.0	0.400	0.448	0.515	0.535	0.479
9	700.0	0.402	0.450	0.518	0.537	0.482
10	800.0	0.404	0.453	0.521	0.541	0.485
11	900.0	0.408	0.457	0.526	0.545	0.489
12	1000.0	0.412	0.461	0.531	0.550	0.494
13	1100.0	0.416	0.466	0.536	0.556	0.499
14	1200.0	0.421	0.471	0.542	0.562	0.504
15	1300.0	0.426	0.477	0.548	0.568	0.510

4.2.2 Problem 3.2.2

4.2.2.1 Description

Figure 9 shows the quarter core geometry for Problem 3.2.2, which is the same as Problem 3.1.2. The geometry remains ⅛ symmetric. The diagonal dashed line illustrates an axis of reflected symmetry. The main control bank is inserted in the following charge-pans: 0729, 0730, 0927, 0929, and 1027. Material densities are listed in Table1.4. Temperatures are listed in Table 10. Burnup states used for comparison are listed in Table 1.5 and the total system specific power is listed in Table 1.6.

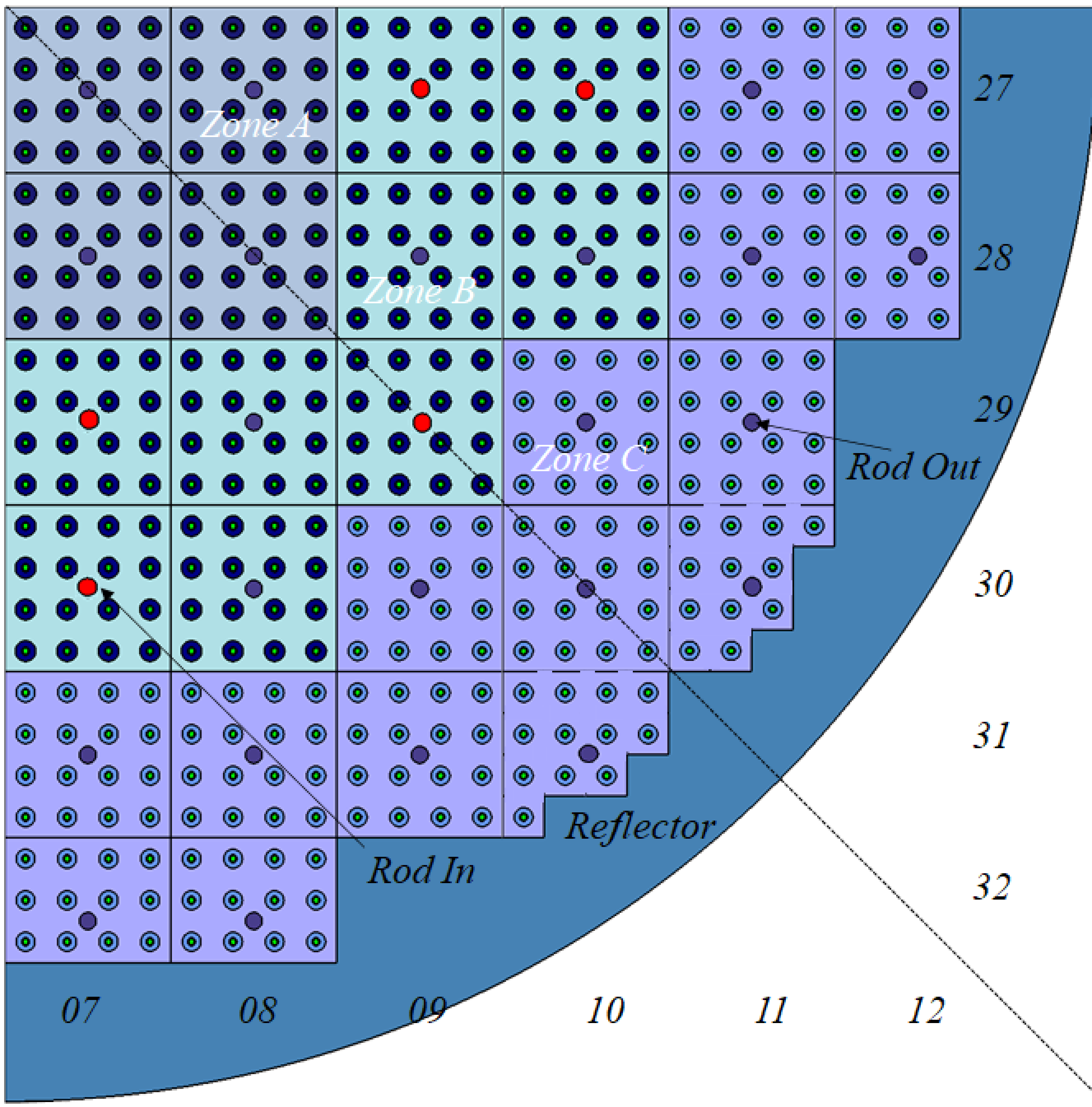


Figure 15. Quarter core 2D with main control bank inserted.

4.2.2.2 Reference Solution

Table 4.40. Neutron multiplication factor for the reference solution of Problem 3.2.2.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift k_{eff} (1σ)	MPACT k_{eff} (1σ)	Difference [pcm]
0	0.0	1.02371(5)	1.02365(1)	-6(5)
1	25.0	1.01060(5)	1.008(1)	-260(5)
2	50.0	1.01070(5)	1.0083(1)	-240(5)
3	100.0	1.01148(5)	1.01032(1)	-116(5)
4	200.0	1.01444(5)	1.0151(1)	66(5)
5	300.0	1.01740(5)	1.01904(1)	165(5)
6	400.0	1.01995(5)	1.02205(1)	211(6)
7	500.0	1.02200(5)	1.0243(1)	229(5)
8	600.0	1.02392(5)	1.02594(1)	202(5)
9	700.0	1.02530(6)	1.0271(1)	180(6)
10	800.0	1.0266(5)	1.0279(1)	130(5)
11	900.0	1.02736(5)	1.0284(1)	103(5)
12	1000.0	1.02834(5)	1.02866(1)	32(5)
13	1100.0	1.02890(5)	1.02872(1)	-18(5)
14	1200.0	1.02936(5)	1.02862(1)	-74(5)
15	1300.0	1.02950(5)	1.02838(1)	-112(5)

Table 4.41. Timing variables for the reference solution of Problem 3.2.2

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
15	1500	1200	200000	4	48	41.13

MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
15	1.0×10^{-04}	1.0×10^{-04}	0.01	3	128	39.11

Charge-Pan 0727

Table 4.42. Power peaking factors for charge-pan 0727 of the reference solution of Problem 3.2.2.

Step	Burnup	Shift Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	1.965	1.996	2.031	1.929	1.960	2.030	2.071	1.884	1.978	2.099
1	25.0	2.047	2.083	2.120	2.008	2.043	2.125	2.160	1.961	2.060	2.189
2	50.0	2.033	2.069	2.106	1.998	2.029	2.104	2.148	1.950	2.048	2.173
3	100.0	1.998	2.035	2.072	1.961	1.999	2.072	2.116	1.913	2.016	2.137
4	200.0	1.961	2.002	2.038	1.930	1.965	2.038	2.078	1.880	1.983	2.097
5	300.0	1.935	1.981	2.016	1.907	1.946	2.017	2.053	1.861	1.961	2.077
6	400.0	1.906	1.963	2.001	1.883	1.929	1.996	2.034	1.837	1.945	2.059
7	500.0	1.909	1.969	2.004	1.885	1.934	1.999	2.039	1.833	1.948	2.061
8	600.0	1.913	1.979	2.014	1.892	1.944	2.011	2.051	1.838	1.957	2.071
9	700.0	1.914	1.986	2.021	1.895	1.944	2.020	2.055	1.842	1.964	2.082
10	800.0	1.923	1.997	2.029	1.902	1.962	2.027	2.066	1.847	1.976	2.087
11	900.0	1.924	2.003	2.037	1.909	1.965	2.037	2.072	1.850	1.981	2.095
12	1000.0	1.937	2.019	2.058	1.922	1.985	2.055	2.094	1.865	2.001	2.120
13	1100.0	1.970	2.054	2.085	1.951	2.015	2.088	2.129	1.892	2.033	2.153
14	1200.0	1.973	2.056	2.094	1.958	2.024	2.089	2.132	1.892	2.035	2.154
15	1300.0	1.977	2.067	2.103	1.962	2.028	2.102	2.144	1.902	2.045	2.165
Step	Burnup	MPACT Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	1.978	2.011	2.046	1.943	1.973	2.048	2.087	1.899	1.992	2.111
1	25.0	1.804	1.830	1.859	1.778	1.802	1.863	1.894	1.744	1.817	1.914
2	50.0	1.845	1.873	1.903	1.817	1.843	1.907	1.940	1.780	1.859	1.961
3	100.0	1.908	1.938	1.971	1.876	1.904	1.974	2.011	1.836	1.922	2.033
4	200.0	1.989	2.022	2.059	1.954	1.985	2.061	2.101	1.909	2.004	2.125
5	300.0	2.022	2.056	2.094	1.985	2.017	2.096	2.137	1.939	2.037	2.162
6	400.0	2.030	2.065	2.102	1.994	2.026	2.105	2.146	1.947	2.045	2.170
7	500.0	2.020	2.054	2.090	1.985	2.016	2.093	2.133	1.939	2.035	2.157
8	600.0	1.998	2.031	2.066	1.964	1.994	2.069	2.108	1.921	2.013	2.131
9	700.0	1.969	2.000	2.033	1.937	1.966	2.037	2.073	1.895	1.983	2.096
10	800.0	1.935	1.964	1.996	1.905	1.932	1.999	2.034	1.865	1.949	2.055
11	900.0	1.898	1.925	1.955	1.870	1.896	1.959	1.992	1.833	1.911	2.012
12	1000.0	1.860	1.886	1.914	1.834	1.858	1.918	1.949	1.800	1.873	1.968
13	1100.0	1.822	1.846	1.872	1.798	1.821	1.877	1.906	1.766	1.835	1.924
14	1200.0	1.783	1.806	1.831	1.762	1.783	1.836	1.863	1.732	1.796	1.880
15	1300.0	1.746	1.767	1.790	1.727	1.746	1.795	1.821	1.699	1.758	1.836

Charge-Pans 0827 and 0728

Table 4.43. Problem 3.2.2 reference solution power peaking factors for charge-pans 0827 and 0728.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift Power Peaking Factors A (A)	B (D)	C (C)	D (B)	P (R)	Q (Q)	R (P)	S (S)
0	0.0	1.637	1.645	1.759	1.744	1.823	1.520	1.517	1.894
1	25.0	1.694	1.705	1.823	1.811	1.889	1.569	1.574	1.972
2	50.0	1.687	1.696	1.818	1.798	1.879	1.563	1.566	1.959
3	100.0	1.660	1.672	1.789	1.768	1.850	1.541	1.540	1.928
4	200.0	1.638	1.647	1.766	1.744	1.827	1.524	1.520	1.901
5	300.0	1.625	1.637	1.751	1.729	1.812	1.514	1.510	1.883
6	400.0	1.614	1.625	1.740	1.713	1.798	1.505	1.496	1.865
7	500.0	1.616	1.629	1.743	1.721	1.801	1.511	1.503	1.868
8	600.0	1.620	1.639	1.750	1.727	1.809	1.517	1.512	1.878
9	700.0	1.626	1.642	1.758	1.731	1.813	1.521	1.516	1.885
10	800.0	1.639	1.657	1.770	1.742	1.825	1.534	1.528	1.899
11	900.0	1.643	1.662	1.774	1.748	1.830	1.537	1.536	1.906
12	1000.0	1.655	1.673	1.788	1.760	1.843	1.547	1.543	1.922
13	1100.0	1.678	1.696	1.814	1.788	1.875	1.564	1.569	1.952
14	1200.0	1.687	1.702	1.822	1.793	1.877	1.569	1.572	1.953
15	1300.0	1.689	1.706	1.827	1.801	1.887	1.574	1.578	1.962
Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	MPACT Power Peaking Factors A (A)	B (D)	C (C)	D (B)	P (R)	Q (Q)	R (P)	S (S)
0	0.0	1.637	1.645	1.759	1.744	1.823	1.520	1.517	1.894
1	25.0	1.694	1.705	1.823	1.811	1.889	1.569	1.574	1.972
2	50.0	1.687	1.696	1.818	1.798	1.879	1.563	1.566	1.959
3	100.0	1.660	1.672	1.789	1.768	1.850	1.541	1.540	1.928
4	200.0	1.638	1.647	1.766	1.744	1.827	1.524	1.520	1.901
5	300.0	1.625	1.637	1.751	1.729	1.812	1.514	1.510	1.883
6	400.0	1.614	1.625	1.740	1.713	1.798	1.505	1.496	1.865
7	500.0	1.616	1.629	1.743	1.721	1.801	1.511	1.503	1.868
8	600.0	1.620	1.639	1.750	1.727	1.809	1.517	1.512	1.878
9	700.0	1.626	1.642	1.758	1.731	1.813	1.521	1.516	1.885
10	800.0	1.639	1.657	1.770	1.742	1.825	1.534	1.528	1.899
11	900.0	1.643	1.662	1.774	1.748	1.830	1.537	1.536	1.906
12	1000.0	1.655	1.673	1.788	1.760	1.843	1.547	1.543	1.922
13	1100.0	1.678	1.696	1.814	1.788	1.875	1.564	1.569	1.952
14	1200.0	1.687	1.702	1.822	1.793	1.877	1.569	1.572	1.953
15	1300.0	1.689	1.706	1.827	1.801	1.887	1.574	1.578	1.962

Table 4.44. Problem 3.2.2 reference solution power peaking factors for charge-pans 0827 and 0728.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	1.740	1.638	1.510	1.510	1.663	1.789	1.880	1.859
1	25.0	1.797	1.689	1.564	1.567	1.726	1.858	1.952	1.930
2	50.0	1.789	1.687	1.557	1.557	1.716	1.847	1.947	1.920
3	100.0	1.763	1.659	1.533	1.532	1.691	1.816	1.913	1.886
4	200.0	1.740	1.641	1.516	1.515	1.668	1.796	1.890	1.861
5	300.0	1.728	1.627	1.505	1.507	1.655	1.776	1.872	1.842
6	400.0	1.715	1.618	1.494	1.495	1.640	1.762	1.858	1.826
7	500.0	1.715	1.625	1.496	1.501	1.642	1.765	1.858	1.831
8	600.0	1.728	1.629	1.502	1.510	1.654	1.775	1.870	1.839
9	700.0	1.729	1.634	1.504	1.511	1.658	1.782	1.875	1.842
10	800.0	1.743	1.645	1.520	1.526	1.673	1.795	1.887	1.856
11	900.0	1.751	1.653	1.526	1.536	1.678	1.800	1.893	1.863
12	1000.0	1.758	1.660	1.536	1.541	1.689	1.814	1.911	1.878
13	1100.0	1.787	1.681	1.553	1.560	1.714	1.842	1.945	1.907
14	1200.0	1.789	1.687	1.558	1.565	1.718	1.843	1.944	1.912
15	1300.0	1.797	1.694	1.568	1.575	1.725	1.856	1.951	1.914

Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	1.740	1.638	1.510	1.510	1.663	1.789	1.880	1.859
1	25.0	1.797	1.689	1.564	1.567	1.726	1.858	1.952	1.930
2	50.0	1.789	1.687	1.557	1.557	1.716	1.847	1.947	1.920
3	100.0	1.763	1.659	1.533	1.532	1.691	1.816	1.913	1.886
4	200.0	1.740	1.641	1.516	1.515	1.668	1.796	1.890	1.861
5	300.0	1.728	1.627	1.505	1.507	1.655	1.776	1.872	1.842
6	400.0	1.715	1.618	1.494	1.495	1.640	1.762	1.858	1.826
7	500.0	1.715	1.625	1.496	1.501	1.642	1.765	1.858	1.831
8	600.0	1.728	1.629	1.502	1.510	1.654	1.775	1.870	1.839
9	700.0	1.729	1.634	1.504	1.511	1.658	1.782	1.875	1.842
10	800.0	1.743	1.645	1.520	1.526	1.673	1.795	1.887	1.856
11	900.0	1.751	1.653	1.526	1.536	1.678	1.800	1.893	1.863
12	1000.0	1.758	1.660	1.536	1.541	1.689	1.814	1.911	1.878
13	1100.0	1.787	1.681	1.553	1.560	1.714	1.842	1.945	1.907
14	1200.0	1.789	1.687	1.558	1.565	1.718	1.843	1.944	1.912
15	1300.0	1.797	1.694	1.568	1.575	1.725	1.856	1.951	1.914

Charge-Pans 0927 and 0729

Table 4.45. Problem 3.2.2 reference solution power peaking factors for charge-pans 0927 and 0729.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.911	0.880	0.997	1.023	1.381	1.069	0.965	1.336
1	25.0	0.936	0.906	1.032	1.052	1.422	1.089	0.993	1.387
2	50.0	0.935	0.906	1.028	1.053	1.414	1.091	0.992	1.379
3	100.0	0.924	0.892	1.013	1.035	1.395	1.083	0.983	1.361
4	200.0	0.912	0.886	1.002	1.025	1.384	1.068	0.967	1.339
5	300.0	0.907	0.880	0.998	1.018	1.373	1.063	0.962	1.331
6	400.0	0.904	0.876	0.995	1.010	1.366	1.060	0.959	1.318
7	500.0	0.906	0.879	0.995	1.015	1.372	1.065	0.960	1.321
8	600.0	0.911	0.887	1.004	1.021	1.379	1.070	0.970	1.332
9	700.0	0.911	0.885	1.004	1.019	1.376	1.068	0.970	1.333
10	800.0	0.924	0.893	1.017	1.031	1.389	1.080	0.978	1.344
11	900.0	0.926	0.901	1.018	1.035	1.399	1.086	0.986	1.351
12	1000.0	0.931	0.906	1.024	1.041	1.403	1.092	0.992	1.358
13	1100.0	0.938	0.913	1.037	1.054	1.420	1.102	1.001	1.380
14	1200.0	0.945	0.919	1.039	1.057	1.419	1.105	1.009	1.382
15	1300.0	0.951	0.928	1.049	1.062	1.431	1.114	1.016	1.391
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.909	0.879	0.998	1.022	1.386	1.068	0.965	1.343
1	25.0	0.886	0.855	0.956	0.980	1.317	1.054	0.950	1.269
2	50.0	0.892	0.861	0.966	0.990	1.333	1.058	0.954	1.286
3	100.0	0.900	0.870	0.981	1.005	1.357	1.063	0.960	1.313
4	200.0	0.912	0.883	1.002	1.025	1.390	1.070	0.969	1.349
5	300.0	0.918	0.889	1.012	1.035	1.405	1.074	0.973	1.365
6	400.0	0.922	0.892	1.017	1.039	1.411	1.077	0.976	1.371
7	500.0	0.923	0.894	1.017	1.040	1.410	1.079	0.978	1.370
8	600.0	0.923	0.893	1.015	1.038	1.405	1.080	0.978	1.363
9	700.0	0.922	0.892	1.010	1.034	1.396	1.080	0.978	1.354
10	800.0	0.920	0.890	1.005	1.028	1.386	1.080	0.977	1.342
11	900.0	0.917	0.887	0.998	1.022	1.374	1.079	0.976	1.328
12	1000.0	0.914	0.884	0.991	1.015	1.361	1.078	0.975	1.314
13	1100.0	0.911	0.880	0.984	1.008	1.348	1.076	0.973	1.299
14	1200.0	0.907	0.877	0.976	1.001	1.334	1.075	0.971	1.284
15	1300.0	0.904	0.873	0.968	0.993	1.320	1.073	0.969	1.269

Table 4.46. Problem 3.2.2 reference solution power peaking factors for charge-pans 0927 and 0729.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	1.226	1.119	0.978	0.947	1.024	1.146	1.312	1.324
1	25.0	1.257	1.147	1.005	0.975	1.057	1.187	1.358	1.370
2	50.0	1.256	1.148	1.006	0.972	1.056	1.184	1.351	1.366
3	100.0	1.240	1.135	0.994	0.962	1.040	1.168	1.333	1.344
4	200.0	1.229	1.122	0.983	0.951	1.025	1.149	1.312	1.328
5	300.0	1.221	1.117	0.976	0.947	1.021	1.145	1.309	1.318
6	400.0	1.214	1.112	0.971	0.945	1.017	1.136	1.298	1.309
7	500.0	1.221	1.116	0.976	0.947	1.019	1.139	1.303	1.315
8	600.0	1.227	1.124	0.982	0.955	1.028	1.147	1.312	1.321
9	700.0	1.227	1.121	0.979	0.954	1.026	1.147	1.313	1.320
10	800.0	1.238	1.134	0.992	0.965	1.036	1.158	1.326	1.333
11	900.0	1.243	1.140	0.999	0.970	1.041	1.166	1.330	1.335
12	1000.0	1.251	1.143	1.004	0.980	1.047	1.173	1.339	1.345
13	1100.0	1.263	1.154	1.013	0.986	1.060	1.189	1.357	1.363
14	1200.0	1.267	1.162	1.016	0.991	1.065	1.191	1.362	1.366
15	1300.0	1.275	1.165	1.024	0.998	1.073	1.202	1.368	1.375
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	1.228	1.122	0.980	0.946	1.024	1.151	1.318	1.331
1	25.0	1.182	1.094	0.967	0.933	0.994	1.100	1.246	1.262
2	50.0	1.193	1.101	0.971	0.937	1.002	1.113	1.263	1.278
3	100.0	1.209	1.111	0.976	0.942	1.013	1.131	1.288	1.303
4	200.0	1.232	1.125	0.983	0.950	1.029	1.156	1.323	1.336
5	300.0	1.243	1.132	0.987	0.954	1.036	1.167	1.339	1.352
6	400.0	1.248	1.136	0.990	0.957	1.040	1.172	1.345	1.358
7	500.0	1.248	1.138	0.992	0.959	1.042	1.172	1.344	1.357
8	600.0	1.246	1.137	0.993	0.960	1.041	1.169	1.338	1.351
9	700.0	1.241	1.135	0.993	0.960	1.038	1.164	1.329	1.342
10	800.0	1.235	1.132	0.993	0.959	1.035	1.157	1.317	1.332
11	900.0	1.227	1.129	0.992	0.958	1.031	1.148	1.304	1.319
12	1000.0	1.219	1.125	0.991	0.957	1.026	1.139	1.291	1.306
13	1100.0	1.211	1.120	0.990	0.956	1.021	1.130	1.277	1.292
14	1200.0	1.202	1.115	0.988	0.954	1.016	1.121	1.262	1.278
15	1300.0	1.193	1.110	0.986	0.952	1.011	1.111	1.248	1.265

Charge-Pans 1027 and (0730)

Table 4.47. Problem 3.2.2 reference solution power peaking factors for charge-pans 1027 and 0730.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.719	0.693	0.722	0.755	1.002	0.892	0.820	0.902
1	25.0	0.739	0.713	0.743	0.772	1.024	0.911	0.846	0.927
2	50.0	0.739	0.713	0.741	0.771	1.024	0.912	0.849	0.927
3	100.0	0.734	0.707	0.734	0.765	1.013	0.906	0.836	0.914
4	200.0	0.722	0.695	0.721	0.751	1.003	0.891	0.822	0.897
5	300.0	0.714	0.688	0.716	0.745	0.995	0.883	0.810	0.892
6	400.0	0.713	0.685	0.715	0.742	0.993	0.882	0.810	0.885
7	500.0	0.713	0.689	0.715	0.746	0.997	0.885	0.812	0.885
8	600.0	0.716	0.693	0.722	0.749	1.002	0.887	0.816	0.890
9	700.0	0.715	0.691	0.717	0.747	1.000	0.888	0.814	0.885
10	800.0	0.726	0.700	0.727	0.756	1.007	0.902	0.829	0.896
11	900.0	0.727	0.705	0.732	0.760	1.013	0.905	0.834	0.902
12	1000.0	0.732	0.709	0.737	0.765	1.019	0.909	0.838	0.907
13	1100.0	0.736	0.712	0.743	0.768	1.026	0.913	0.841	0.913
14	1200.0	0.740	0.719	0.746	0.773	1.031	0.920	0.851	0.918
15	1300.0	0.748	0.731	0.757	0.782	1.038	0.931	0.863	0.930
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.718	0.690	0.718	0.750	1.004	0.890	0.819	0.900
1	25.0	0.738	0.709	0.726	0.759	1.004	0.922	0.850	0.898
2	50.0	0.734	0.705	0.725	0.757	1.004	0.915	0.843	0.899
3	100.0	0.727	0.699	0.722	0.755	1.004	0.904	0.833	0.900
4	200.0	0.719	0.691	0.719	0.751	1.006	0.890	0.819	0.903
5	300.0	0.716	0.688	0.719	0.750	1.007	0.884	0.814	0.905
6	400.0	0.716	0.688	0.720	0.751	1.009	0.883	0.813	0.906
7	500.0	0.717	0.689	0.721	0.753	1.011	0.885	0.815	0.908
8	600.0	0.721	0.692	0.724	0.755	1.013	0.889	0.818	0.910
9	700.0	0.724	0.696	0.726	0.758	1.015	0.894	0.824	0.911
10	800.0	0.729	0.700	0.729	0.761	1.017	0.901	0.830	0.913
11	900.0	0.734	0.705	0.732	0.764	1.018	0.908	0.836	0.914
12	1000.0	0.739	0.710	0.735	0.767	1.020	0.915	0.843	0.915
13	1100.0	0.744	0.715	0.738	0.770	1.021	0.922	0.850	0.916
14	1200.0	0.749	0.720	0.741	0.773	1.022	0.929	0.857	0.917
15	1300.0	0.754	0.725	0.744	0.776	1.022	0.936	0.864	0.917

Table 4.48. Problem 3.2.2 reference solution power peaking factors for charge-pans 1027 and 0730.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.929	0.890	0.832	0.809	0.799	0.827	0.889	0.924
1	25.0	0.949	0.908	0.853	0.833	0.825	0.853	0.915	0.948
2	50.0	0.947	0.910	0.854	0.833	0.823	0.851	0.912	0.944
3	100.0	0.942	0.903	0.845	0.824	0.812	0.840	0.902	0.936
4	200.0	0.928	0.891	0.832	0.813	0.796	0.827	0.889	0.921
5	300.0	0.922	0.883	0.820	0.797	0.788	0.819	0.880	0.912
6	400.0	0.919	0.882	0.819	0.800	0.787	0.817	0.876	0.909
7	500.0	0.922	0.885	0.823	0.803	0.789	0.817	0.876	0.911
8	600.0	0.926	0.890	0.825	0.807	0.795	0.820	0.883	0.918
9	700.0	0.924	0.886	0.823	0.806	0.791	0.818	0.881	0.913
10	800.0	0.935	0.900	0.836	0.819	0.803	0.828	0.887	0.923
11	900.0	0.941	0.903	0.840	0.825	0.810	0.834	0.893	0.927
12	1000.0	0.947	0.908	0.845	0.827	0.816	0.839	0.901	0.931
13	1100.0	0.952	0.909	0.848	0.831	0.819	0.845	0.909	0.937
14	1200.0	0.956	0.918	0.856	0.841	0.827	0.852	0.914	0.944
15	1300.0	0.966	0.928	0.866	0.852	0.839	0.860	0.920	0.950
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.928	0.889	0.830	0.807	0.796	0.824	0.887	0.922
1	25.0	0.939	0.911	0.861	0.838	0.817	0.834	0.886	0.920
2	50.0	0.937	0.906	0.855	0.831	0.813	0.833	0.887	0.921
3	100.0	0.933	0.899	0.844	0.821	0.807	0.830	0.888	0.922
4	200.0	0.929	0.890	0.830	0.807	0.798	0.827	0.890	0.924
5	300.0	0.928	0.886	0.825	0.802	0.795	0.826	0.892	0.926
6	400.0	0.929	0.886	0.824	0.801	0.795	0.827	0.894	0.927
7	500.0	0.931	0.888	0.826	0.802	0.797	0.829	0.896	0.929
8	600.0	0.934	0.891	0.829	0.806	0.800	0.831	0.897	0.931
9	700.0	0.937	0.896	0.835	0.812	0.804	0.834	0.899	0.933
10	800.0	0.941	0.901	0.841	0.818	0.809	0.838	0.900	0.935
11	900.0	0.944	0.906	0.848	0.824	0.814	0.841	0.902	0.936
12	1000.0	0.948	0.912	0.855	0.831	0.819	0.844	0.903	0.937
13	1100.0	0.951	0.917	0.862	0.838	0.824	0.847	0.904	0.938
14	1200.0	0.955	0.923	0.869	0.845	0.829	0.850	0.905	0.939
15	1300.0	0.958	0.928	0.876	0.852	0.835	0.853	0.905	0.940

Charge-Pans 1127 and (0731)

Table 4.49. Problem 3.2.2 reference solution power peaking factors for charge-pans 1127 and 0731.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.785	0.783	0.816	0.825	0.879	0.730	0.732	0.833
1	25.0	0.810	0.814	0.847	0.853	0.902	0.751	0.761	0.863
2	50.0	0.815	0.814	0.849	0.855	0.905	0.754	0.762	0.860
3	100.0	0.805	0.805	0.838	0.845	0.895	0.748	0.753	0.851
4	200.0	0.788	0.785	0.817	0.827	0.876	0.730	0.735	0.833
5	300.0	0.772	0.769	0.802	0.814	0.864	0.715	0.716	0.819
6	400.0	0.776	0.771	0.807	0.815	0.861	0.713	0.719	0.819
7	500.0	0.778	0.772	0.805	0.819	0.862	0.716	0.719	0.819
8	600.0	0.778	0.773	0.809	0.821	0.864	0.717	0.719	0.820
9	700.0	0.779	0.772	0.808	0.823	0.863	0.712	0.718	0.816
10	800.0	0.796	0.786	0.825	0.836	0.876	0.727	0.731	0.833
11	900.0	0.798	0.792	0.828	0.840	0.878	0.731	0.737	0.838
12	1000.0	0.803	0.795	0.831	0.843	0.882	0.730	0.738	0.842
13	1100.0	0.805	0.799	0.833	0.845	0.882	0.733	0.742	0.843
14	1200.0	0.812	0.808	0.843	0.857	0.890	0.740	0.752	0.854
15	1300.0	0.827	0.824	0.860	0.872	0.905	0.751	0.764	0.865
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.787	0.783	0.818	0.827	0.880	0.731	0.733	0.833
1	25.0	0.836	0.833	0.863	0.872	0.920	0.782	0.785	0.872
2	50.0	0.825	0.822	0.853	0.862	0.911	0.770	0.773	0.864
3	100.0	0.808	0.805	0.837	0.846	0.897	0.753	0.756	0.850
4	200.0	0.785	0.781	0.816	0.825	0.879	0.728	0.731	0.832
5	300.0	0.774	0.771	0.807	0.816	0.871	0.717	0.720	0.825
6	400.0	0.771	0.767	0.804	0.813	0.869	0.713	0.716	0.823
7	500.0	0.771	0.768	0.805	0.814	0.870	0.714	0.716	0.824
8	600.0	0.776	0.773	0.810	0.818	0.875	0.718	0.720	0.828
9	700.0	0.782	0.779	0.816	0.825	0.881	0.724	0.726	0.834
10	800.0	0.790	0.787	0.824	0.833	0.888	0.731	0.734	0.842
11	900.0	0.799	0.796	0.833	0.841	0.896	0.740	0.743	0.849
12	1000.0	0.809	0.805	0.842	0.850	0.905	0.750	0.753	0.858
13	1100.0	0.818	0.815	0.851	0.860	0.913	0.759	0.763	0.866
14	1200.0	0.828	0.825	0.861	0.869	0.922	0.770	0.773	0.875
15	1300.0	0.839	0.836	0.870	0.879	0.930	0.780	0.784	0.883

Table 4.50. Problem 3.2.2 reference solution power peaking factors for charge-pans 1127 and 0731.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.849	0.800	0.732	0.733	0.787	0.821	0.835	0.851
1	25.0	0.869	0.819	0.756	0.759	0.817	0.855	0.863	0.875
2	50.0	0.875	0.821	0.757	0.761	0.818	0.854	0.864	0.879
3	100.0	0.865	0.813	0.752	0.751	0.809	0.844	0.855	0.871
4	200.0	0.846	0.797	0.734	0.734	0.789	0.823	0.836	0.851
5	300.0	0.834	0.785	0.719	0.717	0.771	0.805	0.821	0.841
6	400.0	0.834	0.785	0.721	0.719	0.772	0.808	0.824	0.841
7	500.0	0.833	0.785	0.723	0.721	0.772	0.809	0.827	0.842
8	600.0	0.835	0.789	0.724	0.720	0.772	0.810	0.826	0.848
9	700.0	0.833	0.788	0.726	0.722	0.773	0.809	0.826	0.848
10	800.0	0.848	0.798	0.737	0.734	0.788	0.823	0.841	0.862
11	900.0	0.854	0.804	0.744	0.738	0.794	0.829	0.846	0.866
12	1000.0	0.857	0.805	0.745	0.741	0.794	0.830	0.851	0.869
13	1100.0	0.857	0.806	0.750	0.747	0.797	0.834	0.853	0.873
14	1200.0	0.864	0.816	0.759	0.755	0.808	0.844	0.862	0.883
15	1300.0	0.879	0.829	0.773	0.771	0.824	0.859	0.875	0.896
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.849	0.798	0.732	0.732	0.788	0.823	0.835	0.851
1	25.0	0.895	0.847	0.783	0.784	0.838	0.869	0.875	0.891
2	50.0	0.884	0.836	0.771	0.772	0.827	0.859	0.866	0.882
3	100.0	0.868	0.819	0.754	0.754	0.810	0.843	0.852	0.868
4	200.0	0.847	0.796	0.729	0.730	0.786	0.822	0.835	0.850
5	300.0	0.838	0.785	0.718	0.719	0.776	0.812	0.827	0.843
6	400.0	0.835	0.781	0.714	0.715	0.772	0.809	0.825	0.841
7	500.0	0.836	0.782	0.715	0.715	0.773	0.811	0.826	0.842
8	600.0	0.840	0.787	0.719	0.719	0.777	0.815	0.831	0.847
9	700.0	0.847	0.793	0.725	0.725	0.784	0.821	0.837	0.853
10	800.0	0.855	0.801	0.733	0.733	0.792	0.829	0.844	0.860
11	900.0	0.863	0.810	0.741	0.742	0.801	0.838	0.852	0.868
12	1000.0	0.873	0.820	0.751	0.752	0.811	0.847	0.860	0.876
13	1100.0	0.882	0.829	0.761	0.762	0.821	0.857	0.868	0.885
14	1200.0	0.892	0.840	0.771	0.772	0.831	0.866	0.877	0.893
15	1300.0	0.901	0.850	0.781	0.782	0.841	0.876	0.886	0.902

Charge-Pans 1227 and (0732)

Table 4.51. Problem 3.2.2 reference solution power peaking factors for charge-pans 1227 and 0732.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Shift Power Peaking Factors A (A)	B (D)	C (C)	D (B)	P (R)	S (Q)
0	0.0	0.517	0.522	0.570	0.565	0.650	0.660
1	25.0	0.538	0.545	0.592	0.585	0.669	0.687
2	50.0	0.538	0.547	0.592	0.587	0.670	0.688
3	100.0	0.534	0.540	0.588	0.579	0.663	0.681
4	200.0	0.520	0.526	0.573	0.568	0.650	0.662
5	300.0	0.508	0.509	0.557	0.552	0.636	0.645
6	400.0	0.510	0.514	0.560	0.555	0.639	0.646
7	500.0	0.509	0.511	0.561	0.553	0.637	0.643
8	600.0	0.509	0.511	0.561	0.553	0.638	0.644
9	700.0	0.509	0.508	0.558	0.550	0.637	0.642
10	800.0	0.518	0.519	0.571	0.563	0.651	0.655
11	900.0	0.524	0.524	0.578	0.567	0.656	0.661
12	1000.0	0.523	0.521	0.578	0.568	0.656	0.661
13	1100.0	0.526	0.525	0.581	0.570	0.658	0.662
14	1200.0	0.534	0.533	0.588	0.577	0.666	0.674
15	1300.0	0.544	0.542	0.599	0.586	0.679	0.685
Step	Burnup $\left[\frac{MWd}{MtU}\right]$	MPACT Power Peaking Factors A (A)	B (D)	C (C)	D (B)	P (R)	S (Q)
0	0.0	0.519	0.526	0.571	0.566	0.650	0.660
1	25.0	0.564	0.571	0.618	0.613	0.699	0.711
2	50.0	0.555	0.562	0.608	0.603	0.688	0.700
3	100.0	0.539	0.546	0.591	0.586	0.671	0.682
4	200.0	0.517	0.523	0.568	0.564	0.647	0.658
5	300.0	0.506	0.513	0.558	0.553	0.636	0.646
6	400.0	0.502	0.508	0.553	0.548	0.631	0.642
7	500.0	0.501	0.507	0.553	0.548	0.631	0.642
8	600.0	0.503	0.509	0.555	0.551	0.635	0.645
9	700.0	0.507	0.514	0.560	0.556	0.640	0.651
10	800.0	0.513	0.520	0.567	0.562	0.647	0.659
11	900.0	0.520	0.526	0.574	0.569	0.656	0.667
12	1000.0	0.527	0.534	0.582	0.577	0.664	0.676
13	1100.0	0.535	0.542	0.591	0.586	0.674	0.686
14	1200.0	0.543	0.550	0.600	0.594	0.683	0.696
15	1300.0	0.551	0.558	0.609	0.603	0.693	0.706

Table 4.52. Problem 3.2.2 reference solution power peaking factors for charge-pans 1227 and 0732.

Step	Burnup	Shift Power Peaking Factors					
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)
0	0.0	0.564	0.511	0.529	0.580	0.657	0.654
1	25.0	0.581	0.527	0.551	0.601	0.683	0.677
2	50.0	0.582	0.529	0.555	0.604	0.683	0.677
3	100.0	0.578	0.522	0.547	0.598	0.677	0.672
4	200.0	0.565	0.512	0.532	0.581	0.660	0.656
5	300.0	0.550	0.501	0.518	0.565	0.643	0.642
6	400.0	0.557	0.504	0.520	0.569	0.646	0.645
7	500.0	0.554	0.502	0.519	0.566	0.645	0.643
8	600.0	0.556	0.504	0.519	0.566	0.645	0.648
9	700.0	0.554	0.502	0.517	0.564	0.643	0.644
10	800.0	0.566	0.514	0.528	0.575	0.655	0.657
11	900.0	0.571	0.519	0.534	0.581	0.661	0.665
12	1000.0	0.572	0.518	0.532	0.579	0.665	0.665
13	1100.0	0.573	0.519	0.537	0.584	0.667	0.670
14	1200.0	0.580	0.528	0.544	0.593	0.678	0.678
15	1300.0	0.592	0.539	0.555	0.605	0.690	0.688
Step	Burnup	MPACT Power Peaking Factors					
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)
0	0.0	0.564	0.511	0.532	0.580	0.657	0.654
1	25.0	0.610	0.555	0.578	0.628	0.708	0.704
2	50.0	0.600	0.546	0.568	0.617	0.697	0.693
3	100.0	0.584	0.530	0.552	0.601	0.679	0.676
4	200.0	0.561	0.509	0.529	0.577	0.655	0.652
5	300.0	0.551	0.498	0.519	0.567	0.644	0.641
6	400.0	0.546	0.493	0.514	0.562	0.639	0.636
7	500.0	0.546	0.493	0.513	0.561	0.639	0.636
8	600.0	0.548	0.495	0.515	0.564	0.643	0.639
9	700.0	0.553	0.499	0.520	0.569	0.648	0.645
10	800.0	0.559	0.505	0.526	0.576	0.656	0.652
11	900.0	0.567	0.511	0.533	0.583	0.664	0.661
12	1000.0	0.575	0.518	0.540	0.592	0.673	0.670
13	1100.0	0.583	0.526	0.548	0.600	0.683	0.679
14	1200.0	0.592	0.534	0.556	0.609	0.693	0.689
15	1300.0	0.600	0.542	0.565	0.619	0.702	0.699

Charge-Pan 0828

Table 4.53. Problem 3.2.2 reference solution power peaking factors for charge-pan 0828.

Step	Burnup	Shift Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	1.507	1.557	1.624	1.455	1.498	1.613	1.697	1.402	1.517	1.767
1	25.0	1.539	1.596	1.665	1.483	1.529	1.661	1.753	1.421	1.561	1.827
2	50.0	1.536	1.596	1.662	1.482	1.527	1.654	1.741	1.421	1.556	1.824
3	100.0	1.523	1.577	1.642	1.468	1.512	1.634	1.722	1.411	1.537	1.794
4	200.0	1.510	1.561	1.628	1.456	1.501	1.618	1.697	1.403	1.523	1.777
5	300.0	1.500	1.558	1.623	1.454	1.496	1.608	1.689	1.398	1.515	1.766
6	400.0	1.490	1.549	1.615	1.445	1.487	1.597	1.682	1.393	1.511	1.754
7	500.0	1.493	1.554	1.618	1.450	1.490	1.601	1.682	1.398	1.511	1.759
8	600.0	1.498	1.558	1.623	1.453	1.496	1.607	1.691	1.402	1.517	1.767
9	700.0	1.501	1.563	1.628	1.454	1.502	1.611	1.698	1.402	1.522	1.768
10	800.0	1.503	1.573	1.635	1.460	1.509	1.626	1.710	1.404	1.533	1.783
11	900.0	1.507	1.575	1.637	1.461	1.514	1.629	1.714	1.403	1.538	1.784
12	1000.0	1.514	1.585	1.649	1.468	1.523	1.638	1.722	1.411	1.544	1.799
13	1100.0	1.528	1.599	1.667	1.481	1.535	1.658	1.747	1.422	1.563	1.823
14	1200.0	1.528	1.605	1.671	1.484	1.542	1.665	1.753	1.418	1.568	1.829
15	1300.0	1.534	1.611	1.678	1.485	1.548	1.672	1.758	1.422	1.572	1.834
Step	Burnup	MPACT Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	1.515	1.566	1.631	1.462	1.503	1.621	1.706	1.406	1.527	1.779
1	25.0	1.438	1.477	1.529	1.398	1.429	1.521	1.590	1.354	1.444	1.649
2	50.0	1.455	1.497	1.553	1.413	1.446	1.544	1.617	1.366	1.463	1.680
3	100.0	1.482	1.528	1.589	1.435	1.472	1.579	1.658	1.384	1.492	1.726
4	200.0	1.519	1.570	1.637	1.466	1.507	1.627	1.713	1.409	1.532	1.788
5	300.0	1.536	1.589	1.658	1.480	1.523	1.647	1.736	1.421	1.549	1.814
6	400.0	1.542	1.596	1.665	1.486	1.530	1.655	1.744	1.426	1.556	1.822
7	500.0	1.541	1.594	1.662	1.485	1.529	1.652	1.740	1.427	1.554	1.816
8	600.0	1.534	1.586	1.652	1.481	1.523	1.642	1.728	1.424	1.547	1.802
9	700.0	1.524	1.574	1.637	1.473	1.513	1.628	1.710	1.418	1.536	1.781
10	800.0	1.512	1.559	1.620	1.463	1.501	1.610	1.690	1.411	1.522	1.757
11	900.0	1.498	1.542	1.600	1.452	1.488	1.591	1.667	1.402	1.507	1.731
12	1000.0	1.483	1.525	1.579	1.440	1.474	1.571	1.643	1.393	1.491	1.703
13	1100.0	1.467	1.506	1.558	1.428	1.459	1.550	1.618	1.383	1.474	1.676
14	1200.0	1.451	1.488	1.537	1.415	1.444	1.529	1.594	1.372	1.457	1.648
15	1300.0	1.435	1.470	1.515	1.402	1.428	1.508	1.569	1.362	1.440	1.620

Charge-Pans 0928 and (0829)

Table 4.54. Problem 3.2.2 reference solution power peaking factors for charge-pans 0928 and 0829.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	1.228	1.230	1.309	1.292	1.333	1.154	1.137	1.411
1	25.0	1.238	1.249	1.327	1.310	1.344	1.158	1.158	1.442
2	50.0	1.239	1.248	1.328	1.309	1.343	1.159	1.156	1.442
3	100.0	1.231	1.240	1.318	1.301	1.336	1.154	1.149	1.428
4	200.0	1.228	1.234	1.315	1.292	1.331	1.152	1.142	1.422
5	300.0	1.223	1.234	1.314	1.290	1.327	1.152	1.140	1.416
6	400.0	1.221	1.232	1.306	1.284	1.328	1.149	1.136	1.408
7	500.0	1.227	1.239	1.312	1.289	1.332	1.151	1.142	1.413
8	600.0	1.230	1.243	1.318	1.295	1.332	1.157	1.149	1.422
9	700.0	1.228	1.244	1.320	1.294	1.335	1.157	1.147	1.422
10	800.0	1.237	1.252	1.331	1.300	1.337	1.160	1.158	1.434
11	900.0	1.237	1.257	1.333	1.303	1.340	1.162	1.162	1.439
12	1000.0	1.247	1.264	1.340	1.307	1.343	1.167	1.168	1.445
13	1100.0	1.249	1.271	1.346	1.314	1.353	1.170	1.176	1.464
14	1200.0	1.251	1.269	1.349	1.315	1.350	1.171	1.180	1.463
15	1300.0	1.256	1.280	1.358	1.321	1.354	1.176	1.190	1.473
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	1.229	1.234	1.311	1.295	1.332	1.154	1.139	1.417
1	25.0	1.209	1.209	1.271	1.261	1.293	1.154	1.126	1.353
2	50.0	1.213	1.215	1.280	1.269	1.302	1.153	1.129	1.368
3	100.0	1.220	1.223	1.294	1.280	1.315	1.153	1.134	1.391
4	200.0	1.230	1.235	1.314	1.296	1.334	1.154	1.141	1.421
5	300.0	1.235	1.242	1.323	1.305	1.344	1.155	1.145	1.435
6	400.0	1.238	1.245	1.327	1.309	1.348	1.157	1.148	1.441
7	500.0	1.240	1.247	1.328	1.310	1.349	1.159	1.149	1.441
8	600.0	1.240	1.247	1.327	1.309	1.348	1.162	1.150	1.436
9	700.0	1.240	1.245	1.323	1.306	1.344	1.164	1.151	1.428
10	800.0	1.238	1.243	1.318	1.303	1.339	1.166	1.151	1.419
11	900.0	1.236	1.240	1.312	1.298	1.334	1.167	1.150	1.407
12	1000.0	1.234	1.237	1.305	1.292	1.327	1.169	1.149	1.395
13	1100.0	1.231	1.233	1.298	1.287	1.320	1.170	1.147	1.383
14	1200.0	1.228	1.228	1.290	1.281	1.313	1.171	1.146	1.370
15	1300.0	1.224	1.224	1.283	1.274	1.305	1.171	1.144	1.357

Table 4.55. Problem 3.2.2 reference solution power peaking factors for charge-pans 0928 and 0829.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Shift Power Peaking Factors E (H)	F (G)	G (F)	H (E)	J (M)	K (L)	L (K)	M (J)
0	0.0	1.252	1.195	1.178	1.173	1.209	1.303	1.409	1.383
1	25.0	1.264	1.200	1.189	1.188	1.230	1.329	1.435	1.404
2	50.0	1.264	1.199	1.188	1.190	1.230	1.327	1.437	1.403
3	100.0	1.256	1.195	1.183	1.180	1.220	1.314	1.425	1.392
4	200.0	1.252	1.190	1.175	1.173	1.215	1.307	1.418	1.386
5	300.0	1.250	1.190	1.174	1.173	1.212	1.303	1.414	1.379
6	400.0	1.249	1.190	1.172	1.174	1.207	1.299	1.408	1.374
7	500.0	1.253	1.193	1.176	1.178	1.213	1.305	1.414	1.379
8	600.0	1.257	1.196	1.182	1.185	1.221	1.311	1.422	1.384
9	700.0	1.255	1.198	1.178	1.183	1.221	1.312	1.424	1.387
10	800.0	1.261	1.201	1.186	1.194	1.233	1.326	1.431	1.392
11	900.0	1.260	1.201	1.190	1.202	1.236	1.330	1.436	1.396
12	1000.0	1.269	1.208	1.194	1.203	1.242	1.337	1.445	1.402
13	1100.0	1.274	1.213	1.203	1.208	1.251	1.346	1.454	1.410
14	1200.0	1.272	1.214	1.201	1.212	1.253	1.351	1.455	1.410
15	1300.0	1.279	1.218	1.206	1.220	1.264	1.358	1.463	1.416
Step	Burnup $\left[\frac{MWd}{MtU}\right]$	MPACT Power Peaking Factors E (H)	F (G)	G (F)	H (E)	J (M)	K (L)	L (K)	M (J)
0	0.0	1.255	1.194	1.179	1.175	1.211	1.305	1.415	1.386
1	25.0	1.229	1.182	1.173	1.165	1.183	1.260	1.358	1.337
2	50.0	1.235	1.184	1.174	1.167	1.189	1.270	1.371	1.348
3	100.0	1.244	1.188	1.176	1.170	1.199	1.286	1.391	1.365
4	200.0	1.256	1.195	1.180	1.176	1.213	1.308	1.419	1.389
5	300.0	1.263	1.199	1.182	1.179	1.221	1.319	1.431	1.400
6	400.0	1.267	1.202	1.185	1.182	1.224	1.323	1.437	1.405
7	500.0	1.268	1.204	1.187	1.184	1.226	1.324	1.437	1.406
8	600.0	1.268	1.205	1.188	1.185	1.225	1.322	1.433	1.403
9	700.0	1.267	1.206	1.190	1.186	1.223	1.317	1.427	1.398
10	800.0	1.265	1.206	1.191	1.186	1.221	1.311	1.418	1.391
11	900.0	1.262	1.205	1.191	1.186	1.217	1.304	1.408	1.383
12	1000.0	1.258	1.204	1.192	1.186	1.213	1.296	1.398	1.374
13	1100.0	1.254	1.203	1.192	1.185	1.208	1.288	1.387	1.365
14	1200.0	1.249	1.201	1.191	1.184	1.203	1.279	1.375	1.356
15	1300.0	1.245	1.199	1.191	1.182	1.198	1.270	1.363	1.346

Charge-Pans 1028 and (0830)

Table 4.56. Problem 3.2.2 reference solution power peaking factors for charge-pans 1028 and 0830.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	1.017	1.003	1.048	1.064	1.120	0.983	0.940	1.071
1	25.0	1.025	1.010	1.056	1.070	1.119	0.982	0.953	1.088
2	50.0	1.023	1.013	1.056	1.073	1.121	0.984	0.959	1.091
3	100.0	1.023	1.009	1.055	1.066	1.122	0.982	0.950	1.086
4	200.0	1.015	1.002	1.050	1.063	1.119	0.981	0.942	1.075
5	300.0	1.015	0.998	1.043	1.064	1.121	0.975	0.938	1.071
6	400.0	1.018	1.002	1.048	1.066	1.123	0.983	0.939	1.071
7	500.0	1.021	1.004	1.048	1.064	1.123	0.981	0.944	1.075
8	600.0	1.023	1.008	1.054	1.072	1.129	0.990	0.944	1.081
9	700.0	1.022	1.006	1.052	1.071	1.129	0.987	0.947	1.078
10	800.0	1.033	1.016	1.063	1.079	1.135	0.995	0.958	1.092
11	900.0	1.035	1.023	1.066	1.082	1.139	0.999	0.962	1.095
12	1000.0	1.043	1.028	1.072	1.090	1.142	1.001	0.968	1.102
13	1100.0	1.040	1.028	1.075	1.088	1.146	0.999	0.970	1.107
14	1200.0	1.045	1.031	1.079	1.094	1.146	1.009	0.980	1.111
15	1300.0	1.051	1.040	1.084	1.097	1.151	1.011	0.986	1.117
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	1.018	1.002	1.047	1.064	1.118	0.981	0.940	1.074
1	25.0	1.045	1.026	1.062	1.082	1.129	1.017	0.972	1.075
2	50.0	1.038	1.020	1.058	1.077	1.126	1.008	0.965	1.074
3	100.0	1.028	1.011	1.053	1.070	1.122	0.995	0.953	1.074
4	200.0	1.016	1.000	1.046	1.063	1.117	0.978	0.938	1.075
5	300.0	1.012	0.996	1.044	1.060	1.116	0.971	0.932	1.076
6	400.0	1.011	0.996	1.045	1.060	1.117	0.969	0.931	1.078
7	500.0	1.013	0.998	1.047	1.063	1.120	0.971	0.933	1.080
8	600.0	1.017	1.002	1.050	1.066	1.123	0.975	0.937	1.082
9	700.0	1.022	1.007	1.054	1.071	1.126	0.981	0.943	1.084
10	800.0	1.028	1.012	1.059	1.075	1.130	0.989	0.949	1.086
11	900.0	1.034	1.018	1.063	1.080	1.134	0.996	0.957	1.088
12	1000.0	1.041	1.024	1.067	1.085	1.137	1.004	0.964	1.090
13	1100.0	1.047	1.030	1.071	1.089	1.141	1.012	0.971	1.091
14	1200.0	1.053	1.036	1.075	1.094	1.144	1.020	0.978	1.092
15	1300.0	1.059	1.041	1.079	1.098	1.147	1.028	0.986	1.093

Table 4.57. Problem 3.2.2 reference solution power peaking factors for charge-pans 1028 and 0830.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	1.077	1.030	0.982	0.967	0.969	1.013	1.113	1.125
1	25.0	1.074	1.029	0.987	0.977	0.985	1.030	1.125	1.133
2	50.0	1.078	1.031	0.988	0.979	0.987	1.030	1.126	1.136
3	100.0	1.078	1.031	0.984	0.975	0.977	1.023	1.120	1.131
4	200.0	1.077	1.031	0.980	0.970	0.970	1.016	1.114	1.126
5	300.0	1.075	1.031	0.975	0.965	0.966	1.013	1.111	1.124
6	400.0	1.078	1.034	0.979	0.970	0.968	1.012	1.113	1.126
7	500.0	1.084	1.036	0.981	0.973	0.970	1.016	1.114	1.127
8	600.0	1.086	1.039	0.986	0.976	0.977	1.021	1.120	1.137
9	700.0	1.090	1.040	0.983	0.975	0.975	1.020	1.117	1.132
10	800.0	1.094	1.050	0.995	0.987	0.986	1.030	1.128	1.139
11	900.0	1.094	1.049	0.999	0.991	0.992	1.038	1.133	1.147
12	1000.0	1.101	1.052	1.001	0.994	0.998	1.041	1.139	1.147
13	1100.0	1.104	1.055	1.002	0.996	0.999	1.043	1.144	1.156
14	1200.0	1.107	1.059	1.007	1.004	1.005	1.049	1.144	1.158
15	1300.0	1.109	1.065	1.017	1.011	1.015	1.057	1.152	1.160
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	1.076	1.030	0.980	0.968	0.969	1.013	1.113	1.126
1	25.0	1.097	1.060	1.015	1.001	0.992	1.026	1.116	1.133
2	50.0	1.092	1.052	1.006	0.993	0.987	1.023	1.115	1.130
3	100.0	1.084	1.041	0.994	0.981	0.978	1.019	1.114	1.128
4	200.0	1.075	1.028	0.978	0.966	0.968	1.013	1.113	1.126
5	300.0	1.071	1.023	0.971	0.960	0.964	1.012	1.114	1.126
6	400.0	1.071	1.022	0.969	0.958	0.964	1.013	1.116	1.127
7	500.0	1.074	1.024	0.971	0.960	0.966	1.015	1.118	1.129
8	600.0	1.077	1.028	0.976	0.965	0.970	1.018	1.120	1.132
9	700.0	1.082	1.034	0.982	0.971	0.975	1.022	1.123	1.135
10	800.0	1.087	1.040	0.989	0.977	0.980	1.026	1.125	1.138
11	900.0	1.093	1.047	0.996	0.984	0.986	1.029	1.128	1.141
12	1000.0	1.098	1.053	1.004	0.992	0.991	1.033	1.130	1.144
13	1100.0	1.103	1.060	1.012	0.999	0.997	1.037	1.131	1.146
14	1200.0	1.108	1.067	1.019	1.007	1.003	1.041	1.133	1.148
15	1300.0	1.113	1.073	1.027	1.014	1.008	1.044	1.134	1.150

Charge-Pans 1128 and (0831)

Table 4.58. Problem 3.2.2 reference solution power peaking factors for charge-pans 1128 and 0831.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.780	0.789	0.854	0.850	0.919	0.692	0.727	0.905
1	25.0	0.787	0.802	0.867	0.856	0.919	0.698	0.741	0.924
2	50.0	0.788	0.803	0.869	0.859	0.922	0.698	0.745	0.927
3	100.0	0.783	0.801	0.863	0.856	0.920	0.695	0.737	0.918
4	200.0	0.777	0.787	0.851	0.847	0.918	0.693	0.727	0.906
5	300.0	0.772	0.781	0.846	0.845	0.913	0.689	0.718	0.898
6	400.0	0.774	0.785	0.849	0.847	0.917	0.693	0.723	0.897
7	500.0	0.775	0.788	0.853	0.850	0.919	0.694	0.724	0.899
8	600.0	0.779	0.789	0.854	0.853	0.923	0.697	0.726	0.903
9	700.0	0.780	0.788	0.853	0.851	0.922	0.697	0.724	0.903
10	800.0	0.788	0.799	0.865	0.863	0.933	0.706	0.737	0.916
11	900.0	0.794	0.805	0.870	0.866	0.934	0.711	0.743	0.919
12	1000.0	0.793	0.806	0.873	0.868	0.936	0.709	0.744	0.923
13	1100.0	0.794	0.807	0.871	0.867	0.936	0.711	0.742	0.925
14	1200.0	0.803	0.815	0.882	0.877	0.946	0.718	0.754	0.933
15	1300.0	0.812	0.824	0.893	0.883	0.949	0.724	0.766	0.946
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.779	0.789	0.854	0.851	0.919	0.693	0.726	0.906
1	25.0	0.826	0.837	0.900	0.896	0.960	0.740	0.776	0.946
2	50.0	0.815	0.826	0.889	0.885	0.950	0.729	0.764	0.937
3	100.0	0.798	0.809	0.873	0.869	0.935	0.712	0.747	0.923
4	200.0	0.775	0.786	0.851	0.847	0.915	0.689	0.723	0.904
5	300.0	0.765	0.776	0.842	0.838	0.907	0.679	0.712	0.896
6	400.0	0.761	0.772	0.839	0.834	0.904	0.674	0.708	0.894
7	500.0	0.762	0.773	0.840	0.836	0.905	0.674	0.708	0.896
8	600.0	0.766	0.777	0.845	0.840	0.910	0.678	0.712	0.900
9	700.0	0.772	0.783	0.851	0.846	0.916	0.683	0.718	0.906
10	800.0	0.780	0.791	0.859	0.854	0.924	0.690	0.726	0.914
11	900.0	0.788	0.800	0.867	0.863	0.932	0.698	0.734	0.922
12	1000.0	0.797	0.809	0.876	0.872	0.941	0.707	0.744	0.930
13	1100.0	0.807	0.818	0.886	0.881	0.950	0.716	0.753	0.939
14	1200.0	0.816	0.828	0.895	0.890	0.959	0.725	0.763	0.947
15	1300.0	0.826	0.838	0.905	0.900	0.968	0.734	0.773	0.956

Table 4.59. Problem 3.2.2 reference solution power peaking factors for charge-pans 1128 and 0831.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.845	0.769	0.700	0.716	0.800	0.860	0.920	0.926
1	25.0	0.848	0.771	0.708	0.726	0.815	0.879	0.931	0.933
2	50.0	0.849	0.771	0.710	0.728	0.820	0.882	0.932	0.934
3	100.0	0.848	0.771	0.706	0.725	0.811	0.871	0.930	0.931
4	200.0	0.845	0.767	0.699	0.715	0.799	0.860	0.916	0.923
5	300.0	0.843	0.763	0.695	0.708	0.792	0.851	0.912	0.918
6	400.0	0.848	0.766	0.696	0.710	0.793	0.857	0.916	0.920
7	500.0	0.845	0.769	0.698	0.712	0.795	0.855	0.916	0.922
8	600.0	0.852	0.771	0.702	0.714	0.801	0.858	0.919	0.926
9	700.0	0.850	0.771	0.701	0.715	0.796	0.858	0.917	0.927
10	800.0	0.861	0.781	0.712	0.724	0.810	0.871	0.928	0.935
11	900.0	0.862	0.787	0.716	0.732	0.817	0.877	0.934	0.938
12	1000.0	0.864	0.785	0.715	0.731	0.817	0.878	0.938	0.946
13	1100.0	0.864	0.784	0.717	0.731	0.820	0.880	0.937	0.942
14	1200.0	0.873	0.790	0.724	0.737	0.830	0.890	0.947	0.953
15	1300.0	0.877	0.799	0.732	0.750	0.841	0.902	0.958	0.958
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.846	0.768	0.700	0.714	0.799	0.860	0.921	0.925
1	25.0	0.892	0.814	0.747	0.763	0.848	0.906	0.961	0.966
2	50.0	0.881	0.803	0.736	0.752	0.837	0.895	0.951	0.956
3	100.0	0.865	0.786	0.720	0.735	0.820	0.879	0.937	0.941
4	200.0	0.843	0.764	0.696	0.711	0.797	0.858	0.918	0.922
5	300.0	0.833	0.753	0.686	0.700	0.786	0.848	0.910	0.913
6	400.0	0.830	0.749	0.682	0.696	0.783	0.845	0.908	0.911
7	500.0	0.831	0.750	0.682	0.697	0.784	0.846	0.909	0.913
8	600.0	0.835	0.754	0.685	0.700	0.788	0.851	0.914	0.917
9	700.0	0.841	0.760	0.691	0.706	0.794	0.857	0.920	0.923
10	800.0	0.849	0.767	0.698	0.714	0.802	0.865	0.928	0.931
11	900.0	0.858	0.776	0.707	0.722	0.811	0.874	0.936	0.939
12	1000.0	0.867	0.785	0.715	0.731	0.820	0.883	0.944	0.948
13	1100.0	0.876	0.794	0.724	0.740	0.830	0.893	0.953	0.957
14	1200.0	0.886	0.803	0.734	0.750	0.840	0.902	0.962	0.965
15	1300.0	0.895	0.813	0.743	0.760	0.850	0.912	0.970	0.974

Charge-Pans 1228 and (0832)

Table 4.60. Problem 3.2.2 reference solution power peaking factors for charge-pans 1228 and 0832.

Step	Burnup	Shift Power Peaking Factors					
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	S
		(A)	(D)	(C)	(B)	(R)	(Q)
0	0.0	0.443	0.469	0.524	0.508	0.627	0.641
1	25.0	0.452	0.479	0.536	0.514	0.634	0.656
2	50.0	0.452	0.478	0.536	0.517	0.635	0.656
3	100.0	0.449	0.476	0.534	0.514	0.632	0.651
4	200.0	0.444	0.468	0.526	0.507	0.628	0.638
5	300.0	0.437	0.458	0.518	0.498	0.619	0.626
6	400.0	0.439	0.460	0.520	0.503	0.623	0.628
7	500.0	0.437	0.457	0.520	0.499	0.622	0.628
8	600.0	0.440	0.458	0.523	0.503	0.626	0.632
9	700.0	0.440	0.458	0.521	0.502	0.627	0.629
10	800.0	0.446	0.464	0.529	0.508	0.633	0.641
11	900.0	0.450	0.469	0.537	0.514	0.639	0.645
12	1000.0	0.450	0.467	0.536	0.513	0.637	0.645
13	1100.0	0.452	0.469	0.537	0.513	0.638	0.645
14	1200.0	0.458	0.474	0.542	0.519	0.645	0.652
15	1300.0	0.466	0.483	0.552	0.527	0.653	0.664
Step	Burnup	MPACT Power Peaking Factors					
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	S
		(A)	(D)	(C)	(B)	(R)	(Q)
0	0.0	0.443	0.468	0.524	0.507	0.628	0.639
1	25.0	0.480	0.508	0.567	0.548	0.674	0.688
2	50.0	0.472	0.499	0.557	0.539	0.663	0.677
3	100.0	0.459	0.485	0.543	0.524	0.647	0.660
4	200.0	0.440	0.465	0.522	0.504	0.624	0.637
5	300.0	0.431	0.456	0.512	0.495	0.613	0.626
6	400.0	0.427	0.451	0.507	0.490	0.608	0.621
7	500.0	0.426	0.451	0.507	0.490	0.608	0.621
8	600.0	0.428	0.452	0.509	0.492	0.611	0.624
9	700.0	0.431	0.456	0.514	0.496	0.616	0.630
10	800.0	0.436	0.461	0.519	0.501	0.622	0.637
11	900.0	0.441	0.467	0.526	0.508	0.630	0.645
12	1000.0	0.447	0.473	0.533	0.514	0.638	0.653
13	1100.0	0.453	0.480	0.540	0.522	0.646	0.662
14	1200.0	0.460	0.487	0.548	0.529	0.655	0.672
15	1300.0	0.467	0.494	0.556	0.537	0.664	0.681

Table 4.61. Problem 3.2.2 reference solution power peaking factors for charge-pans 1228 and 0832.

Step	Burnup	Shift Power Peaking Factors					
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)
0	0.0	0.530	0.439	0.493	0.552	0.624	0.609
1	25.0	0.535	0.446	0.508	0.566	0.635	0.616
2	50.0	0.538	0.445	0.509	0.566	0.636	0.617
3	100.0	0.534	0.443	0.505	0.560	0.632	0.614
4	200.0	0.530	0.439	0.495	0.552	0.624	0.608
5	300.0	0.524	0.436	0.485	0.541	0.614	0.603
6	400.0	0.527	0.437	0.489	0.543	0.616	0.605
7	500.0	0.528	0.436	0.486	0.541	0.617	0.603
8	600.0	0.533	0.440	0.489	0.546	0.621	0.609
9	700.0	0.533	0.441	0.488	0.542	0.618	0.605
10	800.0	0.538	0.446	0.497	0.554	0.627	0.615
11	900.0	0.544	0.451	0.503	0.558	0.635	0.621
12	1000.0	0.539	0.449	0.500	0.556	0.634	0.620
13	1100.0	0.542	0.452	0.506	0.560	0.637	0.621
14	1200.0	0.551	0.457	0.511	0.565	0.643	0.628
15	1300.0	0.557	0.464	0.521	0.576	0.654	0.635
Step	Burnup	MPACT Power Peaking Factors					
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)
0	0.0	0.530	0.438	0.494	0.550	0.623	0.608
1	25.0	0.572	0.475	0.536	0.595	0.669	0.653
2	50.0	0.563	0.467	0.527	0.585	0.659	0.643
3	100.0	0.548	0.454	0.512	0.569	0.643	0.627
4	200.0	0.527	0.436	0.491	0.548	0.620	0.604
5	300.0	0.517	0.427	0.481	0.537	0.609	0.594
6	400.0	0.512	0.422	0.477	0.533	0.605	0.590
7	500.0	0.512	0.422	0.476	0.532	0.605	0.589
8	600.0	0.514	0.423	0.478	0.535	0.608	0.592
9	700.0	0.518	0.426	0.482	0.539	0.613	0.597
10	800.0	0.523	0.431	0.487	0.545	0.620	0.604
11	900.0	0.530	0.436	0.493	0.552	0.627	0.611
12	1000.0	0.537	0.442	0.500	0.560	0.636	0.619
13	1100.0	0.544	0.448	0.508	0.568	0.644	0.627
14	1200.0	0.551	0.454	0.515	0.577	0.653	0.636
15	1300.0	0.559	0.460	0.523	0.585	0.662	0.645

Charge-Pan 0929

Table 4.62. Problem 3.2.2 reference solution power peaking factors for charge-pan 0929.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Shift Power Peaking Factors A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	0.851	1.098	0.931	0.986	1.022	1.098	1.151	0.997	1.097	1.248
1	25.0	0.837	1.075	0.926	0.969	1.010	1.099	1.151	0.973	1.093	1.252
2	50.0	0.837	1.081	0.927	0.969	1.010	1.097	1.151	0.972	1.095	1.252
3	100.0	0.845	1.090	0.935	0.979	1.020	1.100	1.152	0.980	1.099	1.251
4	200.0	0.849	1.097	0.937	0.982	1.025	1.104	1.157	0.994	1.102	1.252
5	300.0	0.855	1.108	0.942	0.988	1.032	1.107	1.161	0.997	1.104	1.258
6	400.0	0.857	1.110	0.945	0.989	1.036	1.110	1.160	1.003	1.107	1.256
7	500.0	0.858	1.113	0.944	0.992	1.034	1.111	1.163	1.004	1.112	1.259
8	600.0	0.859	1.113	0.948	0.994	1.042	1.117	1.168	1.006	1.117	1.262
9	700.0	0.859	1.112	0.947	0.995	1.043	1.119	1.166	1.006	1.118	1.265
10	800.0	0.858	1.103	0.947	0.991	1.041	1.119	1.168	1.000	1.118	1.261
11	900.0	0.855	1.099	0.945	0.989	1.038	1.120	1.169	0.998	1.116	1.263
12	1000.0	0.858	1.100	0.947	0.992	1.043	1.122	1.171	0.997	1.123	1.269
13	1100.0	0.852	1.092	0.949	0.985	1.040	1.125	1.176	0.989	1.124	1.268
14	1200.0	0.850	1.086	0.943	0.988	1.038	1.123	1.174	0.989	1.121	1.264
15	1300.0	0.847	1.084	0.943	0.984	1.036	1.126	1.176	0.983	1.125	1.270
Step	Burnup $\left[\frac{MWd}{MtU}\right]$	MPACT Power Peaking Factors A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	0.846	1.097	0.929	0.983	1.019	1.098	1.150	0.992	1.097	1.249
1	25.0	0.859	1.103	0.924	1.003	1.033	1.094	1.135	1.019	1.103	1.222
2	50.0	0.855	1.101	0.925	0.998	1.029	1.094	1.138	1.012	1.101	1.228
3	100.0	0.851	1.098	0.926	0.990	1.024	1.095	1.143	1.002	1.098	1.237
4	200.0	0.846	1.096	0.929	0.981	1.018	1.098	1.151	0.990	1.096	1.251
5	300.0	0.844	1.096	0.931	0.978	1.017	1.101	1.156	0.985	1.096	1.258
6	400.0	0.845	1.098	0.934	0.979	1.018	1.103	1.159	0.985	1.098	1.262
7	500.0	0.847	1.100	0.936	0.981	1.020	1.105	1.161	0.987	1.100	1.263
8	600.0	0.851	1.103	0.938	0.985	1.024	1.107	1.162	0.991	1.103	1.263
9	700.0	0.854	1.106	0.939	0.990	1.028	1.109	1.162	0.997	1.106	1.261
10	800.0	0.858	1.109	0.940	0.995	1.032	1.110	1.162	1.003	1.109	1.259
11	900.0	0.863	1.112	0.942	1.000	1.036	1.111	1.161	1.009	1.112	1.255
12	1000.0	0.867	1.115	0.942	1.006	1.040	1.112	1.159	1.016	1.115	1.251
13	1100.0	0.871	1.118	0.943	1.011	1.044	1.113	1.157	1.022	1.118	1.247
14	1200.0	0.875	1.120	0.943	1.016	1.048	1.113	1.155	1.029	1.120	1.242
15	1300.0	0.878	1.122	0.944	1.021	1.052	1.113	1.153	1.035	1.122	1.237

Charge-Pans 1029 and (0930)

Table 4.63. Problem 3.2.2 reference solution power peaking factors for charge-pans 1029 and 0930.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift Power Peaking Factors							
		A (A)	B (D)	C (C)	D (B)	P (R)	Q (Q)	R (P)	S (S)
0	0.0	0.954	0.985	1.021	0.992	0.993	0.862	0.966	1.086
1	25.0	0.934	0.971	1.009	0.973	0.967	0.838	0.959	1.081
2	50.0	0.936	0.975	1.007	0.973	0.968	0.842	0.962	1.083
3	100.0	0.945	0.982	1.018	0.981	0.979	0.850	0.965	1.085
4	200.0	0.949	0.983	1.020	0.989	0.988	0.858	0.966	1.086
5	300.0	0.954	0.988	1.024	0.991	0.995	0.861	0.966	1.089
6	400.0	0.958	0.993	1.026	0.996	0.999	0.868	0.971	1.091
7	500.0	0.962	0.993	1.028	0.998	1.001	0.866	0.973	1.092
8	600.0	0.963	0.997	1.033	1.002	1.005	0.870	0.979	1.099
9	700.0	0.965	0.998	1.035	1.003	1.005	0.872	0.978	1.099
10	800.0	0.964	1.002	1.036	1.001	0.999	0.872	0.986	1.098
11	900.0	0.963	1.000	1.033	1.000	0.996	0.868	0.987	1.101
12	1000.0	0.964	1.002	1.038	1.001	0.999	0.869	0.989	1.107
13	1100.0	0.955	0.998	1.034	0.994	0.989	0.863	0.986	1.107
14	1200.0	0.962	1.002	1.038	0.995	0.987	0.865	0.990	1.109
15	1300.0	0.956	1.002	1.036	0.991	0.983	0.862	0.995	1.109
Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	MPACT Power Peaking Factors							
		A (A)	B (D)	C (C)	D (B)	P (R)	Q (Q)	R (P)	S (S)
0	0.0	0.951	0.983	1.020	0.988	0.987	0.857	0.965	1.086
1	25.0	0.989	1.019	1.049	1.021	1.020	0.901	1.003	1.102
2	50.0	0.979	1.010	1.041	1.012	1.011	0.890	0.994	1.098
3	100.0	0.965	0.997	1.031	1.000	0.999	0.874	0.979	1.092
4	200.0	0.947	0.980	1.017	0.984	0.984	0.853	0.961	1.085
5	300.0	0.939	0.973	1.012	0.978	0.978	0.844	0.954	1.083
6	400.0	0.937	0.971	1.011	0.977	0.977	0.840	0.951	1.083
7	500.0	0.939	0.973	1.013	0.979	0.979	0.842	0.953	1.085
8	600.0	0.943	0.978	1.017	0.983	0.984	0.846	0.958	1.089
9	700.0	0.949	0.984	1.023	0.989	0.989	0.852	0.964	1.093
10	800.0	0.957	0.991	1.029	0.996	0.996	0.860	0.971	1.098
11	900.0	0.965	0.998	1.036	1.003	1.004	0.868	0.979	1.102
12	1000.0	0.973	1.006	1.043	1.011	1.011	0.877	0.988	1.107
13	1100.0	0.981	1.014	1.050	1.018	1.018	0.886	0.996	1.111
14	1200.0	0.989	1.022	1.056	1.026	1.026	0.895	1.004	1.116
15	1300.0	0.998	1.030	1.063	1.033	1.033	0.905	1.013	1.119

Table 4.64. Problem 3.2.2 reference solution power peaking factors for charge-pans 1029 and 0930.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.966	0.922	0.905	0.940	1.018	1.063	1.046	1.014
1	25.0	0.943	0.900	0.887	0.928	1.014	1.053	1.034	0.992
2	50.0	0.944	0.898	0.888	0.929	1.012	1.058	1.034	0.997
3	100.0	0.956	0.912	0.898	0.937	1.016	1.058	1.042	1.005
4	200.0	0.962	0.919	0.902	0.938	1.018	1.056	1.044	1.012
5	300.0	0.969	0.923	0.902	0.940	1.016	1.058	1.048	1.017
6	400.0	0.974	0.929	0.909	0.947	1.023	1.065	1.053	1.020
7	500.0	0.975	0.930	0.909	0.950	1.024	1.066	1.053	1.023
8	600.0	0.978	0.933	0.913	0.952	1.027	1.069	1.059	1.024
9	700.0	0.979	0.934	0.910	0.954	1.032	1.072	1.061	1.028
10	800.0	0.976	0.931	0.915	0.959	1.038	1.077	1.061	1.024
11	900.0	0.972	0.926	0.913	0.957	1.037	1.079	1.057	1.020
12	1000.0	0.973	0.928	0.913	0.958	1.040	1.084	1.060	1.024
13	1100.0	0.967	0.921	0.908	0.952	1.038	1.082	1.058	1.015
14	1200.0	0.964	0.922	0.913	0.958	1.042	1.086	1.060	1.014
15	1300.0	0.960	0.918	0.911	0.961	1.050	1.087	1.057	1.014
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.962	0.917	0.901	0.938	1.017	1.059	1.045	1.010
1	25.0	0.999	0.958	0.943	0.978	1.050	1.084	1.067	1.037
2	50.0	0.990	0.948	0.933	0.968	1.041	1.077	1.061	1.030
3	100.0	0.976	0.933	0.917	0.953	1.029	1.068	1.053	1.020
4	200.0	0.958	0.913	0.897	0.934	1.014	1.057	1.043	1.008
5	300.0	0.951	0.905	0.888	0.925	1.008	1.053	1.039	1.003
6	400.0	0.949	0.902	0.885	0.923	1.007	1.052	1.039	1.002
7	500.0	0.951	0.903	0.886	0.925	1.009	1.054	1.042	1.005
8	600.0	0.955	0.908	0.891	0.929	1.013	1.058	1.046	1.009
9	700.0	0.961	0.914	0.897	0.935	1.019	1.064	1.051	1.014
10	800.0	0.969	0.922	0.905	0.943	1.026	1.069	1.056	1.021
11	900.0	0.977	0.930	0.913	0.951	1.033	1.076	1.062	1.027
12	1000.0	0.985	0.939	0.922	0.960	1.040	1.082	1.067	1.034
13	1100.0	0.993	0.948	0.931	0.968	1.048	1.088	1.073	1.040
14	1200.0	1.001	0.957	0.940	0.977	1.055	1.094	1.078	1.047
15	1300.0	1.009	0.965	0.949	0.986	1.062	1.099	1.083	1.053

Charge-Pans 1129 and (0931)

Table 4.65. Problem 3.2.2 reference solution power peaking factors for charge-pans 1129 and 0931.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.664	0.704	0.782	0.742	0.788	0.567	0.700	0.903
1	25.0	0.655	0.699	0.772	0.730	0.767	0.557	0.700	0.896
2	50.0	0.654	0.697	0.773	0.732	0.770	0.560	0.702	0.899
3	100.0	0.659	0.700	0.776	0.735	0.777	0.562	0.700	0.900
4	200.0	0.658	0.701	0.776	0.738	0.781	0.565	0.699	0.897
5	300.0	0.658	0.698	0.776	0.736	0.782	0.567	0.699	0.895
6	400.0	0.665	0.703	0.778	0.743	0.788	0.572	0.701	0.900
7	500.0	0.664	0.706	0.783	0.743	0.787	0.573	0.702	0.903
8	600.0	0.667	0.709	0.783	0.746	0.792	0.576	0.705	0.906
9	700.0	0.669	0.711	0.785	0.746	0.796	0.576	0.708	0.903
10	800.0	0.670	0.714	0.792	0.750	0.795	0.580	0.713	0.911
11	900.0	0.672	0.715	0.794	0.751	0.794	0.579	0.720	0.915
12	1000.0	0.671	0.713	0.792	0.751	0.795	0.576	0.717	0.915
13	1100.0	0.669	0.713	0.791	0.747	0.790	0.576	0.716	0.914
14	1200.0	0.674	0.720	0.795	0.753	0.792	0.582	0.722	0.920
15	1300.0	0.677	0.723	0.798	0.756	0.791	0.583	0.728	0.925
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
		(A)	(D)	(C)	(B)	(R)	(Q)	(P)	(S)
0	0.0	0.661	0.703	0.778	0.738	0.783	0.565	0.700	0.900
1	25.0	0.703	0.747	0.822	0.782	0.827	0.606	0.747	0.943
2	50.0	0.693	0.736	0.811	0.772	0.817	0.596	0.736	0.932
3	100.0	0.677	0.720	0.795	0.756	0.800	0.582	0.719	0.916
4	200.0	0.656	0.698	0.773	0.734	0.778	0.561	0.695	0.896
5	300.0	0.646	0.688	0.763	0.724	0.769	0.551	0.684	0.887
6	400.0	0.642	0.684	0.760	0.720	0.765	0.547	0.680	0.884
7	500.0	0.642	0.684	0.761	0.721	0.766	0.546	0.680	0.885
8	600.0	0.645	0.688	0.764	0.724	0.770	0.549	0.683	0.890
9	700.0	0.650	0.693	0.770	0.730	0.776	0.553	0.688	0.896
10	800.0	0.657	0.700	0.778	0.737	0.783	0.559	0.695	0.904
11	900.0	0.664	0.708	0.786	0.745	0.791	0.565	0.703	0.912
12	1000.0	0.672	0.716	0.795	0.754	0.800	0.572	0.712	0.921
13	1100.0	0.680	0.725	0.804	0.762	0.809	0.579	0.721	0.930
14	1200.0	0.689	0.734	0.813	0.771	0.818	0.586	0.730	0.939
15	1300.0	0.697	0.742	0.822	0.780	0.827	0.594	0.739	0.948

Table 4.66. Problem 3.2.2 reference solution power peaking factors for charge-pans 1129 and 0931.

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.702	0.617	0.622	0.673	0.743	0.825	0.870	0.833
1	25.0	0.688	0.605	0.617	0.669	0.743	0.820	0.861	0.818
2	50.0	0.688	0.607	0.616	0.670	0.744	0.821	0.861	0.818
3	100.0	0.695	0.612	0.619	0.672	0.745	0.822	0.866	0.826
4	200.0	0.696	0.612	0.618	0.671	0.743	0.822	0.865	0.825
5	300.0	0.697	0.613	0.620	0.670	0.740	0.819	0.867	0.829
6	400.0	0.702	0.620	0.627	0.677	0.743	0.824	0.870	0.833
7	500.0	0.702	0.620	0.628	0.678	0.746	0.825	0.872	0.832
8	600.0	0.706	0.623	0.633	0.680	0.749	0.830	0.876	0.837
9	700.0	0.709	0.623	0.632	0.679	0.749	0.828	0.874	0.838
10	800.0	0.712	0.627	0.634	0.687	0.757	0.837	0.880	0.842
11	900.0	0.711	0.626	0.639	0.690	0.757	0.839	0.880	0.839
12	1000.0	0.708	0.625	0.636	0.688	0.758	0.839	0.880	0.839
13	1100.0	0.708	0.623	0.634	0.686	0.758	0.835	0.878	0.836
14	1200.0	0.713	0.626	0.641	0.694	0.765	0.845	0.883	0.841
15	1300.0	0.712	0.630	0.644	0.697	0.769	0.848	0.886	0.843
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
		(H)	(G)	(F)	(E)	(M)	(L)	(K)	(J)
0	0.0	0.698	0.614	0.622	0.672	0.744	0.822	0.868	0.829
1	25.0	0.741	0.655	0.665	0.718	0.789	0.867	0.911	0.873
2	50.0	0.731	0.645	0.655	0.707	0.778	0.856	0.901	0.862
3	100.0	0.715	0.630	0.639	0.690	0.762	0.840	0.885	0.846
4	200.0	0.693	0.609	0.617	0.667	0.739	0.818	0.864	0.824
5	300.0	0.683	0.600	0.607	0.657	0.729	0.808	0.854	0.815
6	400.0	0.679	0.596	0.602	0.652	0.725	0.805	0.851	0.811
7	500.0	0.680	0.596	0.602	0.652	0.725	0.806	0.852	0.812
8	600.0	0.683	0.598	0.604	0.655	0.729	0.810	0.857	0.816
9	700.0	0.689	0.603	0.609	0.660	0.735	0.816	0.863	0.823
10	800.0	0.695	0.609	0.615	0.666	0.742	0.824	0.871	0.830
11	900.0	0.703	0.616	0.622	0.674	0.750	0.832	0.879	0.839
12	1000.0	0.711	0.624	0.630	0.682	0.759	0.841	0.888	0.847
13	1100.0	0.720	0.632	0.638	0.691	0.768	0.850	0.897	0.857
14	1200.0	0.729	0.640	0.646	0.699	0.777	0.860	0.906	0.866
15	1300.0	0.737	0.648	0.654	0.708	0.786	0.869	0.915	0.875

Charge-Pan 1030

Table 4.67. Problem 3.2.2 reference solution power peaking factors for charge-pan 1030.

Step	Burnup	Shift Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	0.752	0.810	0.865	0.687	0.751	0.872	0.924	0.628	0.809	0.964
1	25.0	0.725	0.779	0.839	0.665	0.729	0.849	0.896	0.606	0.789	0.934
2	50.0	0.726	0.778	0.839	0.665	0.728	0.848	0.900	0.607	0.788	0.940
3	100.0	0.739	0.792	0.847	0.674	0.737	0.862	0.913	0.615	0.800	0.948
4	200.0	0.746	0.802	0.858	0.680	0.744	0.866	0.921	0.627	0.803	0.959
5	300.0	0.752	0.814	0.863	0.690	0.751	0.875	0.927	0.632	0.811	0.965
6	400.0	0.761	0.820	0.872	0.696	0.756	0.878	0.933	0.638	0.817	0.971
7	500.0	0.758	0.822	0.872	0.694	0.754	0.876	0.932	0.637	0.814	0.974
8	600.0	0.760	0.816	0.870	0.697	0.756	0.882	0.934	0.638	0.817	0.973
9	700.0	0.759	0.816	0.870	0.697	0.757	0.881	0.932	0.638	0.819	0.970
10	800.0	0.755	0.807	0.862	0.690	0.754	0.880	0.929	0.634	0.816	0.964
11	900.0	0.752	0.808	0.860	0.688	0.750	0.875	0.925	0.632	0.815	0.961
12	1000.0	0.749	0.802	0.858	0.688	0.749	0.875	0.923	0.629	0.812	0.960
13	1100.0	0.744	0.790	0.852	0.684	0.745	0.868	0.916	0.625	0.811	0.954
14	1200.0	0.736	0.787	0.851	0.680	0.742	0.866	0.915	0.621	0.810	0.948
15	1300.0	0.735	0.778	0.844	0.677	0.740	0.866	0.912	0.618	0.807	0.946
Step	Burnup	MPACT Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B,D	C	G,F	H,E	J,M	K,L	Q	R,P	S
0	0.0	0.748	0.805	0.861	0.683	0.746	0.869	0.921	0.625	0.805	0.961
1	25.0	0.791	0.850	0.904	0.726	0.790	0.912	0.961	0.667	0.850	0.998
2	50.0	0.781	0.839	0.893	0.716	0.779	0.902	0.951	0.657	0.839	0.988
3	100.0	0.765	0.823	0.877	0.700	0.763	0.886	0.936	0.641	0.823	0.975
4	200.0	0.743	0.801	0.857	0.678	0.741	0.865	0.917	0.620	0.801	0.957
5	300.0	0.733	0.791	0.848	0.668	0.731	0.856	0.908	0.610	0.791	0.950
6	400.0	0.729	0.788	0.844	0.664	0.727	0.852	0.906	0.606	0.788	0.948
7	500.0	0.730	0.788	0.846	0.665	0.728	0.854	0.907	0.606	0.788	0.950
8	600.0	0.734	0.793	0.850	0.668	0.732	0.858	0.912	0.609	0.793	0.955
9	700.0	0.739	0.799	0.856	0.673	0.738	0.865	0.918	0.614	0.799	0.961
10	800.0	0.747	0.806	0.864	0.680	0.745	0.872	0.926	0.620	0.806	0.968
11	900.0	0.755	0.815	0.872	0.688	0.753	0.881	0.934	0.627	0.815	0.976
12	1000.0	0.763	0.823	0.881	0.696	0.761	0.890	0.943	0.635	0.823	0.984
13	1100.0	0.772	0.832	0.890	0.704	0.770	0.899	0.952	0.643	0.832	0.992
14	1200.0	0.781	0.842	0.899	0.713	0.779	0.908	0.960	0.651	0.842	1.000
15	1300.0	0.790	0.851	0.908	0.722	0.788	0.917	0.969	0.659	0.851	1.008

Charge-Pans 1130 and (1031)

Table 4.68. Problem 3.2.2 reference solution power peaking factors for charge-pans 1130 and 1031.

Step	Burnup	Shift Power Peaking Factors						
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	R	S
		(A)	(D)	(C)	(B)	(R)	(P)	(S)
0	0.0	0.494	0.528	0.582	0.533	0.579	0.529	0.731
1	25.0	0.479	0.517	0.565	0.515	0.559	0.518	0.714
2	50.0	0.481	0.519	0.568	0.518	0.560	0.518	0.715
3	100.0	0.485	0.523	0.573	0.524	0.569	0.521	0.720
4	200.0	0.491	0.526	0.579	0.528	0.575	0.523	0.725
5	300.0	0.494	0.530	0.581	0.532	0.580	0.526	0.727
6	400.0	0.497	0.533	0.587	0.539	0.585	0.530	0.731
7	500.0	0.495	0.535	0.585	0.536	0.582	0.531	0.728
8	600.0	0.499	0.538	0.588	0.539	0.585	0.536	0.731
9	700.0	0.498	0.537	0.588	0.539	0.586	0.534	0.731
10	800.0	0.499	0.539	0.588	0.538	0.582	0.536	0.731
11	900.0	0.497	0.536	0.588	0.536	0.582	0.537	0.729
12	1000.0	0.496	0.536	0.587	0.536	0.578	0.534	0.728
13	1100.0	0.496	0.534	0.584	0.533	0.576	0.533	0.727
14	1200.0	0.495	0.537	0.583	0.532	0.575	0.538	0.726
15	1300.0	0.495	0.534	0.583	0.533	0.572	0.538	0.726
Step	Burnup	MPACT Power Peaking Factors						
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	R	S
		(A)	(D)	(C)	(B)	(R)	(P)	(S)
0	0.0	0.490	0.527	0.579	0.530	0.577	0.525	0.728
1	25.0	0.527	0.565	0.619	0.568	0.618	0.564	0.772
2	50.0	0.519	0.556	0.609	0.559	0.608	0.555	0.762
3	100.0	0.505	0.542	0.595	0.545	0.593	0.541	0.746
4	200.0	0.487	0.523	0.574	0.526	0.572	0.521	0.724
5	300.0	0.478	0.513	0.565	0.517	0.562	0.512	0.714
6	400.0	0.473	0.509	0.561	0.513	0.558	0.508	0.710
7	500.0	0.473	0.509	0.561	0.512	0.558	0.507	0.710
8	600.0	0.475	0.511	0.563	0.515	0.560	0.509	0.714
9	700.0	0.478	0.515	0.568	0.519	0.565	0.513	0.720
10	800.0	0.483	0.520	0.574	0.524	0.570	0.518	0.727
11	900.0	0.489	0.526	0.580	0.530	0.577	0.524	0.735
12	1000.0	0.495	0.532	0.587	0.536	0.584	0.530	0.743
13	1100.0	0.501	0.539	0.595	0.543	0.591	0.537	0.752
14	1200.0	0.507	0.546	0.602	0.550	0.599	0.544	0.761
15	1300.0	0.514	0.554	0.610	0.558	0.607	0.551	0.770

Table 4.69. Problem 3.2.2 reference solution power peaking factors for charge-pans 1130 and 1031.

Step	Burnup	Power Peaking Factors				
	$\left[\frac{MWd}{MtU}\right]$	E	J	K	L	M
		(H)	(M)	(L)	(K)	(J)
0	0.0	0.521	0.570	0.647	0.670	0.610
1	25.0	0.504	0.557	0.633	0.651	0.591
2	50.0	0.505	0.557	0.632	0.651	0.592
3	100.0	0.512	0.561	0.639	0.660	0.601
4	200.0	0.515	0.565	0.640	0.664	0.606
5	300.0	0.523	0.565	0.643	0.668	0.611
6	400.0	0.528	0.570	0.646	0.677	0.616
7	500.0	0.525	0.568	0.645	0.674	0.612
8	600.0	0.530	0.573	0.648	0.676	0.617
9	700.0	0.529	0.572	0.650	0.677	0.616
10	800.0	0.528	0.574	0.648	0.676	0.615
11	900.0	0.526	0.574	0.648	0.674	0.612
12	1000.0	0.524	0.572	0.646	0.671	0.610
13	1100.0	0.524	0.571	0.645	0.672	0.609
14	1200.0	0.520	0.571	0.647	0.668	0.606
15	1300.0	0.518	0.573	0.646	0.668	0.604
Step	Burnup	MPACT Power Peaking Factors				
	$\left[\frac{MWd}{MtU}\right]$	E	J	K	L	M
		(H)	(M)	(L)	(K)	(J)
0	0.0	0.518	0.567	0.643	0.667	0.608
1	25.0	0.556	0.606	0.685	0.710	0.649
2	50.0	0.547	0.597	0.675	0.700	0.639
3	100.0	0.533	0.582	0.660	0.684	0.624
4	200.0	0.514	0.562	0.639	0.662	0.603
5	300.0	0.504	0.553	0.629	0.653	0.593
6	400.0	0.500	0.549	0.625	0.648	0.589
7	500.0	0.500	0.548	0.625	0.649	0.589
8	600.0	0.502	0.551	0.628	0.652	0.592
9	700.0	0.505	0.555	0.633	0.657	0.597
10	800.0	0.510	0.561	0.640	0.664	0.603
11	900.0	0.516	0.567	0.647	0.671	0.610
12	1000.0	0.523	0.574	0.655	0.679	0.617
13	1100.0	0.529	0.582	0.663	0.688	0.625
14	1200.0	0.536	0.589	0.671	0.696	0.633
15	1300.0	0.543	0.597	0.679	0.705	0.641

5. PROBLEM 4: FUEL CHANNEL 3D

Problem 4 is a single 3D fuel channel with upper and lower axial reflector regions. The top and bottom have vacuum (zero-return) boundaries, and the north, south, east, and west boundaries are fully reflected. Problem 4 is more complex than previous problems because it is 3D and includes axial reflectors.

5.1 BEGINNING-OF-CYCLE

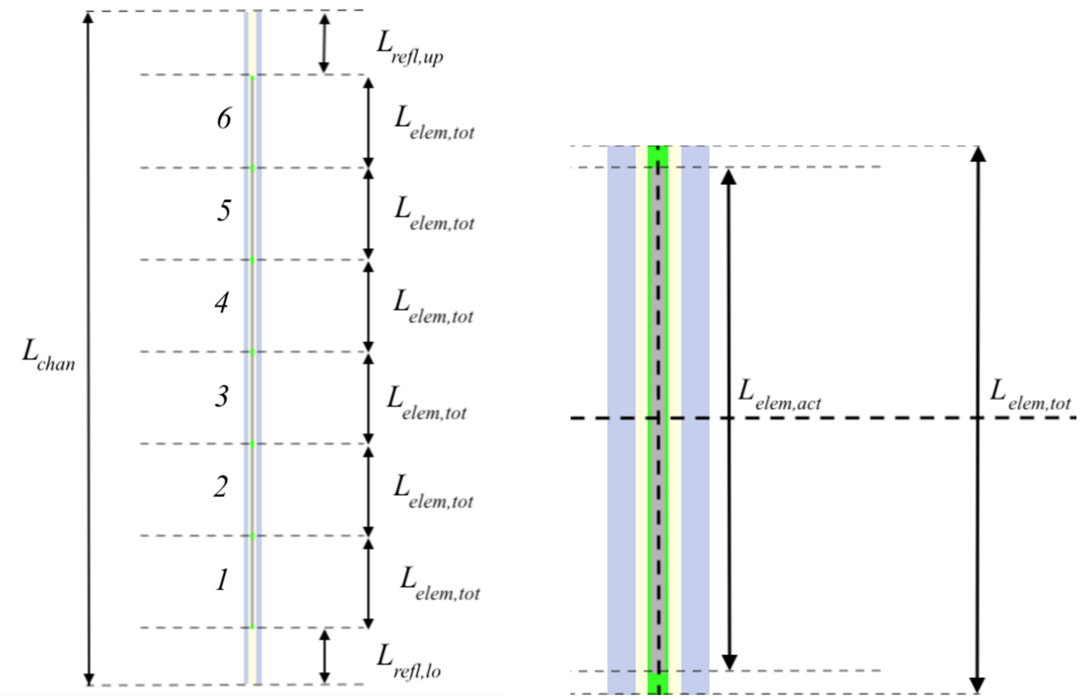
5.1.1 Problem 4.1.1

5.1.1.1 Description

Figure 16 shows the axial fuel channel geometry for Problem 4.1.1. Six fuel rods are stacked on one another within the fuel channel. Within each fuel element, the active (uranium-bearing) length is centered in the total length such that two end cap regions are formed at the top and bottom of each element. These regions are each

$$L_{\text{cap}} = \frac{L_{\text{elem,tot}} - L_{\text{elem,act}}}{2}$$

in length and composed entirely of cladding material. In the reference solution for Problem 4.1.1, each fuel element is divided into 20 segments, each representing 5% of the active fuel length. The values reported are the average values over each segment. The transverse geometry is illustrated by Figure 16. Zone B coolant channel radius is used for this problem. Geometric dimensions are listed in Table 1.2. Material densities are listed in Table 1.4. Temperatures are listed in Table 2.4.



(a) Fuel channel 3D, six fuel element stack **(b) Single fuel element**

Figure 16. 3D fuel channel.

5.1.1.2 Reference Solution

The neutron multiplication factor results are shown in Table 5.1. The timing variables for Shift and MPACT are shown in Table 5.2. Power peaking factors are displayed for BOC and EOC in Figure 17 and fully tabulated for all time steps in Tables 5.3-5.8. MPACT and Shift agree well for this case.

Table 5.1. Neutron multiplication factor for the reference solution of Problem 4.1.1.

Step	Burnup	Shift	MPACT	Difference
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	k_{eff} (1σ)	k_{eff} (1σ)	[pcm]
0	0.0	1.05183(5)	1.05091(10)	-98(11)

Table 5.2. Timing variables for the reference solution of Problem 4.1.1

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1500	1200	250000	2	48	1.95
MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1.0×10^{-04}	1.0×10^{-03}	0.01	4	32	0.72

Table 5.3. Problem 4.1.1 reference solution power peaking factors for axial segments in element 1.

Power Peaking Factors	1	2	3	4	5	6	7	8	9	10
Shift	0.467	0.455	0.461	0.473	0.489	0.508	0.528	0.551	0.574	0.597
MPACT	0.453	0.448	0.453	0.465	0.481	0.500	0.521	0.544	0.567	0.591
	11	12	13	14	15	16	17	18	19	20
Shift	0.621	0.646	0.672	0.698	0.725	0.755	0.787	0.821	0.857	0.925
MPACT	0.616	0.641	0.667	0.694	0.722	0.752	0.784	0.819	0.859	0.911

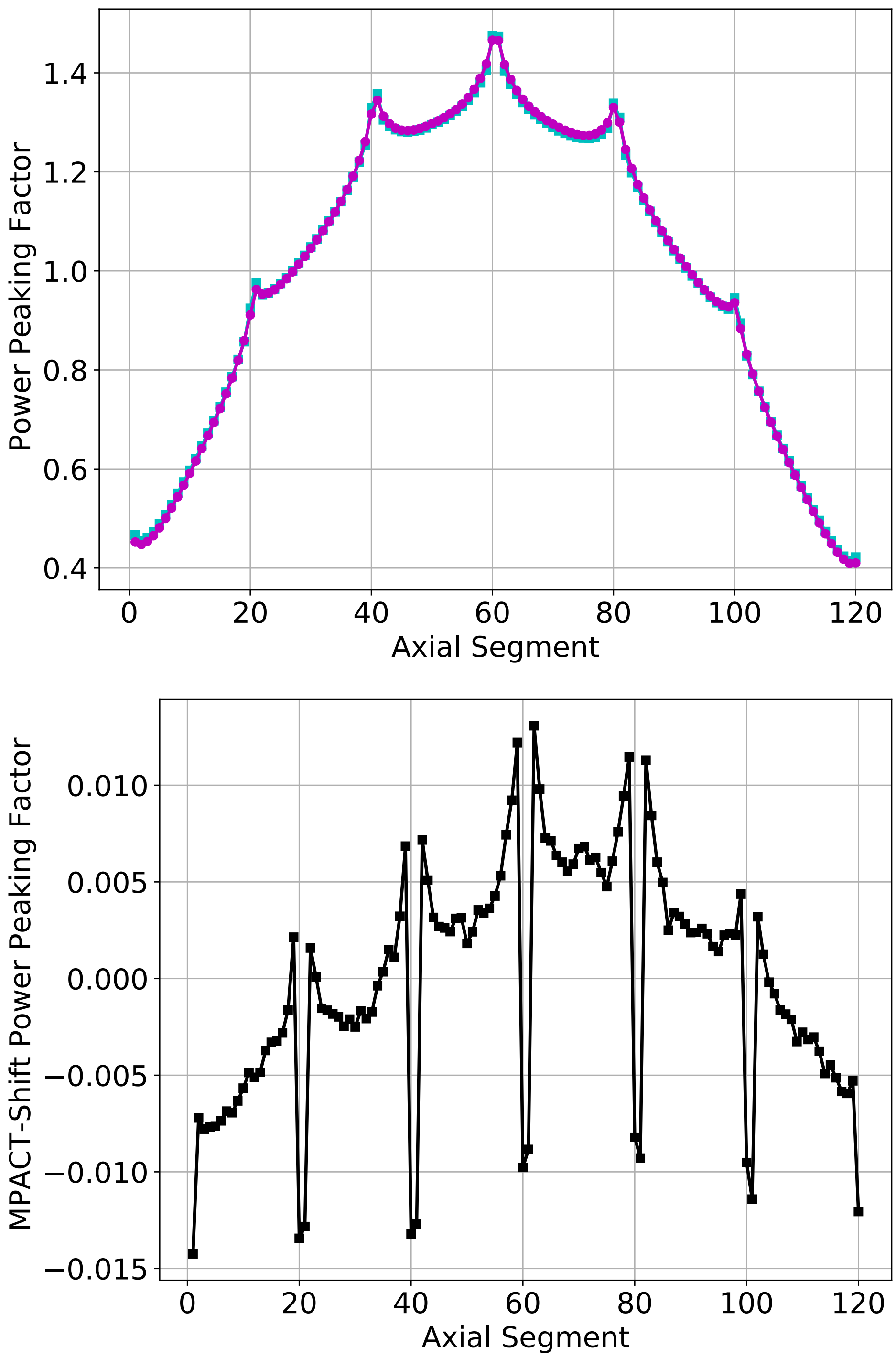


Figure 17. Power peaking factors for Problem 4.1.1 for Shift and MPACT (top) and their absolute difference (bottom).

Table 5.4. Problem 4.1.1 reference solution power peaking factors for axial segments in element 2.

	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
Shift	0.975	0.951	0.955	0.964	0.974	0.986	1.000	1.016	1.031	1.048
MPACT	0.962	0.953	0.955	0.962	0.972	0.984	0.998	1.013	1.029	1.046
	11	12	13	14	15	16	17	18	19	20
Shift	1.065	1.083	1.101	1.119	1.140	1.163	1.190	1.220	1.254	1.330
MPACT	1.063	1.081	1.099	1.119	1.140	1.164	1.191	1.223	1.261	1.316

Table 5.5. Problem 4.1.1 reference solution power peaking factors for axial segments in element 3.

	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
Shift	1.357	1.305	1.292	1.285	1.282	1.281	1.282	1.285	1.289	1.295
MPACT	1.344	1.312	1.297	1.288	1.284	1.283	1.285	1.288	1.292	1.297
	11	12	13	14	15	16	17	18	19	20
Shift	1.301	1.306	1.314	1.322	1.332	1.345	1.360	1.380	1.406	1.476
MPACT	1.303	1.310	1.317	1.326	1.337	1.350	1.367	1.389	1.418	1.466

Table 5.6. Problem 4.1.1 reference solution power peaking factors for axial segments in element 4.

	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
Shift	1.474	1.404	1.377	1.357	1.340	1.326	1.315	1.306	1.298	1.290
MPACT	1.465	1.417	1.387	1.364	1.347	1.333	1.321	1.312	1.304	1.296
	11	12	13	14	15	16	17	18	19	20
Shift	1.283	1.278	1.273	1.270	1.268	1.267	1.269	1.275	1.288	1.338
MPACT	1.290	1.284	1.279	1.275	1.273	1.273	1.277	1.285	1.299	1.330

Table 5.7. Problem 4.1.1 reference solution power peaking factors for axial segments in element 5.

	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
Shift	1.310	1.234	1.198	1.169	1.142	1.120	1.097	1.077	1.059	1.041
MPACT	1.301	1.245	1.207	1.175	1.147	1.123	1.101	1.081	1.062	1.043
	11	12	13	14	15	16	17	18	19	20
Shift	1.023	1.006	0.990	0.975	0.961	0.947	0.936	0.928	0.923	0.945
MPACT	1.026	1.009	0.992	0.976	0.962	0.949	0.938	0.931	0.927	0.936

Table 5.8. Problem 4.1.1 reference solution power peaking factors for axial segments in element 6.

	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
Shift	0.895	0.829	0.791	0.757	0.725	0.696	0.668	0.641	0.616	0.590
MPACT	0.883	0.832	0.792	0.757	0.724	0.695	0.666	0.639	0.613	0.588
	11	12	13	14	15	16	17	18	19	20
Shift	0.566	0.541	0.518	0.496	0.474	0.454	0.438	0.424	0.414	0.422
MPACT	0.562	0.538	0.514	0.491	0.469	0.449	0.432	0.418	0.409	0.410

5.2 DEPLETION

5.2.1 Problem 4.2.1

5.2.1.1 Description

This problem uses exactly the same geometry as Problem 4.1.1 shown in Figure 16. Material densities are listed in Table 1.4. Temperatures are listed in Table 2.4. The total system specific power is listed in Table 1.6.

5.2.1.2 Reference Solution

The neutron multiplication factor results are shown in Table 5.9. The timing variables for Shift and MPACT are shown in Table 5.10. For this problem, the MPACT solution converges much quicker than the Shift solution. This is because MPACT uses the converged solution from the previous step as the initial source distribution for the next step. While MC codes do this as well, as with Shift, its convergence is solely proportional to the number of neutron histories run. Additionally, loose convergence criteria relative to the 2D problems was required for the problem to finish. It is hypothesized that the non-fueled end cap regions cause the MPACT solution to remain unconverged if the convergence criteria is too precise.

Power peaking factors are displayed for BOC and EOC in Figures 18-19 and fully tabulated for all time steps in Tables 5.11-5.22. The peaking factors agree to about 2%.

Table 5.9. Neutron multiplication factor for the reference solution of Problem 4.2.1.

Step	Burnup	Shift	MPACT	Difference
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	k_{eff} (1σ)	k_{eff} (1σ)	[pcm]
0	0.0	1.05187(10)	1.05093(10)	-94(14)
1	25.0	1.03587(11)	1.03527(10)	-60(15)
2	50.0	1.03563(11)	1.03543(10)	-19(15)
3	100.0	1.03720(10)	1.03688(10)	-32(14)
4	200.0	1.04119(11)	1.04137(10)	18(15)
5	300.0	1.04465(10)	1.04530(10)	65(14)
6	400.0	1.04736(10)	1.04794(10)	59(14)
7	500.0	1.04937(10)	1.05029(10)	93(14)
8	600.0	1.05112(11)	1.05218(10)	105(15)
9	700.0	1.05196(11)	1.05315(10)	119(15)
10	800.0	1.05280(10)	1.05418(10)	138(14)
11	900.0	1.05334(11)	1.05465(10)	131(15)
12	1000.0	1.05336(11)	1.05510(10)	174(15)
13	1100.0	1.05349(10)	1.05536(10)	186(14)
14	1200.0	1.05325(11)	1.05512(10)	187(15)
15	1300.0	1.05310(11)	1.05488(10)	178(15)

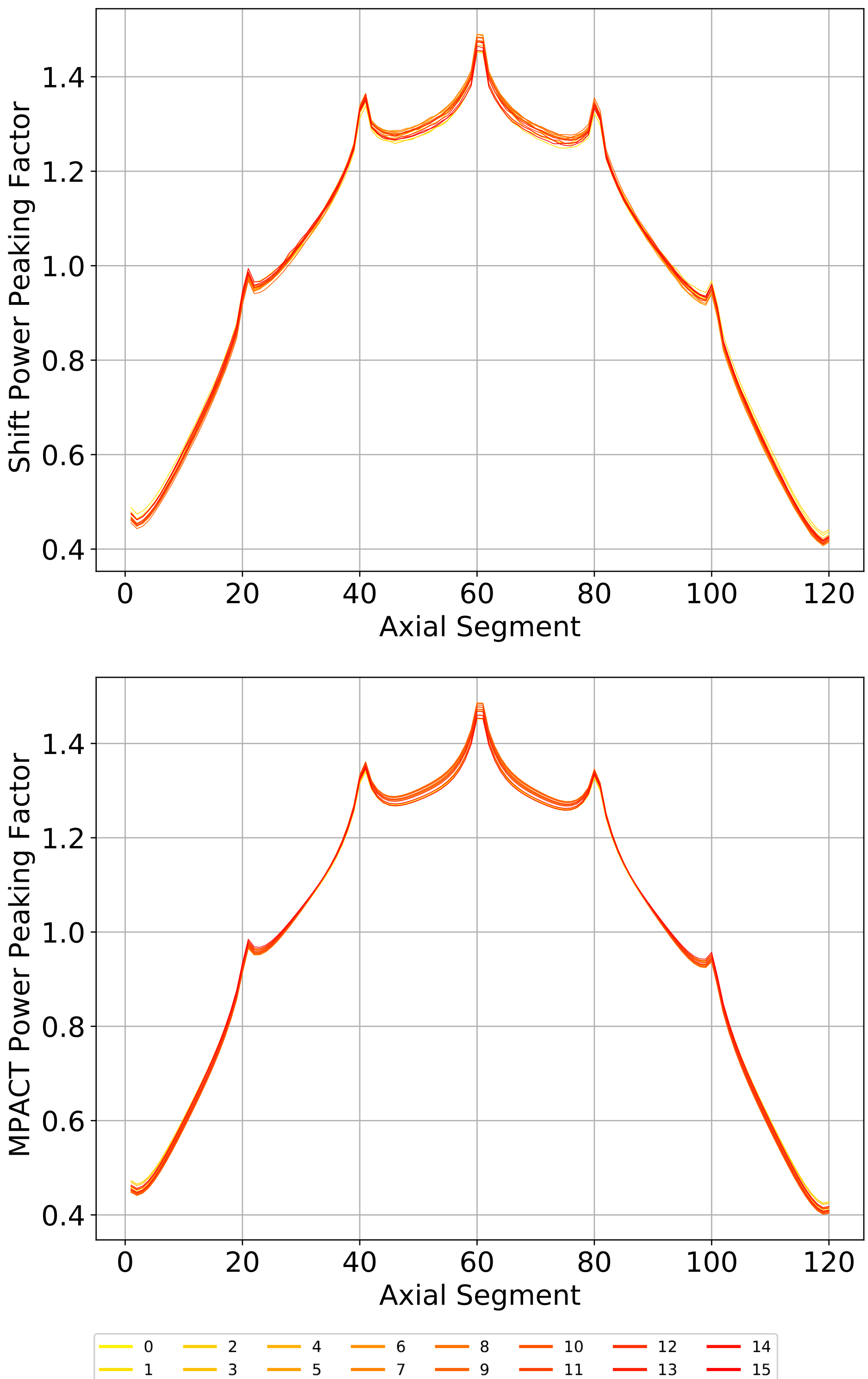


Figure 18. Power peaking factors for Problem 4.2.1 for Shift (top) and MPACT (bottom). Yellow represents time step 0 and red represents time step 15, with a gradient of colors in between.

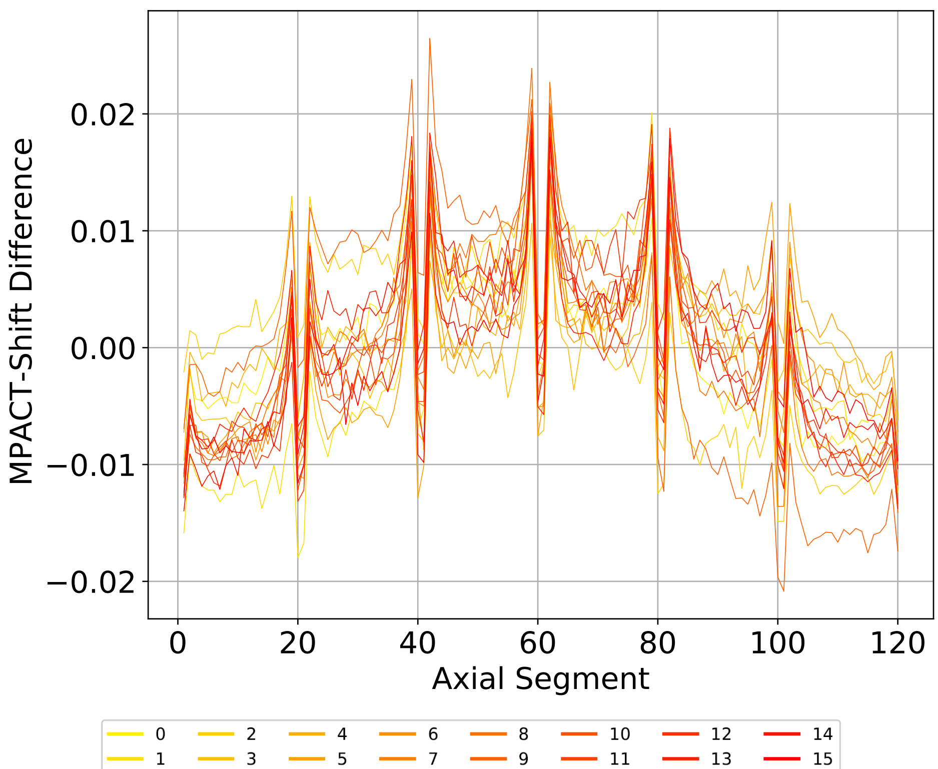


Figure 19. Power peaking factors absolute difference MPACT-Shift. Yellow represents time step 0 and red represents time step 15, with a gradient of colors in between.

Table 5.10. Timing variables for the reference solution of Problem 4.2.1

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
15	1500	1200	50000	2	48	15.93

MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
15	1.0×10^{-04}	1.0×10^{-03}	0.01	1	128	1.39

Table 5.11. Problem 4.2.1 reference solution power peaking factors for axial segments 1-10 in element 1.

Step	Burnup	Shift Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.465	0.454	0.461	0.472	0.488	0.506	0.527	0.549	0.572	0.596
1	25.0	0.488	0.474	0.481	0.493	0.508	0.527	0.549	0.571	0.594	0.616
2	50.0	0.475	0.464	0.469	0.482	0.497	0.516	0.535	0.557	0.580	0.604
3	100.0	0.479	0.464	0.472	0.484	0.499	0.518	0.539	0.561	0.585	0.608
4	200.0	0.469	0.455	0.460	0.474	0.489	0.508	0.529	0.552	0.574	0.598
5	300.0	0.466	0.454	0.460	0.472	0.488	0.508	0.528	0.549	0.572	0.597
6	400.0	0.463	0.450	0.457	0.468	0.485	0.503	0.524	0.546	0.569	0.592
7	500.0	0.460	0.448	0.455	0.467	0.483	0.502	0.523	0.544	0.569	0.593
8	600.0	0.461	0.449	0.455	0.466	0.483	0.501	0.522	0.545	0.567	0.591
9	700.0	0.456	0.443	0.448	0.460	0.478	0.497	0.517	0.538	0.562	0.585
10	800.0	0.462	0.449	0.454	0.469	0.485	0.503	0.523	0.545	0.570	0.593
11	900.0	0.463	0.450	0.458	0.469	0.485	0.505	0.527	0.549	0.570	0.595
12	1000.0	0.466	0.453	0.461	0.472	0.489	0.510	0.531	0.552	0.574	0.600
13	1100.0	0.466	0.453	0.461	0.473	0.489	0.508	0.528	0.551	0.575	0.599
14	1200.0	0.474	0.462	0.468	0.481	0.496	0.515	0.538	0.559	0.582	0.608
15	1300.0	0.476	0.462	0.469	0.482	0.498	0.516	0.539	0.562	0.586	0.611

Step	Burnup	MPACT Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.458	0.452	0.456	0.467	0.483	0.501	0.522	0.544	0.568	0.592
1	25.0	0.472	0.465	0.470	0.481	0.496	0.515	0.536	0.558	0.581	0.605
2	50.0	0.472	0.465	0.470	0.481	0.497	0.515	0.536	0.559	0.582	0.606
3	100.0	0.469	0.462	0.467	0.478	0.493	0.512	0.533	0.555	0.578	0.602
4	200.0	0.461	0.454	0.459	0.470	0.485	0.504	0.525	0.547	0.571	0.595
5	300.0	0.455	0.448	0.453	0.464	0.480	0.499	0.519	0.542	0.565	0.589
6	400.0	0.452	0.445	0.449	0.461	0.476	0.495	0.516	0.538	0.561	0.585
7	500.0	0.449	0.442	0.447	0.458	0.474	0.493	0.514	0.536	0.560	0.584
8	600.0	0.448	0.441	0.446	0.457	0.473	0.492	0.513	0.535	0.559	0.583
9	700.0	0.449	0.442	0.447	0.458	0.474	0.493	0.514	0.536	0.560	0.584
10	800.0	0.450	0.443	0.448	0.459	0.475	0.494	0.515	0.537	0.561	0.585
11	900.0	0.452	0.445	0.450	0.461	0.477	0.496	0.518	0.540	0.564	0.588
12	1000.0	0.453	0.447	0.452	0.463	0.479	0.498	0.519	0.542	0.566	0.590
13	1100.0	0.455	0.448	0.453	0.465	0.481	0.500	0.521	0.544	0.568	0.593
14	1200.0	0.460	0.453	0.458	0.469	0.485	0.505	0.526	0.549	0.573	0.597
15	1300.0	0.463	0.456	0.461	0.473	0.489	0.509	0.530	0.553	0.577	0.602

Table 5.12. Problem 4.2.1 reference solution power peaking factors for axial segments 11-20 in element 1.

Step	Burnup	Shift Power Peaking Factors									
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.619	0.645	0.671	0.696	0.722	0.752	0.785	0.818	0.856	0.923
1	25.0	0.642	0.666	0.691	0.720	0.746	0.773	0.808	0.840	0.879	0.946
2	50.0	0.629	0.654	0.677	0.706	0.733	0.762	0.792	0.825	0.861	0.929
3	100.0	0.633	0.658	0.682	0.708	0.736	0.764	0.796	0.829	0.868	0.934
4	200.0	0.621	0.646	0.672	0.696	0.725	0.756	0.784	0.820	0.858	0.927
5	300.0	0.622	0.647	0.675	0.700	0.727	0.757	0.789	0.823	0.860	0.929
6	400.0	0.617	0.641	0.670	0.694	0.724	0.752	0.785	0.818	0.855	0.925
7	500.0	0.617	0.641	0.667	0.695	0.721	0.752	0.779	0.817	0.855	0.923
8	600.0	0.617	0.641	0.666	0.693	0.719	0.749	0.781	0.815	0.852	0.922
9	700.0	0.611	0.634	0.660	0.687	0.715	0.744	0.775	0.808	0.846	0.917
10	800.0	0.618	0.644	0.668	0.696	0.723	0.752	0.782	0.818	0.856	0.929
11	900.0	0.620	0.646	0.671	0.698	0.727	0.755	0.786	0.820	0.857	0.928
12	1000.0	0.625	0.649	0.677	0.703	0.731	0.760	0.793	0.825	0.866	0.936
13	1100.0	0.623	0.649	0.676	0.701	0.729	0.757	0.789	0.823	0.861	0.933
14	1200.0	0.629	0.656	0.682	0.708	0.736	0.765	0.797	0.831	0.867	0.939
15	1300.0	0.636	0.660	0.686	0.713	0.740	0.772	0.802	0.837	0.873	0.945
Step	Burnup	MPACT Power Peaking Factors									
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.616	0.641	0.667	0.693	0.721	0.751	0.783	0.819	0.861	0.916
1	25.0	0.630	0.655	0.680	0.706	0.734	0.763	0.795	0.831	0.872	0.928
2	50.0	0.631	0.656	0.681	0.708	0.735	0.765	0.797	0.833	0.874	0.930
3	100.0	0.627	0.652	0.677	0.704	0.731	0.761	0.793	0.829	0.870	0.926
4	200.0	0.619	0.644	0.670	0.696	0.724	0.754	0.786	0.822	0.864	0.921
5	300.0	0.614	0.639	0.665	0.692	0.720	0.750	0.782	0.819	0.861	0.918
6	400.0	0.610	0.635	0.661	0.688	0.716	0.746	0.778	0.815	0.857	0.914
7	500.0	0.608	0.634	0.659	0.686	0.714	0.744	0.777	0.814	0.856	0.914
8	600.0	0.608	0.633	0.659	0.686	0.715	0.745	0.778	0.815	0.857	0.915
9	700.0	0.609	0.634	0.660	0.687	0.715	0.745	0.778	0.815	0.857	0.915
10	800.0	0.610	0.635	0.661	0.688	0.716	0.746	0.779	0.816	0.859	0.917
11	900.0	0.613	0.639	0.664	0.691	0.720	0.750	0.782	0.819	0.862	0.920
12	1000.0	0.615	0.641	0.667	0.694	0.722	0.752	0.785	0.821	0.864	0.922
13	1100.0	0.618	0.643	0.669	0.696	0.725	0.755	0.788	0.825	0.868	0.926
14	1200.0	0.623	0.648	0.674	0.701	0.729	0.759	0.792	0.829	0.871	0.930
15	1300.0	0.627	0.652	0.678	0.705	0.733	0.763	0.796	0.833	0.875	0.934

Table 5.13. Problem 4.2.1 reference solution power peaking factors for axial segments 1-10 in element 2.

Step	Burnup	Shift Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.970	0.947	0.952	0.960	0.969	0.982	0.995	1.012	1.027	1.042
1	25.0	0.994	0.965	0.968	0.975	0.986	0.995	1.007	1.023	1.036	1.052
2	50.0	0.977	0.952	0.955	0.962	0.971	0.981	0.995	1.009	1.024	1.040
3	100.0	0.982	0.957	0.960	0.967	0.976	0.987	1.003	1.016	1.031	1.047
4	200.0	0.974	0.948	0.953	0.963	0.970	0.983	0.998	1.011	1.028	1.045
5	300.0	0.981	0.955	0.959	0.967	0.979	0.990	1.004	1.018	1.035	1.051
6	400.0	0.975	0.950	0.955	0.960	0.973	0.985	1.000	1.014	1.031	1.047
7	500.0	0.973	0.948	0.953	0.961	0.971	0.982	0.997	1.013	1.029	1.045
8	600.0	0.973	0.946	0.951	0.960	0.970	0.982	0.995	1.011	1.028	1.044
9	700.0	0.968	0.941	0.943	0.951	0.962	0.974	0.988	1.003	1.019	1.036
10	800.0	0.979	0.953	0.956	0.965	0.975	0.988	1.003	1.018	1.034	1.048
11	900.0	0.980	0.954	0.956	0.963	0.976	0.987	1.001	1.016	1.031	1.048
12	1000.0	0.986	0.958	0.960	0.968	0.976	0.991	1.005	1.018	1.036	1.050
13	1100.0	0.983	0.953	0.958	0.965	0.972	0.985	1.000	1.014	1.032	1.046
14	1200.0	0.987	0.959	0.963	0.970	0.979	0.990	1.006	1.019	1.033	1.050
15	1300.0	0.994	0.966	0.966	0.974	0.983	0.995	1.007	1.027	1.039	1.056
Step	Burnup	MPACT Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.967	0.954	0.955	0.961	0.971	0.983	0.997	1.012	1.028	1.045
1	25.0	0.977	0.963	0.962	0.968	0.976	0.988	1.001	1.015	1.031	1.046
2	50.0	0.979	0.965	0.964	0.969	0.978	0.989	1.002	1.016	1.031	1.047
3	100.0	0.976	0.961	0.961	0.966	0.975	0.987	1.000	1.015	1.030	1.046
4	200.0	0.971	0.957	0.957	0.963	0.972	0.984	0.998	1.013	1.029	1.045
5	300.0	0.969	0.955	0.956	0.961	0.971	0.983	0.997	1.013	1.029	1.045
6	400.0	0.966	0.952	0.952	0.959	0.969	0.981	0.996	1.011	1.028	1.045
7	500.0	0.966	0.952	0.952	0.958	0.968	0.981	0.996	1.012	1.028	1.045
8	600.0	0.967	0.953	0.953	0.959	0.969	0.982	0.996	1.012	1.028	1.045
9	700.0	0.967	0.953	0.953	0.959	0.969	0.982	0.997	1.012	1.029	1.046
10	800.0	0.969	0.954	0.954	0.961	0.971	0.983	0.998	1.013	1.030	1.047
11	900.0	0.972	0.957	0.957	0.963	0.973	0.985	0.999	1.015	1.031	1.048
12	1000.0	0.974	0.959	0.959	0.964	0.974	0.986	1.001	1.016	1.032	1.048
13	1100.0	0.977	0.962	0.961	0.967	0.976	0.988	1.002	1.017	1.033	1.049
14	1200.0	0.980	0.964	0.964	0.969	0.978	0.990	1.004	1.019	1.034	1.050
15	1300.0	0.984	0.968	0.967	0.972	0.981	0.993	1.006	1.021	1.036	1.052

Table 5.14. Problem 4.2.1 reference solution power peaking factors for axial segments 11-20 in element 2.

Step	Burnup	Shift Power Peaking Factors									
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.062	1.076	1.094	1.116	1.136	1.159	1.182	1.212	1.246	1.322
1	25.0	1.067	1.084	1.102	1.119	1.139	1.162	1.187	1.216	1.247	1.322
2	50.0	1.054	1.071	1.088	1.108	1.127	1.152	1.175	1.203	1.240	1.312
3	100.0	1.065	1.083	1.100	1.118	1.137	1.161	1.186	1.217	1.249	1.326
4	200.0	1.061	1.080	1.098	1.117	1.137	1.161	1.186	1.217	1.252	1.327
5	300.0	1.067	1.085	1.104	1.123	1.146	1.168	1.193	1.221	1.260	1.340
6	400.0	1.065	1.083	1.101	1.121	1.144	1.165	1.191	1.222	1.257	1.336
7	500.0	1.063	1.080	1.099	1.118	1.139	1.159	1.189	1.221	1.254	1.334
8	600.0	1.061	1.081	1.098	1.117	1.137	1.160	1.188	1.217	1.256	1.334
9	700.0	1.055	1.073	1.091	1.109	1.132	1.154	1.181	1.210	1.246	1.327
10	800.0	1.064	1.083	1.104	1.121	1.142	1.166	1.189	1.221	1.257	1.336
11	900.0	1.065	1.082	1.100	1.120	1.140	1.164	1.192	1.216	1.253	1.333
12	1000.0	1.069	1.084	1.100	1.121	1.139	1.162	1.188	1.217	1.253	1.334
13	1100.0	1.063	1.078	1.096	1.117	1.137	1.160	1.182	1.211	1.246	1.327
14	1200.0	1.064	1.080	1.099	1.116	1.135	1.158	1.182	1.214	1.246	1.325
15	1300.0	1.070	1.088	1.104	1.122	1.143	1.164	1.188	1.215	1.250	1.330
Step	**Burnup**	**MPACT Power Peaking Factors**									
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.062	1.080	1.098	1.117	1.139	1.162	1.190	1.223	1.263	1.324
1	25.0	1.063	1.079	1.097	1.115	1.136	1.158	1.185	1.217	1.256	1.315
2	50.0	1.063	1.079	1.096	1.115	1.135	1.158	1.184	1.216	1.255	1.314
3	100.0	1.062	1.079	1.097	1.115	1.136	1.159	1.186	1.218	1.258	1.319
4	200.0	1.062	1.080	1.098	1.117	1.138	1.161	1.189	1.222	1.262	1.323
5	300.0	1.062	1.080	1.098	1.118	1.139	1.163	1.190	1.224	1.265	1.327
6	400.0	1.062	1.080	1.099	1.118	1.140	1.164	1.192	1.226	1.268	1.331
7	500.0	1.063	1.081	1.099	1.119	1.141	1.165	1.193	1.227	1.269	1.332
8	600.0	1.063	1.081	1.099	1.119	1.141	1.165	1.193	1.227	1.269	1.332
9	700.0	1.063	1.081	1.100	1.120	1.141	1.165	1.193	1.227	1.269	1.333
10	800.0	1.064	1.082	1.100	1.120	1.141	1.165	1.193	1.227	1.268	1.331
11	900.0	1.065	1.082	1.100	1.120	1.141	1.165	1.192	1.226	1.267	1.331
12	1000.0	1.065	1.083	1.101	1.120	1.141	1.165	1.192	1.225	1.266	1.329
13	1100.0	1.066	1.083	1.101	1.120	1.140	1.164	1.191	1.223	1.264	1.327
14	1200.0	1.067	1.084	1.101	1.120	1.140	1.163	1.190	1.222	1.262	1.324
15	1300.0	1.068	1.084	1.101	1.120	1.140	1.162	1.188	1.220	1.260	1.321

Table 5.15. Problem 4.2.1 reference solution power peaking factors for axial segments 1-10 in element 3.

Step	Burnup	Shift Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	1.351	1.300	1.290	1.280	1.278	1.275	1.277	1.279	1.285	1.291
1	25.0	1.346	1.291	1.277	1.270	1.263	1.264	1.265	1.266	1.268	1.274
2	50.0	1.339	1.287	1.273	1.265	1.264	1.259	1.262	1.266	1.270	1.273
3	100.0	1.353	1.296	1.285	1.277	1.271	1.271	1.273	1.274	1.280	1.286
4	200.0	1.359	1.303	1.290	1.285	1.279	1.279	1.279	1.282	1.287	1.288
5	300.0	1.365	1.309	1.294	1.286	1.285	1.284	1.284	1.289	1.292	1.298
6	400.0	1.365	1.307	1.295	1.288	1.285	1.287	1.287	1.291	1.292	1.298
7	500.0	1.364	1.306	1.295	1.287	1.284	1.282	1.284	1.288	1.294	1.298
8	600.0	1.361	1.304	1.290	1.283	1.282	1.280	1.280	1.285	1.288	1.294
9	700.0	1.355	1.295	1.285	1.277	1.275	1.274	1.275	1.281	1.286	1.291
10	800.0	1.364	1.303	1.292	1.283	1.280	1.278	1.279	1.284	1.285	1.293
11	900.0	1.360	1.300	1.289	1.281	1.278	1.274	1.279	1.282	1.287	1.289
12	1000.0	1.363	1.301	1.289	1.283	1.280	1.276	1.280	1.283	1.289	1.292
13	1100.0	1.351	1.294	1.279	1.274	1.270	1.268	1.273	1.275	1.279	1.284
14	1200.0	1.350	1.293	1.280	1.270	1.268	1.266	1.269	1.273	1.275	1.280
15	1300.0	1.356	1.294	1.282	1.273	1.268	1.266	1.269	1.271	1.274	1.279

Step	Burnup	MPACT Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	1.351	1.314	1.296	1.287	1.282	1.281	1.283	1.286	1.290	1.295
1	25.0	1.341	1.303	1.285	1.275	1.270	1.269	1.270	1.272	1.276	1.281
2	50.0	1.340	1.303	1.284	1.274	1.269	1.267	1.268	1.271	1.275	1.280
3	100.0	1.345	1.306	1.288	1.277	1.272	1.271	1.272	1.275	1.279	1.284
4	200.0	1.350	1.312	1.294	1.284	1.279	1.278	1.279	1.282	1.287	1.292
5	300.0	1.355	1.316	1.298	1.288	1.283	1.282	1.284	1.287	1.291	1.297
6	400.0	1.360	1.320	1.301	1.291	1.287	1.286	1.288	1.291	1.296	1.301
7	500.0	1.360	1.321	1.303	1.293	1.288	1.287	1.289	1.293	1.297	1.303
8	600.0	1.360	1.321	1.303	1.293	1.288	1.287	1.289	1.293	1.297	1.303
9	700.0	1.361	1.321	1.302	1.292	1.287	1.286	1.288	1.292	1.296	1.302
10	800.0	1.359	1.320	1.301	1.291	1.286	1.285	1.287	1.290	1.295	1.300
11	900.0	1.358	1.318	1.298	1.288	1.283	1.282	1.283	1.287	1.291	1.296
12	1000.0	1.355	1.315	1.297	1.286	1.281	1.280	1.281	1.285	1.289	1.294
13	1100.0	1.353	1.313	1.294	1.283	1.278	1.277	1.279	1.282	1.286	1.291
14	1200.0	1.350	1.309	1.290	1.279	1.274	1.273	1.274	1.277	1.281	1.285
15	1300.0	1.346	1.306	1.286	1.275	1.270	1.268	1.269	1.272	1.276	1.280

Table 5.16. Problem 4.2.1 reference solution power peaking factors for axial segments 11-20 in element 3.

Step	Burnup	Shift Power Peaking Factors									
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.295	1.303	1.311	1.321	1.331	1.341	1.360	1.377	1.404	1.474
1	25.0	1.278	1.283	1.293	1.297	1.307	1.321	1.336	1.357	1.381	1.452
2	50.0	1.279	1.285	1.293	1.300	1.308	1.323	1.337	1.357	1.383	1.455
3	100.0	1.291	1.298	1.304	1.311	1.325	1.336	1.350	1.370	1.395	1.467
4	200.0	1.296	1.302	1.310	1.315	1.327	1.340	1.359	1.378	1.400	1.475
5	300.0	1.302	1.309	1.319	1.325	1.333	1.347	1.362	1.383	1.406	1.485
6	400.0	1.304	1.312	1.319	1.328	1.338	1.351	1.368	1.388	1.412	1.490
7	500.0	1.305	1.314	1.317	1.327	1.336	1.350	1.366	1.387	1.414	1.490
8	600.0	1.300	1.306	1.313	1.321	1.331	1.345	1.361	1.380	1.406	1.483
9	700.0	1.296	1.303	1.309	1.320	1.331	1.343	1.359	1.379	1.407	1.484
10	800.0	1.300	1.303	1.313	1.320	1.331	1.344	1.357	1.379	1.405	1.482
11	900.0	1.298	1.301	1.312	1.318	1.330	1.338	1.356	1.374	1.401	1.477
12	1000.0	1.297	1.301	1.310	1.318	1.323	1.340	1.354	1.374	1.398	1.474
13	1100.0	1.290	1.297	1.302	1.311	1.318	1.335	1.352	1.373	1.395	1.473
14	1200.0	1.286	1.290	1.298	1.306	1.313	1.329	1.343	1.365	1.386	1.465
15	1300.0	1.283	1.290	1.295	1.304	1.314	1.324	1.339	1.358	1.381	1.455
Step	Burnup	MPACT Power Peaking Factors									
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.301	1.308	1.315	1.323	1.334	1.347	1.365	1.388	1.420	1.473
1	25.0	1.286	1.292	1.299	1.308	1.318	1.331	1.347	1.370	1.401	1.454
2	50.0	1.285	1.291	1.298	1.306	1.316	1.329	1.346	1.369	1.400	1.452
3	100.0	1.289	1.295	1.302	1.310	1.321	1.334	1.351	1.374	1.406	1.460
4	200.0	1.297	1.304	1.311	1.319	1.330	1.343	1.360	1.384	1.416	1.470
5	300.0	1.303	1.309	1.316	1.325	1.335	1.349	1.366	1.390	1.422	1.477
6	400.0	1.307	1.314	1.321	1.330	1.340	1.354	1.371	1.395	1.428	1.485
7	500.0	1.309	1.315	1.323	1.331	1.342	1.355	1.373	1.397	1.430	1.486
8	600.0	1.309	1.315	1.323	1.331	1.342	1.355	1.373	1.397	1.430	1.486
9	700.0	1.308	1.314	1.321	1.330	1.340	1.354	1.371	1.395	1.429	1.486
10	800.0	1.306	1.312	1.320	1.328	1.338	1.352	1.369	1.393	1.426	1.482
11	900.0	1.302	1.308	1.315	1.324	1.334	1.347	1.364	1.388	1.421	1.478
12	1000.0	1.300	1.306	1.313	1.321	1.331	1.344	1.361	1.384	1.417	1.473
13	1100.0	1.296	1.302	1.309	1.317	1.327	1.340	1.357	1.380	1.413	1.468
14	1200.0	1.291	1.296	1.303	1.311	1.321	1.333	1.350	1.373	1.405	1.460
15	1300.0	1.285	1.291	1.297	1.305	1.315	1.327	1.344	1.366	1.398	1.453

Table 5.17. Problem 4.2.1 reference solution power peaking factors for axial segments 1-10 in element 4.

Step	Burnup	Shift Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	1.474	1.403	1.378	1.355	1.340	1.328	1.315	1.307	1.299	1.290
1	25.0	1.450	1.379	1.355	1.334	1.317	1.303	1.295	1.285	1.279	1.270
2	50.0	1.453	1.385	1.358	1.338	1.323	1.309	1.298	1.289	1.283	1.279
3	100.0	1.466	1.395	1.368	1.347	1.330	1.320	1.306	1.294	1.288	1.280
4	200.0	1.474	1.402	1.379	1.356	1.338	1.324	1.312	1.305	1.298	1.291
5	300.0	1.481	1.410	1.381	1.359	1.344	1.331	1.319	1.307	1.301	1.291
6	400.0	1.489	1.412	1.385	1.363	1.348	1.333	1.324	1.312	1.305	1.297
7	500.0	1.486	1.411	1.384	1.363	1.348	1.334	1.322	1.313	1.303	1.300
8	600.0	1.483	1.405	1.379	1.358	1.341	1.329	1.319	1.312	1.303	1.297
9	700.0	1.483	1.406	1.377	1.361	1.345	1.331	1.322	1.312	1.306	1.297
10	800.0	1.482	1.404	1.380	1.357	1.339	1.327	1.314	1.307	1.299	1.290
11	900.0	1.475	1.401	1.376	1.352	1.336	1.324	1.315	1.307	1.297	1.290
12	1000.0	1.471	1.396	1.369	1.348	1.330	1.322	1.308	1.298	1.290	1.285
13	1100.0	1.473	1.396	1.369	1.350	1.335	1.322	1.311	1.303	1.295	1.290
14	1200.0	1.461	1.386	1.359	1.339	1.323	1.311	1.302	1.294	1.288	1.280
15	1300.0	1.455	1.379	1.354	1.335	1.318	1.305	1.297	1.289	1.282	1.275
Step	Burnup	MPACT Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	1.472	1.418	1.386	1.362	1.344	1.330	1.319	1.310	1.302	1.295
1	25.0	1.453	1.400	1.368	1.345	1.327	1.314	1.303	1.294	1.287	1.280
2	50.0	1.452	1.398	1.367	1.343	1.326	1.312	1.302	1.293	1.285	1.279
3	100.0	1.459	1.404	1.372	1.348	1.330	1.317	1.306	1.297	1.289	1.283
4	200.0	1.469	1.414	1.381	1.358	1.340	1.326	1.315	1.306	1.298	1.291
5	300.0	1.477	1.421	1.388	1.363	1.345	1.331	1.320	1.311	1.303	1.296
6	400.0	1.484	1.427	1.393	1.368	1.350	1.336	1.325	1.315	1.307	1.300
7	500.0	1.485	1.428	1.395	1.370	1.352	1.338	1.326	1.317	1.309	1.302
8	600.0	1.485	1.428	1.394	1.370	1.352	1.338	1.326	1.317	1.309	1.302
9	700.0	1.485	1.427	1.393	1.368	1.350	1.336	1.325	1.316	1.308	1.301
10	800.0	1.481	1.424	1.391	1.366	1.348	1.334	1.323	1.314	1.306	1.299
11	900.0	1.477	1.419	1.386	1.361	1.343	1.330	1.319	1.310	1.302	1.295
12	1000.0	1.472	1.415	1.382	1.358	1.340	1.327	1.316	1.307	1.300	1.293
13	1100.0	1.467	1.411	1.378	1.354	1.337	1.323	1.313	1.304	1.296	1.290
14	1200.0	1.459	1.404	1.371	1.347	1.330	1.317	1.306	1.298	1.291	1.284
15	1300.0	1.452	1.397	1.365	1.341	1.324	1.311	1.301	1.293	1.286	1.279

Table 5.18. Problem 4.2.1 reference solution power peaking factors for axial segments 11-20 in element 4.

Step	Burnup	Shift Power Peaking Factors									
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.283	1.278	1.273	1.270	1.267	1.267	1.271	1.278	1.290	1.339
1	25.0	1.265	1.259	1.254	1.249	1.249	1.250	1.252	1.261	1.271	1.323
2	50.0	1.273	1.269	1.265	1.261	1.258	1.261	1.266	1.274	1.286	1.339
3	100.0	1.275	1.269	1.265	1.262	1.259	1.257	1.263	1.267	1.278	1.333
4	200.0	1.282	1.276	1.272	1.270	1.268	1.267	1.271	1.277	1.291	1.344
5	300.0	1.286	1.280	1.273	1.268	1.266	1.267	1.268	1.275	1.288	1.341
6	400.0	1.294	1.284	1.278	1.275	1.270	1.272	1.274	1.279	1.290	1.347
7	500.0	1.292	1.283	1.278	1.277	1.273	1.272	1.277	1.282	1.293	1.348
8	600.0	1.291	1.287	1.281	1.277	1.273	1.272	1.274	1.281	1.294	1.349
9	700.0	1.294	1.288	1.283	1.278	1.277	1.277	1.279	1.287	1.299	1.355
10	800.0	1.286	1.280	1.275	1.271	1.268	1.271	1.270	1.275	1.289	1.343
11	900.0	1.286	1.280	1.275	1.272	1.266	1.267	1.267	1.277	1.286	1.343
12	1000.0	1.280	1.272	1.266	1.266	1.258	1.259	1.262	1.271	1.283	1.339
13	1100.0	1.285	1.278	1.271	1.269	1.267	1.265	1.268	1.274	1.285	1.344
14	1200.0	1.274	1.272	1.266	1.259	1.259	1.260	1.261	1.270	1.282	1.339
15	1300.0	1.269	1.265	1.258	1.258	1.255	1.254	1.258	1.264	1.277	1.333
Step	Burnup	MPACT Power Peaking Factors									
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.288	1.282	1.277	1.273	1.271	1.271	1.275	1.284	1.301	1.337
1	25.0	1.274	1.269	1.264	1.261	1.259	1.260	1.264	1.274	1.291	1.327
2	50.0	1.273	1.268	1.263	1.260	1.258	1.259	1.263	1.273	1.290	1.327
3	100.0	1.277	1.271	1.267	1.263	1.261	1.262	1.266	1.276	1.294	1.331
4	200.0	1.284	1.279	1.274	1.270	1.268	1.268	1.272	1.282	1.299	1.336
5	300.0	1.289	1.283	1.278	1.274	1.272	1.272	1.276	1.285	1.302	1.340
6	400.0	1.293	1.287	1.282	1.278	1.275	1.275	1.279	1.289	1.306	1.344
7	500.0	1.295	1.289	1.284	1.279	1.277	1.277	1.280	1.290	1.307	1.345
8	600.0	1.295	1.289	1.284	1.279	1.277	1.277	1.280	1.289	1.307	1.345
9	700.0	1.294	1.288	1.283	1.278	1.276	1.276	1.280	1.289	1.307	1.346
10	800.0	1.293	1.287	1.281	1.277	1.275	1.275	1.279	1.288	1.306	1.344
11	900.0	1.289	1.283	1.278	1.274	1.272	1.272	1.276	1.286	1.304	1.343
12	1000.0	1.287	1.281	1.276	1.272	1.270	1.270	1.274	1.284	1.302	1.341
13	1100.0	1.283	1.278	1.273	1.269	1.267	1.268	1.272	1.282	1.300	1.339
14	1200.0	1.278	1.273	1.268	1.265	1.263	1.264	1.268	1.278	1.296	1.336
15	1300.0	1.274	1.268	1.264	1.261	1.259	1.260	1.265	1.275	1.293	1.333

Table 5.19. Problem 4.2.1 reference solution power peaking factors for axial segments 1-10 in element 5.

Step	Burnup	Shift Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	1.313	1.236	1.201	1.173	1.145	1.123	1.102	1.083	1.064	1.046
1	25.0	1.298	1.225	1.192	1.163	1.136	1.114	1.093	1.075	1.058	1.042
2	50.0	1.311	1.237	1.202	1.174	1.150	1.127	1.108	1.087	1.069	1.052
3	100.0	1.306	1.227	1.193	1.163	1.138	1.116	1.096	1.076	1.057	1.041
4	200.0	1.316	1.238	1.200	1.170	1.143	1.120	1.099	1.079	1.060	1.043
5	300.0	1.311	1.233	1.199	1.167	1.140	1.118	1.094	1.075	1.055	1.037
6	400.0	1.316	1.235	1.201	1.170	1.140	1.119	1.097	1.076	1.056	1.039
7	500.0	1.319	1.241	1.202	1.172	1.145	1.120	1.097	1.076	1.058	1.042
8	600.0	1.321	1.239	1.204	1.172	1.146	1.123	1.104	1.084	1.064	1.047
9	700.0	1.329	1.246	1.212	1.181	1.154	1.132	1.108	1.089	1.071	1.054
10	800.0	1.316	1.237	1.200	1.170	1.144	1.122	1.101	1.081	1.062	1.043
11	900.0	1.316	1.236	1.200	1.171	1.144	1.119	1.103	1.079	1.063	1.045
12	1000.0	1.309	1.231	1.196	1.167	1.140	1.118	1.100	1.080	1.060	1.043
13	1100.0	1.317	1.237	1.201	1.171	1.144	1.122	1.102	1.083	1.064	1.046
14	1200.0	1.313	1.232	1.199	1.171	1.143	1.123	1.104	1.081	1.066	1.050
15	1300.0	1.308	1.227	1.194	1.164	1.138	1.118	1.099	1.080	1.061	1.043

Step	Burnup	MPACT Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	1.308	1.248	1.207	1.174	1.146	1.121	1.100	1.080	1.061	1.043
1	25.0	1.300	1.241	1.201	1.169	1.142	1.119	1.098	1.079	1.061	1.044
2	50.0	1.299	1.240	1.201	1.169	1.142	1.119	1.098	1.079	1.061	1.044
3	100.0	1.303	1.243	1.202	1.170	1.143	1.119	1.098	1.079	1.061	1.043
4	200.0	1.307	1.246	1.205	1.172	1.145	1.120	1.099	1.079	1.061	1.043
5	300.0	1.310	1.248	1.207	1.173	1.145	1.121	1.099	1.079	1.060	1.042
6	400.0	1.315	1.251	1.209	1.175	1.146	1.122	1.100	1.079	1.060	1.042
7	500.0	1.315	1.252	1.210	1.176	1.147	1.122	1.100	1.080	1.061	1.042
8	600.0	1.315	1.252	1.209	1.175	1.147	1.122	1.100	1.080	1.061	1.042
9	700.0	1.316	1.252	1.210	1.176	1.147	1.123	1.101	1.080	1.061	1.043
10	800.0	1.315	1.252	1.210	1.176	1.147	1.123	1.101	1.081	1.062	1.043
11	900.0	1.314	1.251	1.209	1.175	1.147	1.123	1.101	1.081	1.062	1.044
12	1000.0	1.312	1.250	1.208	1.175	1.147	1.123	1.102	1.082	1.063	1.045
13	1100.0	1.311	1.248	1.207	1.174	1.146	1.123	1.102	1.082	1.064	1.046
14	1200.0	1.309	1.247	1.206	1.173	1.146	1.123	1.102	1.083	1.065	1.047
15	1300.0	1.306	1.245	1.205	1.172	1.146	1.123	1.102	1.084	1.066	1.049

Table 5.20. Problem 4.2.1 reference solution power peaking factors for axial segments 11-20 in element 5.

Step	Burnup	Shift Power Peaking Factors									
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.031	1.012	0.996	0.981	0.968	0.953	0.944	0.934	0.930	0.951
1	25.0	1.025	1.010	0.996	0.978	0.966	0.954	0.946	0.938	0.933	0.958
2	50.0	1.034	1.020	1.003	0.993	0.976	0.963	0.955	0.948	0.943	0.968
3	100.0	1.023	1.007	0.991	0.976	0.961	0.950	0.940	0.932	0.928	0.952
4	200.0	1.027	1.010	0.992	0.975	0.967	0.952	0.940	0.933	0.926	0.953
5	300.0	1.018	1.003	0.986	0.972	0.953	0.943	0.931	0.921	0.917	0.939
6	400.0	1.023	1.004	0.987	0.971	0.954	0.942	0.930	0.922	0.916	0.942
7	500.0	1.024	1.008	0.988	0.973	0.957	0.943	0.935	0.925	0.920	0.943
8	600.0	1.028	1.011	0.995	0.979	0.963	0.950	0.942	0.931	0.926	0.952
9	700.0	1.034	1.018	1.003	0.987	0.972	0.957	0.949	0.940	0.936	0.958
10	800.0	1.026	1.011	0.993	0.978	0.964	0.950	0.938	0.927	0.925	0.948
11	900.0	1.028	1.010	0.993	0.979	0.964	0.952	0.938	0.930	0.928	0.952
12	1000.0	1.026	1.009	0.992	0.978	0.962	0.949	0.940	0.932	0.928	0.953
13	1100.0	1.030	1.015	1.001	0.983	0.970	0.957	0.946	0.937	0.932	0.959
14	1200.0	1.033	1.016	1.001	0.985	0.972	0.960	0.948	0.938	0.936	0.961
15	1300.0	1.029	1.012	0.998	0.981	0.967	0.956	0.946	0.939	0.933	0.961
Step	Burnup	MPACT Power Peaking Factors									
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.025	1.008	0.991	0.975	0.961	0.948	0.937	0.930	0.929	0.940
1	25.0	1.027	1.011	0.995	0.980	0.966	0.954	0.945	0.939	0.938	0.951
2	50.0	1.028	1.012	0.996	0.981	0.968	0.956	0.946	0.940	0.940	0.953
3	100.0	1.027	1.010	0.994	0.979	0.965	0.953	0.943	0.937	0.936	0.949
4	200.0	1.025	1.008	0.992	0.976	0.962	0.949	0.939	0.932	0.931	0.944
5	300.0	1.025	1.008	0.991	0.975	0.960	0.948	0.937	0.930	0.929	0.942
6	400.0	1.024	1.006	0.989	0.973	0.958	0.945	0.934	0.927	0.925	0.938
7	500.0	1.024	1.006	0.989	0.973	0.958	0.944	0.933	0.926	0.925	0.937
8	600.0	1.024	1.007	0.990	0.974	0.959	0.945	0.934	0.927	0.926	0.938
9	700.0	1.025	1.007	0.990	0.974	0.959	0.945	0.934	0.927	0.926	0.939
10	800.0	1.026	1.008	0.991	0.975	0.960	0.946	0.936	0.928	0.927	0.940
11	900.0	1.027	1.009	0.993	0.977	0.962	0.949	0.938	0.931	0.930	0.943
12	1000.0	1.028	1.011	0.994	0.978	0.963	0.950	0.940	0.933	0.932	0.945
13	1100.0	1.029	1.012	0.996	0.980	0.965	0.953	0.942	0.936	0.935	0.949
14	1200.0	1.030	1.014	0.998	0.982	0.968	0.955	0.945	0.939	0.938	0.952
15	1300.0	1.032	1.016	1.000	0.984	0.970	0.958	0.948	0.942	0.942	0.956

Table 5.21. Problem 4.2.1 reference solution power peaking factors for axial segments 1-10 in element 6.

Step	Burnup	Shift Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.900	0.835	0.796	0.764	0.730	0.702	0.674	0.647	0.620	0.595
1	25.0	0.909	0.841	0.804	0.770	0.739	0.712	0.684	0.657	0.631	0.606
2	50.0	0.917	0.852	0.814	0.779	0.748	0.719	0.692	0.665	0.639	0.614
3	100.0	0.900	0.835	0.798	0.764	0.732	0.703	0.675	0.649	0.623	0.599
4	200.0	0.898	0.831	0.793	0.762	0.729	0.698	0.670	0.644	0.618	0.593
5	300.0	0.889	0.821	0.784	0.751	0.718	0.689	0.663	0.635	0.607	0.583
6	400.0	0.890	0.820	0.783	0.749	0.718	0.688	0.663	0.634	0.608	0.584
7	500.0	0.891	0.826	0.786	0.752	0.719	0.690	0.662	0.637	0.610	0.585
8	600.0	0.899	0.829	0.792	0.758	0.726	0.696	0.667	0.640	0.615	0.589
9	700.0	0.906	0.837	0.799	0.764	0.733	0.702	0.674	0.646	0.620	0.595
10	800.0	0.898	0.829	0.791	0.755	0.724	0.695	0.667	0.641	0.615	0.589
11	900.0	0.901	0.833	0.794	0.759	0.727	0.698	0.671	0.642	0.618	0.592
12	1000.0	0.902	0.833	0.795	0.760	0.729	0.699	0.672	0.645	0.619	0.594
13	1100.0	0.908	0.837	0.797	0.764	0.734	0.703	0.677	0.650	0.622	0.598
14	1200.0	0.910	0.840	0.803	0.768	0.735	0.706	0.679	0.650	0.624	0.598
15	1300.0	0.910	0.840	0.803	0.766	0.736	0.709	0.680	0.653	0.627	0.600
Step	Burnup	MPACT Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.888	0.833	0.792	0.756	0.723	0.693	0.665	0.638	0.612	0.587
1	25.0	0.900	0.845	0.804	0.768	0.736	0.706	0.679	0.652	0.626	0.601
2	50.0	0.902	0.847	0.806	0.770	0.738	0.708	0.680	0.653	0.627	0.602
3	100.0	0.898	0.843	0.801	0.765	0.733	0.704	0.676	0.649	0.623	0.598
4	200.0	0.892	0.836	0.795	0.759	0.726	0.696	0.668	0.641	0.616	0.590
5	300.0	0.889	0.833	0.791	0.755	0.722	0.692	0.663	0.636	0.610	0.585
6	400.0	0.885	0.829	0.786	0.750	0.717	0.687	0.659	0.632	0.606	0.581
7	500.0	0.884	0.827	0.785	0.748	0.716	0.686	0.657	0.630	0.604	0.579
8	600.0	0.885	0.828	0.786	0.749	0.716	0.686	0.657	0.630	0.604	0.578
9	700.0	0.885	0.828	0.786	0.749	0.716	0.686	0.658	0.631	0.604	0.579
10	800.0	0.887	0.830	0.787	0.751	0.718	0.687	0.659	0.632	0.606	0.580
11	900.0	0.890	0.833	0.790	0.754	0.721	0.690	0.662	0.635	0.609	0.583
12	1000.0	0.893	0.835	0.793	0.756	0.723	0.693	0.664	0.637	0.611	0.585
13	1100.0	0.896	0.839	0.796	0.759	0.726	0.696	0.667	0.640	0.613	0.588
14	1200.0	0.900	0.843	0.800	0.763	0.730	0.700	0.672	0.645	0.618	0.592
15	1300.0	0.905	0.847	0.805	0.768	0.735	0.705	0.676	0.649	0.623	0.597

Table 5.22. Problem 4.2.1 reference solution power peaking factors for axial segments 11-20 in element 6.

Step	Burnup	Shift Power Peaking Factors									
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.570	0.545	0.522	0.501	0.479	0.459	0.441	0.427	0.418	0.426
1	25.0	0.581	0.559	0.535	0.511	0.489	0.469	0.451	0.439	0.429	0.437
2	50.0	0.589	0.564	0.540	0.516	0.494	0.476	0.458	0.443	0.434	0.441
3	100.0	0.574	0.550	0.526	0.505	0.482	0.463	0.445	0.432	0.422	0.430
4	200.0	0.569	0.544	0.521	0.498	0.476	0.457	0.440	0.426	0.418	0.425
5	300.0	0.559	0.535	0.512	0.490	0.469	0.450	0.433	0.417	0.409	0.417
6	400.0	0.557	0.535	0.512	0.488	0.468	0.449	0.430	0.417	0.407	0.414
7	500.0	0.560	0.536	0.513	0.490	0.468	0.449	0.430	0.418	0.407	0.415
8	600.0	0.564	0.539	0.515	0.492	0.471	0.449	0.433	0.418	0.410	0.418
9	700.0	0.569	0.545	0.521	0.498	0.478	0.456	0.439	0.425	0.414	0.422
10	800.0	0.564	0.540	0.515	0.493	0.472	0.452	0.433	0.419	0.411	0.418
11	900.0	0.566	0.543	0.519	0.496	0.473	0.453	0.436	0.421	0.411	0.419
12	1000.0	0.569	0.544	0.520	0.498	0.475	0.454	0.437	0.423	0.412	0.422
13	1100.0	0.573	0.547	0.524	0.500	0.479	0.458	0.440	0.425	0.416	0.424
14	1200.0	0.575	0.548	0.524	0.501	0.479	0.458	0.442	0.427	0.418	0.425
15	1300.0	0.575	0.552	0.526	0.503	0.482	0.461	0.445	0.429	0.419	0.428
Step	Burnup	MPACT Power Peaking Factors									
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.562	0.538	0.514	0.491	0.469	0.450	0.433	0.419	0.411	0.414
1	25.0	0.576	0.552	0.528	0.505	0.483	0.463	0.446	0.432	0.425	0.427
2	50.0	0.577	0.552	0.528	0.505	0.483	0.463	0.446	0.433	0.425	0.428
3	100.0	0.573	0.549	0.525	0.502	0.480	0.460	0.443	0.430	0.422	0.425
4	200.0	0.565	0.541	0.517	0.494	0.472	0.452	0.435	0.422	0.414	0.417
5	300.0	0.560	0.535	0.511	0.488	0.467	0.447	0.430	0.416	0.409	0.411
6	400.0	0.556	0.531	0.507	0.484	0.463	0.443	0.426	0.413	0.405	0.407
7	500.0	0.554	0.529	0.505	0.482	0.461	0.441	0.424	0.410	0.403	0.405
8	600.0	0.553	0.528	0.504	0.481	0.459	0.440	0.422	0.409	0.401	0.404
9	700.0	0.554	0.529	0.505	0.482	0.460	0.440	0.423	0.410	0.402	0.404
10	800.0	0.555	0.530	0.506	0.483	0.461	0.441	0.424	0.411	0.403	0.405
11	900.0	0.558	0.533	0.509	0.486	0.464	0.444	0.426	0.413	0.405	0.407
12	1000.0	0.560	0.535	0.511	0.487	0.465	0.445	0.428	0.414	0.406	0.408
13	1100.0	0.562	0.537	0.513	0.489	0.467	0.447	0.429	0.416	0.408	0.410
14	1200.0	0.567	0.542	0.518	0.494	0.472	0.451	0.434	0.420	0.412	0.414
15	1300.0	0.571	0.546	0.522	0.498	0.476	0.455	0.437	0.424	0.415	0.418

6. PROBLEM 5: CHARGE-PAN 3D

Problem 5 is a single 3D charge-pan with upper and lower axial reflector regions. The top and bottom problem edges have vacuum boundaries, and the north, south, east, and west boundaries are fully reflected. Problem 5 is more complex than previous problems because it adds multiple fuel channels and control rods in 3D.

6.1 BEGINNING-OF-CYCLE

6.1.1 Problem 5.1.1

6.1.1.1 Description

Figure 20 shows the axial fuel channel geometry for Problem 5.1.1. Six fuel rods are stacked on one another within each fuel channel. While problem 4 describes the single 3D fuel channel geometry, this problem considers the entire charge-pan in 3D. The transverse geometry is illustrated by Figure 3. Zone C coolant channel radius is used for this problem. Geometric dimensions are listed in Table 1.2. Recall that owing to the ⅛ symmetry, fuel channels A, B, C, and D will have the same power. Also because of symmetry, fuel channels E, F, G, H, J, K, L, and M will have the same power, and fuel channels P, Q, R, and S will have the same power. Material densities are listed in Table 1.4. Temperatures are listed in Table 2.4.

6.1.1.2 Reference Solution

The neutron multiplication factor results are shown in Table 6.1. The timing variables for Shift and MPACT are shown in Table 6.2. Power peaking factors for the three types of charge pan pins are displayed for BOC and EOC in Figure 21 and fully tabulated in Tables 6.3-6.8. The neutron multiplication factor agrees to under 100 pcm and peaking factors agree to about 1.5%.

Table 6.1. Neutron multiplication factor for the reference solution of Problem 5.1.1.

Step	Burnup	Shift		MPACT		Difference
	$\left[\frac{MWd}{MtU}\right]$	k_{eff}	(1σ)	k_{eff}	(1σ)	[pcm]
0	0.0	1.05470(7)		1.05488(10)		18(12)

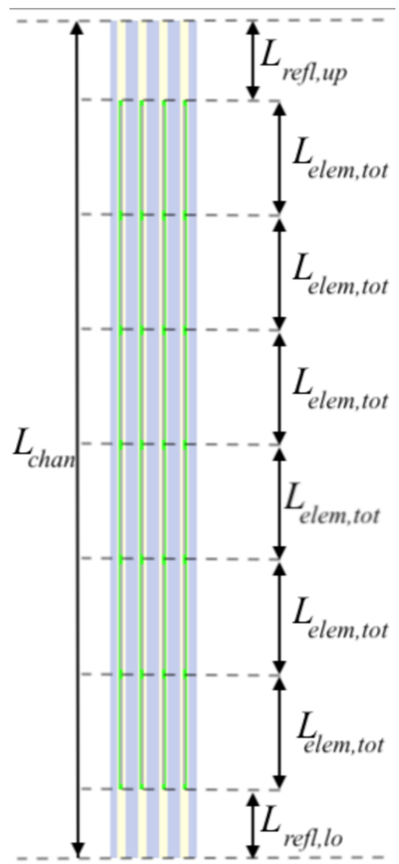


Figure 20. 3D charge-pan with six fuel element stacks.

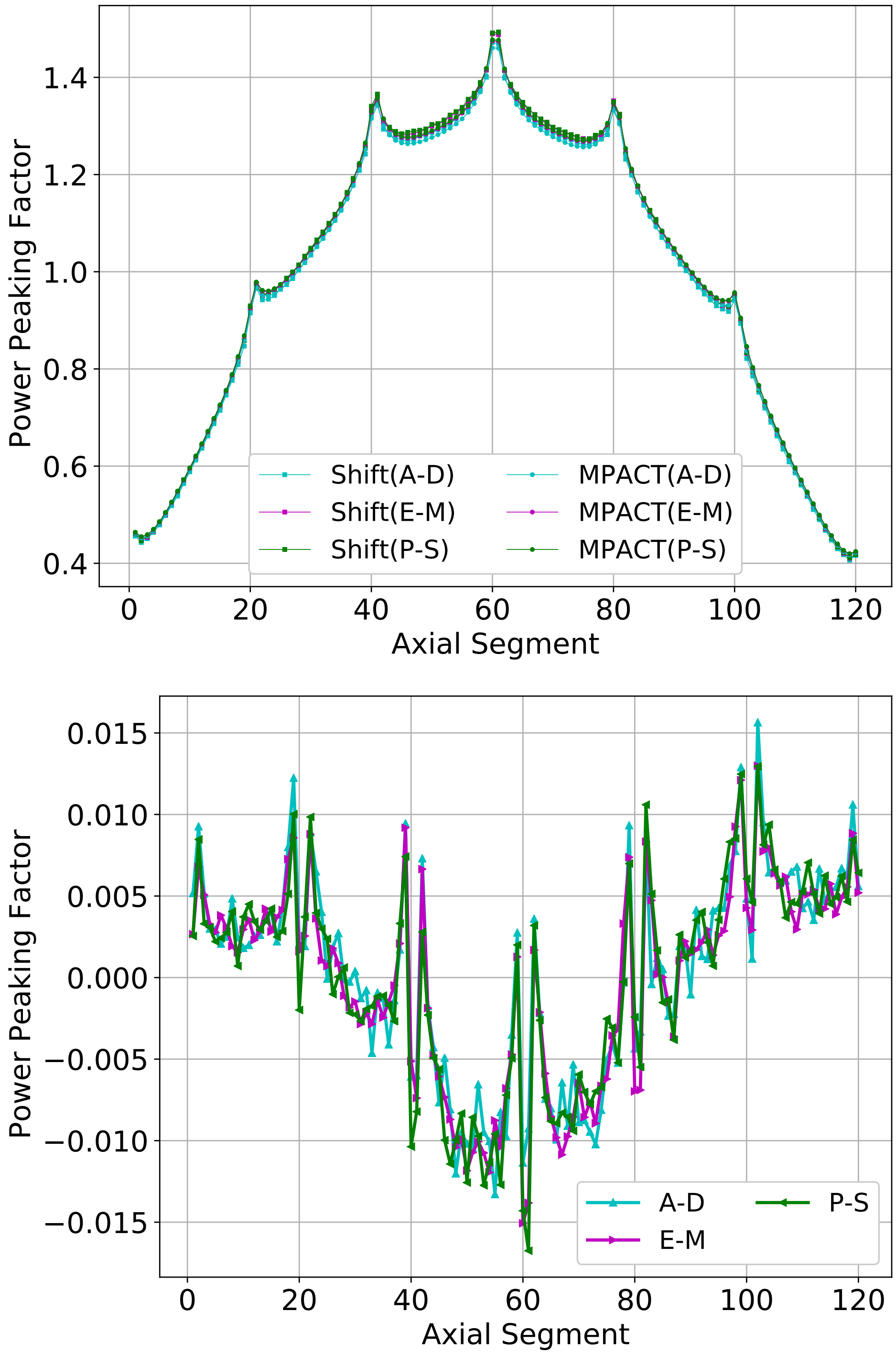


Figure 21. Power peaking factors for Problem 5.1.1 for Shift and MPACT (top) and their absolute difference (bottom). The three series correspond to pins ABCD (central), EFGHJKLM (edge), and PQRS (corner).

Table 6.2. Timing variables for the reference solution of Problem 5.1.1

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1500	1200	100000	4	48	0.54

MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1.0×10^{-04}	1.0×10^{-03}	0.01	5	128	1.73

Table 6.3. Problem 5.1.1 reference solution power peaking factors for axial segments in element 1.

Shift	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	0.456	0.443	0.451	0.464	0.479	0.498	0.519	0.538	0.564	0.588
E, F, G, H, J, K, L, M	0.461	0.448	0.453	0.466	0.482	0.500	0.522	0.546	0.570	0.593
P, Q, R, S	0.461	0.446	0.456	0.467	0.484	0.502	0.523	0.545	0.572	0.593
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	0.613	0.637	0.662	0.687	0.715	0.746	0.776	0.809	0.847	0.915
E, F, G, H, J, K, L, M	0.617	0.643	0.668	0.693	0.722	0.751	0.783	0.817	0.859	0.925
P, Q, R, S	0.617	0.643	0.669	0.695	0.722	0.754	0.786	0.820	0.859	0.930
MPACT	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	0.461	0.452	0.456	0.467	0.482	0.500	0.521	0.543	0.566	0.590
E, F, G, H, J, K, L, M	0.463	0.454	0.459	0.470	0.485	0.504	0.525	0.548	0.571	0.595
P, Q, R, S	0.464	0.455	0.459	0.470	0.486	0.505	0.526	0.549	0.572	0.596
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	0.615	0.638	0.663	0.690	0.717	0.747	0.779	0.816	0.858	0.917
E, F, G, H, J, K, L, M	0.619	0.644	0.669	0.696	0.724	0.754	0.786	0.823	0.866	0.925
P, Q, R, S	0.620	0.645	0.670	0.697	0.725	0.755	0.787	0.824	0.868	0.927

Table 6.4. Problem 5.1.1 reference solution power peaking factors for axial segments in element 2.

Shift	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	0.966	0.942	0.944	0.951	0.964	0.974	0.986	1.003	1.019	1.034
E, F, G, H, J, K, L, M	0.975	0.951	0.955	0.963	0.972	0.982	0.997	1.014	1.030	1.046
P, Q, R, S	0.975	0.952	0.956	0.962	0.972	0.987	0.999	1.014	1.032	1.048
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	1.052	1.069	1.091	1.106	1.127	1.154	1.178	1.208	1.242	1.321
E, F, G, H, J, K, L, M	1.064	1.080	1.099	1.117	1.139	1.161	1.188	1.219	1.254	1.333
P, Q, R, S	1.066	1.082	1.100	1.118	1.139	1.163	1.192	1.220	1.258	1.341
MPACT	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	0.968	0.951	0.950	0.955	0.964	0.975	0.989	1.003	1.019	1.035
E, F, G, H, J, K, L, M	0.977	0.960	0.959	0.964	0.973	0.984	0.998	1.013	1.028	1.044
P, Q, R, S	0.979	0.962	0.960	0.965	0.974	0.986	0.999	1.014	1.030	1.046
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	1.051	1.068	1.086	1.105	1.126	1.150	1.177	1.210	1.252	1.315
E, F, G, H, J, K, L, M	1.061	1.078	1.096	1.115	1.136	1.160	1.187	1.221	1.263	1.328
P, Q, R, S	1.063	1.080	1.098	1.117	1.138	1.162	1.189	1.223	1.265	1.330

Table 6.5. Problem 5.1.1 reference solution power peaking factors for axial segments in element 3.

Shift	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	1.348	1.293	1.283	1.275	1.273	1.268	1.273	1.279	1.281	1.287
E, F, G, H, J, K, L, M	1.363	1.306	1.295	1.286	1.282	1.282	1.285	1.289	1.293	1.300
P, Q, R, S	1.366	1.312	1.297	1.289	1.284	1.287	1.290	1.291	1.294	1.303
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	1.293	1.295	1.305	1.314	1.328	1.336	1.356	1.373	1.400	1.472
E, F, G, H, J, K, L, M	1.305	1.310	1.318	1.328	1.335	1.350	1.365	1.387	1.415	1.490
P, Q, R, S	1.305	1.312	1.322	1.330	1.338	1.355	1.367	1.390	1.417	1.491
MPACT	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	1.342	1.301	1.281	1.270	1.265	1.263	1.265	1.267	1.271	1.276
E, F, G, H, J, K, L, M	1.355	1.313	1.293	1.282	1.276	1.275	1.276	1.279	1.283	1.288
P, Q, R, S	1.357	1.315	1.295	1.284	1.278	1.277	1.278	1.281	1.285	1.291
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	1.282	1.288	1.296	1.304	1.315	1.328	1.346	1.370	1.403	1.461
E, F, G, H, J, K, L, M	1.294	1.300	1.307	1.316	1.327	1.340	1.358	1.382	1.416	1.475
P, Q, R, S	1.296	1.303	1.310	1.318	1.329	1.342	1.360	1.385	1.419	1.477

Table 6.6. Problem 5.1.1 reference solution power peaking factors for axial segments in element 4.

Shift	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	1.469	1.399	1.371	1.352	1.334	1.322	1.307	1.301	1.290	1.286
E, F, G, H, J, K, L, M	1.488	1.413	1.383	1.362	1.346	1.334	1.324	1.314	1.305	1.296
P, Q, R, S	1.493	1.414	1.386	1.366	1.349	1.335	1.323	1.315	1.308	1.298
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	1.280	1.275	1.272	1.266	1.262	1.262	1.268	1.273	1.282	1.336
E, F, G, H, J, K, L, M	1.292	1.285	1.282	1.276	1.274	1.272	1.277	1.281	1.296	1.352
P, Q, R, S	1.292	1.288	1.282	1.278	1.272	1.274	1.281	1.287	1.299	1.350
MPACT	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	1.460	1.402	1.369	1.344	1.326	1.312	1.301	1.292	1.284	1.277
E, F, G, H, J, K, L, M	1.474	1.415	1.381	1.356	1.338	1.324	1.313	1.304	1.296	1.289
P, Q, R, S	1.477	1.418	1.383	1.358	1.340	1.326	1.315	1.306	1.298	1.292
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	1.271	1.266	1.261	1.258	1.256	1.258	1.262	1.273	1.291	1.332
E, F, G, H, J, K, L, M	1.283	1.278	1.273	1.270	1.268	1.269	1.274	1.284	1.303	1.345
P, Q, R, S	1.285	1.280	1.275	1.272	1.270	1.271	1.276	1.286	1.306	1.347

Table 6.7. Problem 5.1.1 reference solution power peaking factors for axial segments in element 5.

Shift	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	1.307	1.232	1.199	1.164	1.137	1.116	1.094	1.071	1.052	1.038
E, F, G, H, J, K, L, M	1.323	1.243	1.205	1.175	1.147	1.125	1.106	1.081	1.062	1.045
P, Q, R, S	1.324	1.243	1.206	1.176	1.151	1.127	1.108	1.082	1.065	1.047
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	1.016	1.002	0.986	0.968	0.954	0.942	0.930	0.923	0.918	0.942
E, F, G, H, J, K, L, M	1.028	1.011	0.994	0.980	0.965	0.952	0.940	0.930	0.928	0.951
P, Q, R, S	1.028	1.010	0.996	0.982	0.965	0.950	0.938	0.933	0.929	0.951
MPACT	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	1.304	1.240	1.198	1.165	1.137	1.113	1.092	1.073	1.054	1.037
E, F, G, H, J, K, L, M	1.316	1.252	1.209	1.175	1.147	1.123	1.102	1.082	1.064	1.046
P, Q, R, S	1.319	1.254	1.211	1.177	1.149	1.125	1.104	1.084	1.066	1.048
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	1.020	1.003	0.987	0.972	0.958	0.946	0.937	0.931	0.931	0.946
E, F, G, H, J, K, L, M	1.029	1.013	0.997	0.981	0.967	0.955	0.945	0.940	0.940	0.956
P, Q, R, S	1.031	1.014	0.998	0.983	0.969	0.956	0.947	0.941	0.941	0.957

Table 6.8. Problem 5.1.1 reference solution power peaking factors for axial segments in element 6.

Shift	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	0.894	0.821	0.785	0.752	0.719	0.690	0.662	0.635	0.609	0.586
E, F, G, H, J, K, L, M	0.901	0.832	0.794	0.757	0.726	0.697	0.668	0.643	0.618	0.591
P, Q, R, S	0.900	0.833	0.795	0.757	0.727	0.697	0.671	0.644	0.618	0.591
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	0.561	0.538	0.511	0.490	0.468	0.448	0.430	0.418	0.406	0.416
E, F, G, H, J, K, L, M	0.566	0.541	0.518	0.494	0.471	0.453	0.434	0.421	0.410	0.419
P, Q, R, S	0.565	0.542	0.519	0.493	0.473	0.452	0.434	0.422	0.411	0.418
MPACT	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	0.895	0.837	0.795	0.758	0.726	0.696	0.668	0.641	0.616	0.590
E, F, G, H, J, K, L, M	0.903	0.845	0.802	0.765	0.732	0.702	0.674	0.647	0.621	0.596
P, Q, R, S	0.905	0.846	0.803	0.766	0.733	0.703	0.675	0.648	0.622	0.597
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	0.566	0.541	0.517	0.495	0.473	0.453	0.437	0.424	0.417	0.422
E, F, G, H, J, K, L, M	0.571	0.546	0.522	0.499	0.477	0.457	0.439	0.426	0.419	0.424
P, Q, R, S	0.572	0.547	0.523	0.499	0.477	0.457	0.440	0.427	0.420	0.424

6.1.2 Problem 5.1.2

6.1.2.1 Description

Problem 5.1.2 uses the same geometry, temperatures and materials as Problem 5.1.1, except Problem 5.1.2 has the control rod inserted half way into the the fuel from the top. The bottom of the control rod coincides with the boundary between elements 3 and 4, at the boundary between both end caps. The boundary conditions are vacuum at the axial bottom and top of the reflectors and reflective at the four sides of the charge-pan. As with Problem 4, each fuel element is divided into 20 segments, each representing 5% of the active fuel length.

6.1.2.2 Reference Solution

The neutron multiplication factor results are shown in Table 6.9. The timing variables for Shift and MPACT are shown in Table 6.10. Power peaking factors for the three types of charge pan pins are displayed for BOC and EOC in Figure 22 and fully tabulated in Tables 6.11-6.16. The neutron multiplication factor agrees to under 50 pcm.

The power peaking factors in Figure 22 show noticeable differences between the MPACT and Shift peaking factors. The overall shape agrees well. The MPACT peaking factors reveal a larger flux depression with the control rod inserted compared to it fully withdrawn in Problem 5.1.1. This issue is still under investigation. Geometry and material composition issues were confirmed to be non-issues. It is suggested that the axial solver in MPACT has trouble with the axial heterogeneity with the added control rod.

Table 6.9. Neutron multiplication factor for the reference solution of Problem 5.1.2

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift k_{eff} (1σ)	MPACT k_{eff} (1σ)	Difference [pcm]
0	0.0	1.02824(7)	1.02867(10)	44(12)

Table 6.10. Timing variables for the reference solution of Problem 5.1.2

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1500	1200	100000	2	48	0.93
MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1.0×10^{-04}	1.0×10^{-03}	0.01	2	128	0.74

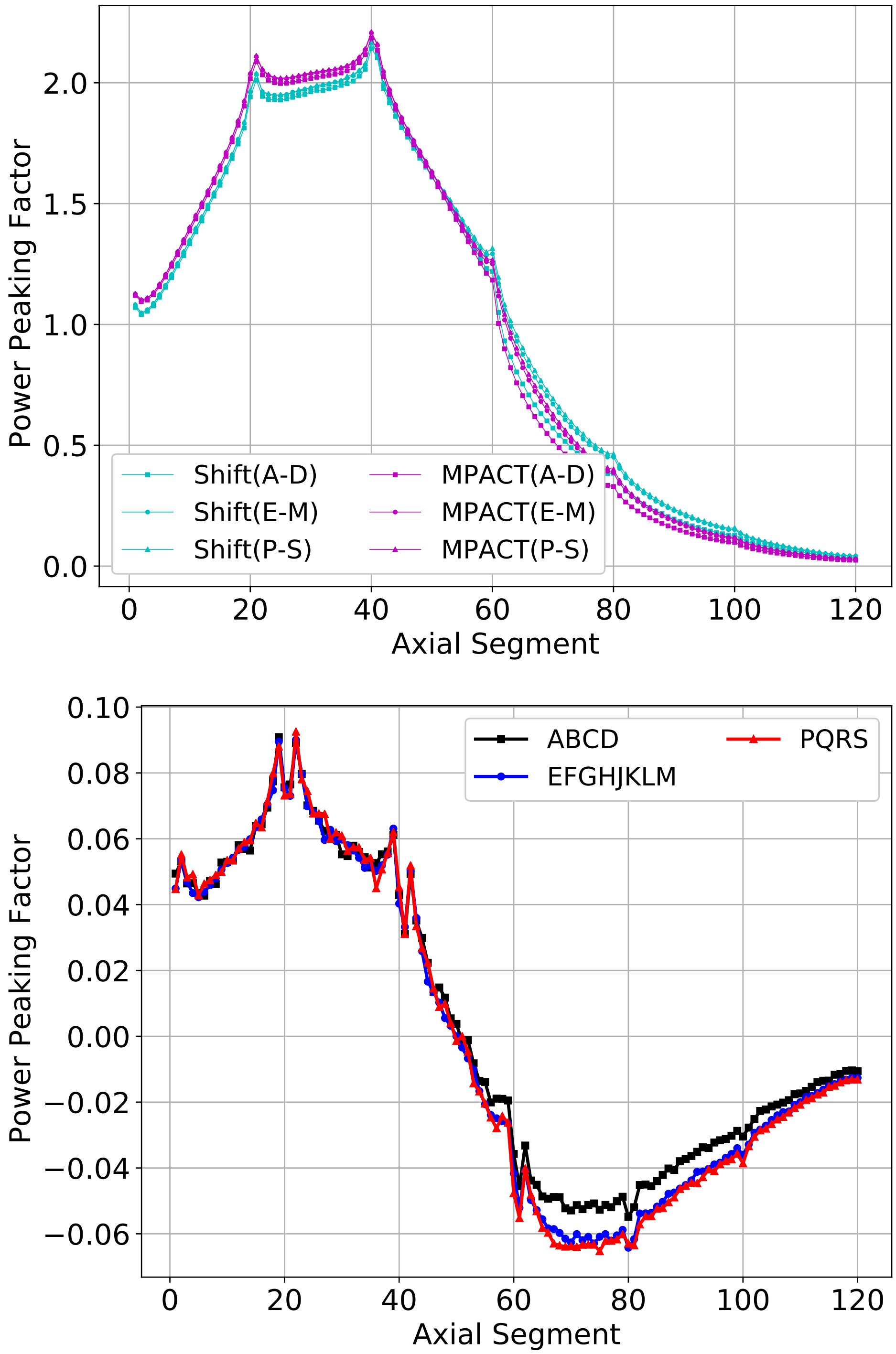


Figure 22. Power peaking factors for Problem 5.1.2 for Shift and MPACT (top) and their absolute difference (bottom). The three series correspond to pins ABCD (central), EFGHJKLM (edge), and PQRS (corner).

Table 6.11. Problem 5.1.2 reference solution power peaking factors for axial segments in element 1.

Shift	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	1.070	1.041	1.055	1.078	1.113	1.151	1.194	1.241	1.290	1.336
E, F, G, H, J, K, L, M	1.081	1.048	1.061	1.086	1.121	1.160	1.206	1.253	1.301	1.350
P, Q, R, S	1.082	1.048	1.061	1.090	1.123	1.161	1.209	1.255	1.302	1.351
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	1.382	1.433	1.480	1.527	1.577	1.635	1.689	1.751	1.821	1.949
E, F, G, H, J, K, L, M	1.399	1.449	1.497	1.546	1.598	1.651	1.706	1.769	1.840	1.971
P, Q, R, S	1.397	1.452	1.500	1.546	1.605	1.654	1.710	1.768	1.842	1.973
MPACT	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	1.117	1.092	1.099	1.122	1.155	1.195	1.240	1.287	1.336	1.385
E, F, G, H, J, K, L, M	1.123	1.099	1.106	1.129	1.163	1.205	1.250	1.299	1.348	1.399
P, Q, R, S	1.124	1.100	1.107	1.131	1.165	1.207	1.253	1.301	1.351	1.401
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	1.435	1.485	1.535	1.585	1.638	1.693	1.754	1.821	1.901	2.013
E, F, G, H, J, K, L, M	1.449	1.499	1.549	1.600	1.653	1.709	1.770	1.838	1.919	2.033
P, Q, R, S	1.451	1.502	1.552	1.603	1.656	1.712	1.773	1.842	1.923	2.037

Table 6.12. Problem 5.1.2 reference solution power peaking factors for axial segments in element 2.

Shift	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	2.018	1.951	1.936	1.936	1.934	1.937	1.938	1.945	1.955	1.961
E, F, G, H, J, K, L, M	2.038	1.968	1.957	1.954	1.955	1.956	1.961	1.969	1.977	1.980
P, Q, R, S	2.046	1.971	1.957	1.956	1.962	1.957	1.965	1.972	1.981	1.986
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	1.966	1.974	1.978	1.983	1.991	1.995	2.013	2.027	2.056	2.140
E, F, G, H, J, K, L, M	1.989	1.994	1.998	2.003	2.011	2.018	2.033	2.049	2.074	2.167
P, Q, R, S	1.992	1.998	2.003	2.006	2.014	2.021	2.037	2.051	2.081	2.169
MPACT	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	2.084	2.030	2.008	1.998	1.995	1.996	2.000	2.005	2.011	2.016
E, F, G, H, J, K, L, M	2.105	2.049	2.027	2.016	2.013	2.015	2.019	2.025	2.030	2.036
P, Q, R, S	2.109	2.053	2.031	2.020	2.017	2.019	2.023	2.028	2.034	2.039
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	2.021	2.025	2.029	2.033	2.038	2.047	2.060	2.081	2.114	2.181
E, F, G, H, J, K, L, M	2.040	2.045	2.048	2.052	2.058	2.066	2.079	2.101	2.134	2.203
P, Q, R, S	2.044	2.048	2.052	2.056	2.061	2.070	2.083	2.104	2.138	2.207

Table 6.13. Problem 5.1.2 reference solution power peaking factors for axial segments in element 3.

Shift	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	2.098	1.974	1.914	1.861	1.813	1.775	1.729	1.689	1.651	1.613
E, F, G, H, J, K, L, M	2.122	1.993	1.936	1.879	1.832	1.791	1.748	1.707	1.666	1.626
P, Q, R, S	2.125	1.998	1.943	1.887	1.834	1.794	1.749	1.711	1.670	1.632
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	1.569	1.532	1.488	1.445	1.403	1.358	1.313	1.269	1.231	1.216
E, F, G, H, J, K, L, M	1.587	1.549	1.508	1.468	1.426	1.385	1.348	1.314	1.281	1.292
P, Q, R, S	1.595	1.554	1.513	1.474	1.433	1.393	1.357	1.329	1.295	1.308
MPACT	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	2.131	2.023	1.950	1.889	1.836	1.787	1.742	1.698	1.655	1.612
E, F, G, H, J, K, L, M	2.153	2.043	1.968	1.907	1.853	1.804	1.759	1.715	1.672	1.629
P, Q, R, S	2.157	2.047	1.972	1.910	1.856	1.808	1.762	1.719	1.676	1.633
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	1.569	1.525	1.480	1.434	1.388	1.342	1.296	1.252	1.210	1.181
E, F, G, H, J, K, L, M	1.586	1.542	1.497	1.453	1.409	1.366	1.326	1.290	1.261	1.252
P, Q, R, S	1.589	1.546	1.502	1.458	1.414	1.373	1.334	1.300	1.274	1.269

Table 6.14. Problem 5.1.2 reference solution power peaking factors for axial segments in element 4.

Shift	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	1.048	0.930	0.863	0.801	0.751	0.705	0.666	0.631	0.599	0.566
E, F, G, H, J, K, L, M	1.168	1.057	0.988	0.928	0.874	0.826	0.781	0.739	0.702	0.666
P, Q, R, S	1.193	1.081	1.015	0.957	0.899	0.851	0.801	0.764	0.724	0.688
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	0.539	0.512	0.490	0.467	0.445	0.427	0.411	0.394	0.384	0.382
E, F, G, H, J, K, L, M	0.633	0.604	0.576	0.548	0.524	0.502	0.483	0.465	0.449	0.449
P, Q, R, S	0.654	0.623	0.595	0.568	0.543	0.519	0.499	0.480	0.465	0.463
MPACT	Power Peaking Factors									
Channels	1	2	3	4	5	6	7	8	9	10
A, B, C, D	1.002	0.898	0.821	0.758	0.705	0.659	0.619	0.582	0.549	0.519
E, F, G, H, J, K, L, M	1.119	1.021	0.945	0.880	0.823	0.772	0.727	0.685	0.647	0.611
P, Q, R, S	1.142	1.045	0.970	0.905	0.848	0.797	0.750	0.708	0.669	0.632
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	0.491	0.465	0.440	0.417	0.397	0.378	0.361	0.346	0.335	0.330
E, F, G, H, J, K, L, M	0.578	0.548	0.519	0.492	0.468	0.445	0.425	0.409	0.395	0.390
P, Q, R, S	0.598	0.567	0.537	0.509	0.484	0.461	0.441	0.423	0.410	0.403

Table 6.15. Problem 5.1.2 reference solution power peaking factors for axial segments in element 5.

Shift Channels	Power Peaking Factors 1	2	3	4	5	6	7	8	9	10
A, B, C, D	0.343	0.310	0.290	0.272	0.255	0.240	0.226	0.216	0.204	0.194
E, F, G, H, J, K, L, M	0.404	0.366	0.341	0.320	0.301	0.283	0.269	0.254	0.239	0.228
P, Q, R, S	0.417	0.376	0.351	0.330	0.311	0.293	0.277	0.261	0.250	0.237
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	0.185	0.176	0.167	0.159	0.150	0.144	0.137	0.132	0.128	0.128
E, F, G, H, J, K, L, M	0.217	0.206	0.196	0.187	0.177	0.170	0.162	0.156	0.149	0.150
P, Q, R, S	0.225	0.213	0.203	0.193	0.185	0.175	0.168	0.162	0.156	0.155
MPACT Channels	Power Peaking Factors 1	2	3	4	5	6	7	8	9	10
A, B, C, D	0.292	0.266	0.246	0.229	0.214	0.201	0.189	0.178	0.168	0.158
E, F, G, H, J, K, L, M	0.345	0.314	0.291	0.270	0.253	0.237	0.223	0.210	0.198	0.187
P, Q, R, S	0.357	0.325	0.301	0.280	0.262	0.245	0.231	0.217	0.205	0.193
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	0.149	0.141	0.134	0.127	0.120	0.114	0.109	0.104	0.100	0.098
E, F, G, H, J, K, L, M	0.176	0.167	0.158	0.149	0.142	0.135	0.128	0.123	0.119	0.116
P, Q, R, S	0.183	0.173	0.163	0.155	0.147	0.139	0.133	0.127	0.123	0.121

Table 6.16. Problem 5.1.2 reference solution power peaking factors for axial segments in element 6.

Shift Channels	Power Peaking Factors 1	2	3	4	5	6	7	8	9	10
A, B, C, D	0.114	0.102	0.095	0.088	0.082	0.076	0.072	0.068	0.063	0.059
E, F, G, H, J, K, L, M	0.134	0.119	0.111	0.104	0.097	0.091	0.085	0.080	0.075	0.070
P, Q, R, S	0.138	0.123	0.115	0.108	0.100	0.093	0.087	0.082	0.078	0.072
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	0.055	0.052	0.049	0.045	0.043	0.040	0.038	0.036	0.034	0.034
E, F, G, H, J, K, L, M	0.066	0.062	0.058	0.054	0.050	0.047	0.045	0.042	0.040	0.040
P, Q, R, S	0.068	0.064	0.059	0.056	0.052	0.049	0.046	0.044	0.042	0.042
MPACT Channels	Power Peaking Factors 1	2	3	4	5	6	7	8	9	10
A, B, C, D	0.087	0.079	0.072	0.067	0.062	0.058	0.054	0.050	0.047	0.044
E, F, G, H, J, K, L, M	0.102	0.093	0.085	0.079	0.073	0.068	0.064	0.060	0.056	0.052
P, Q, R, S	0.106	0.096	0.089	0.082	0.076	0.071	0.066	0.062	0.058	0.054
Channels	11	12	13	14	15	16	17	18	19	20
A, B, C, D	0.041	0.038	0.036	0.033	0.031	0.029	0.027	0.026	0.025	0.025
E, F, G, H, J, K, L, M	0.049	0.045	0.042	0.039	0.037	0.034	0.032	0.031	0.029	0.029
P, Q, R, S	0.050	0.047	0.044	0.041	0.038	0.036	0.033	0.032	0.030	0.030

6.2 DEPLETION

6.2.1 Problem 5.2.1

6.2.1.1 Description

Problem 5.2.1 uses the same geometry, temperatures, and materials as Problem 5.1.2. The control rod does not move during the depletion. As with Problems 5.1.1 and 5.1.2, each fuel element is divided into 20 segments, each representing 5% of the active fuel length.

6.2.1.2 Reference Solution

The neutron multiplication factor results are shown in Table 6.17. The timing variables for Shift and MPACT are shown in Table 6.18. Power peaking factors for the three types of charge pan pins are displayed for all time steps in Figures 23-25. The peaking factors are fully tabulated in Tables 6.19-6.54. The neutron multiplication factor agrees to approximately 200 pcm throughout the entire burnup.

As with Problem 5.1.2, the power peaking factors show noticeable differences between the MPACT and Shift peaking factors. The overall shape agrees well. The MPACT peaking factors reveal a larger flux depression with the control rod inserted compared to it fully withdrawn in Problem 5.1.1. The addition that Problem 5.2.1 confirms is that the discrepancy is not due to differences in burnup. This behavior is noted for all three charge pan pins, revealing that the discrepancy had no radial dependence.

Table 6.17. Neutron multiplication factor for the reference solution of Problem 5.2.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift k_{eff} (1σ)	MPACT k_{eff} (1σ)	Difference [pcm]
0	0.0	1.02840(7)	1.02710(20)	-129(21)
1	25.0	1.00952(7)	1.00872(20)	-80(21)
2	50.0	1.0102(7)	1.01006(20)	-14(21)
3	100.0	1.01305(7)	1.01366(20)	60(21)
4	200.0	1.01834(7)	1.01966(20)	132(21)
5	300.0	1.02207(7)	1.02389(20)	183(21)
6	400.0	1.02462(7)	1.02668(20)	206(21)
7	500.0	1.02621(7)	1.02840(20)	219(21)
8	600.0	1.02732(7)	1.02933(20)	200(21)
9	700.0	1.02762(7)	1.02981(20)	220(21)
10	800.0	1.02763(8)	1.02947(20)	184(21)
11	900.0	1.0273(7)	1.02906(20)	176(21)
12	1000.0	1.02665(8)	1.02808(20)	143(21)
13	1100.0	1.02575(8)	1.02699(20)	124(21)
14	1200.0	1.0246(8)	1.0257(20)	109(21)
15	1300.0	1.02323(8)	1.02423(20)	99(21)

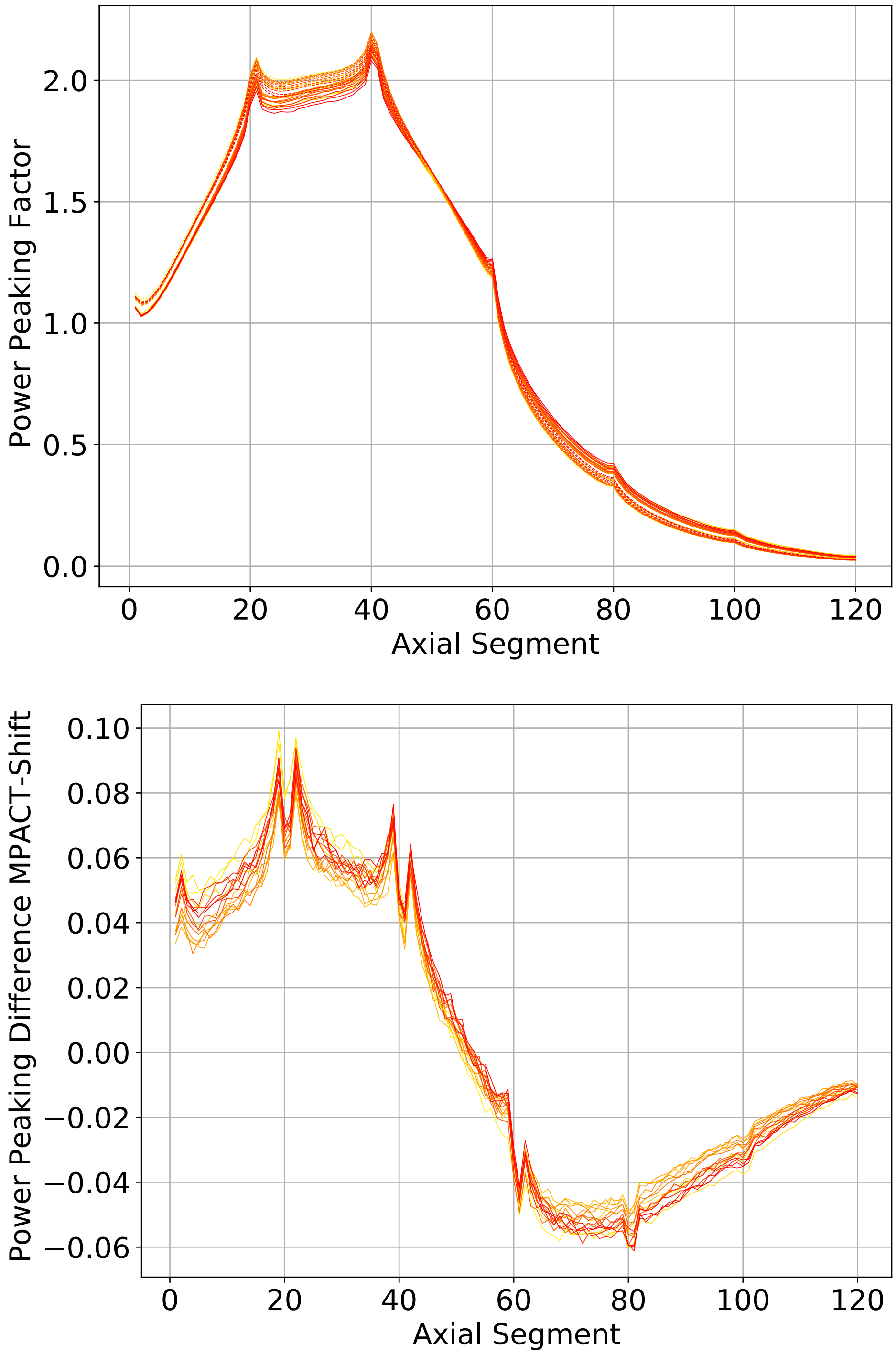


Figure 23. Power peaking factors for rods A-D in Problem 5.2.1 for Shift and MPACT with the latter having dashed lines (top). The absolute difference in the peaking factors MPACT-Shift (bottom). Yellow represents time step 0 and red represents time step 15, with a gradient of colors in between.

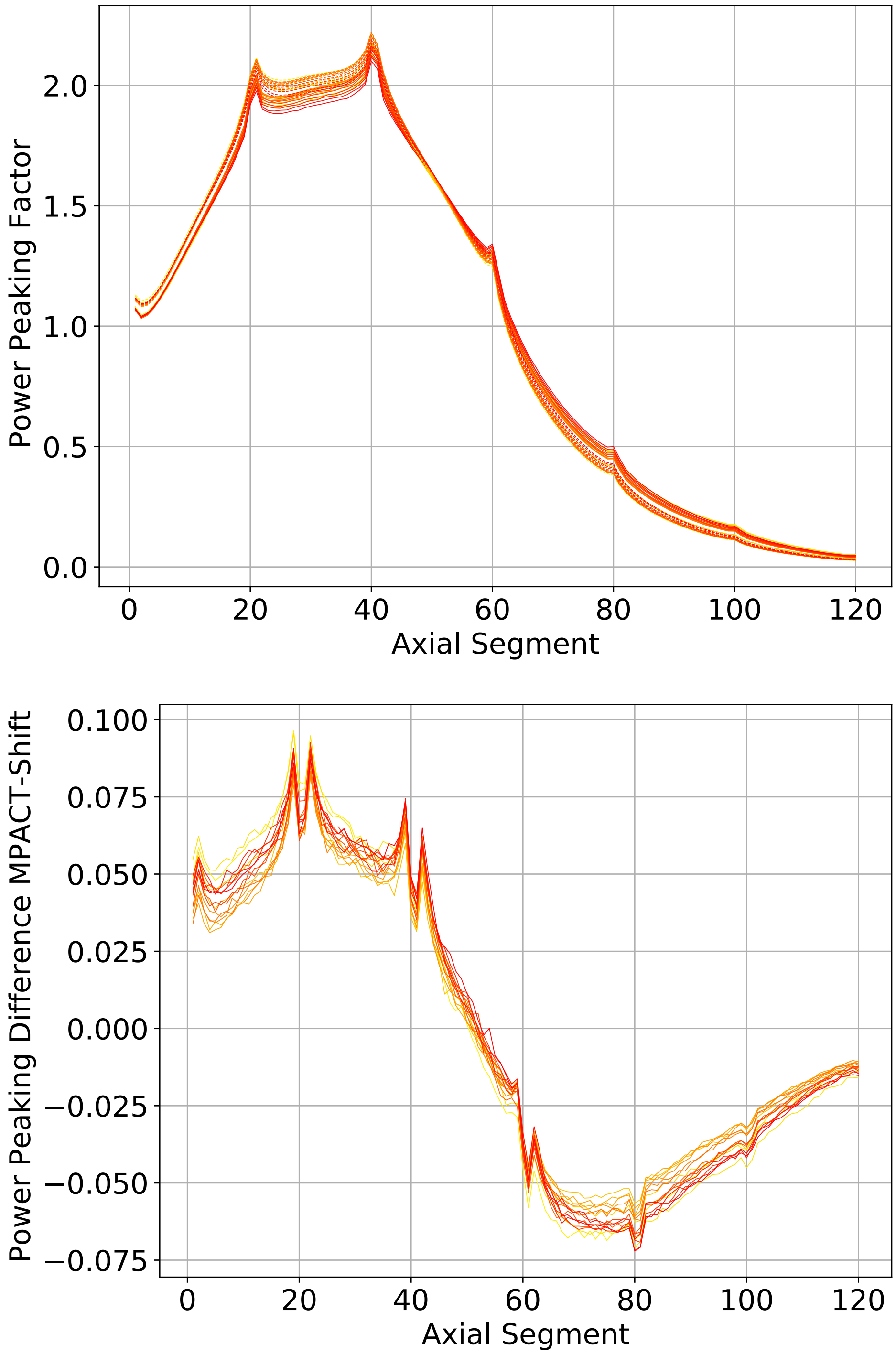


Figure 24. Power peaking factors for rods E-M in Problem 5.2.1 for Shift and MPACT with the latter having dashed lines (top). The absolute difference in the peaking factors MPACT-Shift (bottom). Yellow represents time step 0 and red represents time step 15, with a gradient of colors in between.

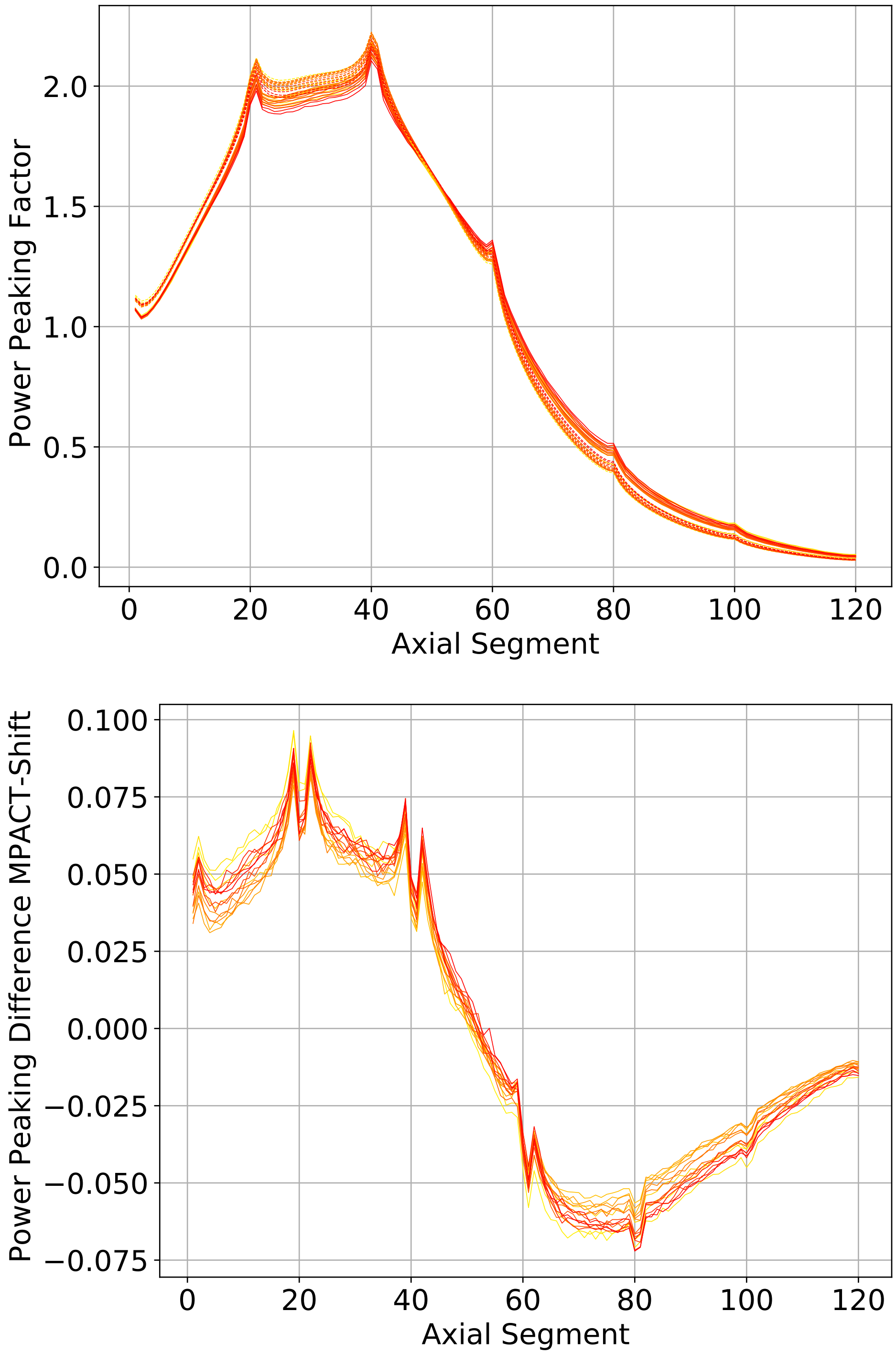


Figure 25. Power peaking factors for rods P-S in Problem 5.2.1 for Shift and MPACT with the latter having dashed lines (top). The absolute difference in the peaking factors MPACT-Shift (bottom). Yellow represents time step 0 and red represents time step 15, with a gradient of colors in between.

Table 6.18. Timing variables for the reference solution of Problem 5.2.1

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
15	1500	1200	100000	8	48	11.26

MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
15	1.0×10^{-04}	1.0×10^{-03}	0.01	2	128	3.81

Fuel Channels A, B, C, and D

Table 6.19. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels A, B, C, and D in element 1.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	1.069	1.036	1.051	1.076	1.112	1.149	1.196	1.240	1.284	1.333
1	25.0	1.064	1.030	1.044	1.068	1.101	1.138	1.179	1.224	1.270	1.315
2	50.0	1.065	1.029	1.042	1.069	1.099	1.138	1.179	1.226	1.271	1.317
3	100.0	1.057	1.025	1.036	1.063	1.097	1.136	1.177	1.221	1.270	1.315
4	200.0	1.065	1.031	1.045	1.068	1.105	1.143	1.185	1.230	1.277	1.322
5	300.0	1.062	1.026	1.038	1.065	1.100	1.140	1.182	1.230	1.276	1.326
6	400.0	1.065	1.033	1.045	1.071	1.108	1.147	1.192	1.235	1.286	1.336
7	500.0	1.061	1.026	1.039	1.065	1.099	1.138	1.181	1.231	1.276	1.330
8	600.0	1.061	1.029	1.040	1.069	1.103	1.144	1.186	1.235	1.279	1.326
9	700.0	1.064	1.031	1.046	1.072	1.105	1.147	1.190	1.239	1.287	1.334
10	800.0	1.061	1.025	1.039	1.067	1.103	1.139	1.184	1.231	1.279	1.329
11	900.0	1.060	1.028	1.043	1.072	1.105	1.142	1.188	1.232	1.282	1.327
12	1000.0	1.065	1.030	1.045	1.070	1.102	1.146	1.190	1.235	1.283	1.330
13	1100.0	1.059	1.022	1.039	1.063	1.100	1.141	1.185	1.228	1.275	1.324
14	1200.0	1.061	1.026	1.043	1.070	1.100	1.143	1.188	1.233	1.278	1.326
15	1300.0	1.060	1.024	1.043	1.067	1.102	1.141	1.187	1.229	1.279	1.325
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.381	1.430	1.477	1.526	1.576	1.630	1.686	1.749	1.813	1.941
1	25.0	1.360	1.412	1.455	1.503	1.554	1.606	1.659	1.718	1.781	1.913
2	50.0	1.363	1.410	1.454	1.503	1.551	1.604	1.658	1.717	1.778	1.912
3	100.0	1.363	1.410	1.460	1.508	1.554	1.611	1.665	1.723	1.793	1.922
4	200.0	1.373	1.419	1.468	1.520	1.569	1.622	1.675	1.739	1.808	1.943
5	300.0	1.373	1.421	1.472	1.519	1.572	1.622	1.679	1.739	1.813	1.946
6	400.0	1.384	1.433	1.478	1.529	1.576	1.633	1.689	1.750	1.819	1.956
7	500.0	1.377	1.424	1.476	1.526	1.577	1.629	1.685	1.743	1.813	1.951
8	600.0	1.375	1.425	1.477	1.524	1.574	1.630	1.679	1.745	1.815	1.949
9	700.0	1.380	1.430	1.478	1.524	1.576	1.629	1.688	1.746	1.813	1.949
10	800.0	1.377	1.426	1.474	1.525	1.570	1.625	1.679	1.742	1.808	1.946
11	900.0	1.375	1.421	1.469	1.519	1.567	1.619	1.675	1.731	1.797	1.938
12	1000.0	1.377	1.421	1.469	1.516	1.564	1.616	1.667	1.729	1.794	1.929
13	1100.0	1.369	1.412	1.462	1.512	1.562	1.614	1.663	1.718	1.790	1.921
14	1200.0	1.370	1.422	1.470	1.509	1.562	1.607	1.661	1.722	1.788	1.916
15	1300.0	1.372	1.417	1.462	1.509	1.550	1.601	1.653	1.710	1.774	1.908

Table 6.20. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels A, B, C, and D in element 1.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Power Peaking Factors 1	2	3	4	5	6	7	8	9	10
0	0.0	1.124	1.099	1.105	1.128	1.161	1.201	1.246	1.294	1.343	1.392
1	25.0	1.116	1.090	1.096	1.117	1.149	1.188	1.232	1.278	1.326	1.374
2	50.0	1.112	1.086	1.092	1.113	1.145	1.184	1.228	1.274	1.322	1.370
3	100.0	1.105	1.079	1.084	1.106	1.139	1.178	1.222	1.269	1.317	1.366
4	200.0	1.101	1.075	1.081	1.103	1.136	1.177	1.221	1.269	1.318	1.368
5	300.0	1.098	1.073	1.080	1.103	1.136	1.177	1.222	1.270	1.320	1.370
6	400.0	1.099	1.074	1.081	1.104	1.138	1.179	1.224	1.272	1.322	1.372
7	500.0	1.101	1.075	1.082	1.105	1.139	1.181	1.226	1.275	1.324	1.375
8	600.0	1.103	1.078	1.084	1.108	1.141	1.183	1.228	1.277	1.326	1.376
9	700.0	1.105	1.080	1.087	1.110	1.144	1.185	1.231	1.279	1.328	1.378
10	800.0	1.107	1.081	1.088	1.111	1.145	1.186	1.231	1.279	1.329	1.378
11	900.0	1.108	1.083	1.090	1.113	1.147	1.188	1.233	1.281	1.330	1.379
12	1000.0	1.110	1.084	1.091	1.114	1.147	1.188	1.233	1.281	1.329	1.378
13	1100.0	1.110	1.085	1.092	1.115	1.149	1.189	1.234	1.282	1.330	1.378
14	1200.0	1.110	1.084	1.091	1.113	1.147	1.187	1.232	1.279	1.327	1.375
15	1300.0	1.110	1.085	1.092	1.115	1.148	1.188	1.233	1.279	1.327	1.374
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.442	1.492	1.542	1.594	1.646	1.702	1.763	1.831	1.911	2.024
1	25.0	1.422	1.471	1.519	1.568	1.619	1.673	1.731	1.798	1.876	1.987
2	50.0	1.418	1.467	1.515	1.564	1.615	1.669	1.728	1.794	1.871	1.982
3	100.0	1.415	1.464	1.514	1.564	1.615	1.670	1.730	1.798	1.877	1.991
4	200.0	1.417	1.467	1.517	1.568	1.621	1.677	1.738	1.807	1.888	2.005
5	300.0	1.420	1.470	1.521	1.572	1.626	1.682	1.743	1.813	1.895	2.013
6	400.0	1.423	1.473	1.524	1.575	1.629	1.685	1.746	1.816	1.898	2.017
7	500.0	1.425	1.475	1.526	1.577	1.630	1.687	1.748	1.817	1.899	2.018
8	600.0	1.427	1.477	1.527	1.578	1.631	1.687	1.748	1.816	1.898	2.017
9	700.0	1.428	1.478	1.528	1.578	1.630	1.686	1.746	1.813	1.894	2.010
10	800.0	1.428	1.477	1.527	1.577	1.629	1.684	1.744	1.812	1.892	2.009
11	900.0	1.428	1.477	1.526	1.576	1.627	1.681	1.740	1.806	1.885	2.000
12	1000.0	1.427	1.476	1.524	1.574	1.624	1.678	1.736	1.802	1.881	1.996
13	1100.0	1.427	1.475	1.523	1.571	1.621	1.673	1.731	1.795	1.872	1.984
14	1200.0	1.422	1.470	1.517	1.565	1.614	1.666	1.723	1.787	1.864	1.976
15	1300.0	1.422	1.469	1.515	1.562	1.611	1.662	1.717	1.780	1.855	1.964

Table 6.21. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels A, B, C, and D in element 2.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	2.012	1.945	1.934	1.930	1.928	1.934	1.939	1.943	1.954	1.961
1	25.0	1.974	1.904	1.895	1.891	1.890	1.893	1.900	1.906	1.906	1.919
2	50.0	1.979	1.905	1.893	1.890	1.890	1.898	1.903	1.908	1.914	1.921
3	100.0	1.990	1.918	1.902	1.901	1.906	1.910	1.917	1.922	1.930	1.940
4	200.0	2.011	1.937	1.924	1.924	1.925	1.927	1.928	1.940	1.945	1.948
5	300.0	2.013	1.939	1.930	1.924	1.929	1.931	1.936	1.942	1.946	1.958
6	400.0	2.028	1.952	1.942	1.937	1.934	1.942	1.947	1.952	1.961	1.966
7	500.0	2.022	1.944	1.938	1.926	1.932	1.935	1.943	1.948	1.958	1.961
8	600.0	2.013	1.941	1.928	1.925	1.930	1.931	1.938	1.944	1.959	1.960
9	700.0	2.020	1.938	1.926	1.926	1.929	1.932	1.933	1.943	1.950	1.955
10	800.0	2.014	1.936	1.922	1.916	1.919	1.924	1.931	1.938	1.943	1.954
11	900.0	2.004	1.927	1.912	1.909	1.911	1.915	1.919	1.924	1.935	1.941
12	1000.0	1.996	1.915	1.906	1.902	1.899	1.909	1.915	1.918	1.929	1.936
13	1100.0	1.986	1.910	1.897	1.893	1.892	1.896	1.906	1.914	1.919	1.930
14	1200.0	1.984	1.903	1.891	1.891	1.892	1.895	1.901	1.906	1.921	1.921
15	1300.0	1.969	1.894	1.885	1.880	1.877	1.886	1.887	1.896	1.901	1.914
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.963	1.968	1.976	1.979	1.992	1.999	2.006	2.026	2.047	2.147
1	25.0	1.927	1.931	1.935	1.940	1.948	1.957	1.974	1.993	2.015	2.103
2	50.0	1.927	1.934	1.939	1.946	1.952	1.961	1.978	1.995	2.018	2.111
3	100.0	1.943	1.947	1.957	1.962	1.973	1.981	1.992	2.009	2.034	2.131
4	200.0	1.962	1.964	1.970	1.978	1.985	1.988	2.007	2.018	2.047	2.142
5	300.0	1.963	1.970	1.973	1.984	1.990	1.998	2.011	2.031	2.055	2.152
6	400.0	1.971	1.977	1.982	1.988	1.991	2.000	2.013	2.034	2.059	2.149
7	500.0	1.970	1.976	1.980	1.992	1.996	2.001	2.018	2.035	2.058	2.160
8	600.0	1.971	1.972	1.981	1.984	1.990	1.993	2.006	2.027	2.052	2.153
9	700.0	1.966	1.973	1.974	1.981	1.984	1.993	2.006	2.025	2.048	2.152
10	800.0	1.956	1.965	1.965	1.979	1.980	1.989	2.002	2.025	2.042	2.150
11	900.0	1.948	1.952	1.957	1.964	1.972	1.981	1.991	2.005	2.038	2.132
12	1000.0	1.940	1.947	1.956	1.959	1.960	1.970	1.985	2.000	2.024	2.127
13	1100.0	1.932	1.939	1.944	1.952	1.959	1.966	1.978	1.996	2.024	2.121
14	1200.0	1.927	1.932	1.939	1.944	1.949	1.959	1.971	1.989	2.016	2.114
15	1300.0	1.913	1.918	1.928	1.931	1.941	1.945	1.958	1.974	2.004	2.097

Table 6.22. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels A, B, C, and D in element 2.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Power Peaking Factors 1	2	3	4	5	6	7	8	9	10
0	0.0	2.095	2.040	2.018	2.007	2.003	2.005	2.008	2.013	2.019	2.024
1	25.0	2.055	1.999	1.976	1.965	1.961	1.962	1.966	1.971	1.976	1.981
2	50.0	2.051	1.996	1.975	1.964	1.961	1.963	1.967	1.972	1.978	1.983
3	100.0	2.061	2.005	1.982	1.972	1.969	1.970	1.975	1.980	1.986	1.991
4	200.0	2.077	2.019	1.997	1.986	1.984	1.986	1.990	1.996	2.002	2.008
5	300.0	2.085	2.027	2.004	1.994	1.991	1.993	1.998	2.004	2.010	2.016
6	400.0	2.090	2.031	2.008	1.997	1.994	1.996	2.001	2.007	2.013	2.019
7	500.0	2.090	2.031	2.007	1.997	1.994	1.996	2.001	2.006	2.013	2.018
8	600.0	2.088	2.028	2.005	1.994	1.991	1.993	1.997	2.003	2.009	2.015
9	700.0	2.081	2.022	2.000	1.989	1.987	1.989	1.993	1.999	2.005	2.011
10	800.0	2.078	2.018	1.994	1.983	1.980	1.982	1.986	1.992	1.998	2.003
11	900.0	2.068	2.009	1.987	1.976	1.973	1.975	1.979	1.985	1.991	1.996
12	1000.0	2.063	2.003	1.979	1.968	1.964	1.966	1.970	1.975	1.981	1.986
13	1100.0	2.050	1.992	1.969	1.958	1.955	1.957	1.961	1.967	1.972	1.978
14	1200.0	2.040	1.981	1.957	1.946	1.942	1.943	1.947	1.952	1.958	1.963
15	1300.0	2.027	1.970	1.947	1.937	1.933	1.935	1.939	1.944	1.950	1.955

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	11	12	13	14	15	16	17	18	19	20
0	0.0	2.028	2.032	2.036	2.040	2.045	2.054	2.067	2.088	2.121	2.188
1	25.0	1.986	1.990	1.994	1.999	2.005	2.014	2.028	2.050	2.084	2.154
2	50.0	1.988	1.993	1.997	2.001	2.008	2.016	2.030	2.052	2.085	2.153
3	100.0	1.997	2.001	2.006	2.010	2.017	2.026	2.040	2.062	2.097	2.168
4	200.0	2.013	2.018	2.022	2.027	2.034	2.043	2.057	2.079	2.114	2.187
5	300.0	2.021	2.026	2.030	2.035	2.041	2.050	2.064	2.087	2.122	2.196
6	400.0	2.024	2.029	2.033	2.038	2.044	2.053	2.067	2.089	2.125	2.199
7	500.0	2.024	2.028	2.032	2.037	2.043	2.052	2.066	2.088	2.124	2.199
8	600.0	2.020	2.024	2.029	2.033	2.039	2.048	2.062	2.085	2.121	2.195
9	700.0	2.016	2.021	2.025	2.029	2.035	2.043	2.057	2.079	2.114	2.187
10	800.0	2.008	2.013	2.017	2.021	2.027	2.036	2.050	2.073	2.109	2.183
11	900.0	2.001	2.006	2.010	2.014	2.020	2.029	2.042	2.064	2.099	2.172
12	1000.0	1.991	1.995	2.000	2.004	2.010	2.019	2.034	2.056	2.092	2.166
13	1100.0	1.983	1.987	1.991	1.995	2.001	2.010	2.024	2.046	2.081	2.152
14	1200.0	1.968	1.972	1.977	1.982	1.988	1.997	2.011	2.034	2.070	2.143
15	1300.0	1.960	1.964	1.968	1.973	1.979	1.988	2.002	2.024	2.059	2.129

Table 6.23. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels A, B, C, and D in element 3.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	2.096	1.969	1.913	1.861	1.812	1.769	1.730	1.693	1.649	1.610
1	25.0	2.067	1.939	1.886	1.838	1.792	1.753	1.711	1.676	1.637	1.600
2	50.0	2.072	1.954	1.888	1.845	1.794	1.751	1.715	1.677	1.637	1.603
3	100.0	2.085	1.958	1.903	1.851	1.805	1.760	1.719	1.682	1.643	1.605
4	200.0	2.104	1.973	1.913	1.863	1.812	1.767	1.726	1.684	1.650	1.610
5	300.0	2.108	1.975	1.917	1.868	1.821	1.772	1.735	1.692	1.655	1.614
6	400.0	2.111	1.977	1.917	1.864	1.819	1.769	1.731	1.690	1.651	1.614
7	500.0	2.114	1.980	1.921	1.871	1.824	1.775	1.738	1.700	1.657	1.617
8	600.0	2.114	1.980	1.915	1.866	1.814	1.775	1.736	1.696	1.661	1.620
9	700.0	2.110	1.972	1.912	1.862	1.820	1.778	1.735	1.696	1.657	1.618
10	800.0	2.106	1.973	1.912	1.863	1.819	1.772	1.734	1.693	1.661	1.615
11	900.0	2.091	1.966	1.907	1.856	1.812	1.772	1.732	1.693	1.655	1.618
12	1000.0	2.083	1.960	1.900	1.848	1.808	1.766	1.725	1.690	1.653	1.619
13	1100.0	2.081	1.956	1.897	1.849	1.808	1.766	1.725	1.688	1.652	1.618
14	1200.0	2.079	1.942	1.891	1.842	1.799	1.760	1.720	1.689	1.649	1.615
15	1300.0	2.065	1.931	1.884	1.835	1.794	1.756	1.718	1.684	1.652	1.613
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.573	1.532	1.487	1.444	1.404	1.365	1.320	1.279	1.235	1.222
1	25.0	1.558	1.523	1.487	1.446	1.408	1.368	1.326	1.282	1.243	1.232
2	50.0	1.565	1.525	1.491	1.448	1.403	1.365	1.323	1.279	1.242	1.232
3	100.0	1.565	1.521	1.486	1.443	1.405	1.358	1.317	1.281	1.240	1.225
4	200.0	1.567	1.528	1.488	1.444	1.401	1.360	1.318	1.274	1.230	1.219
5	300.0	1.573	1.534	1.492	1.449	1.408	1.364	1.318	1.275	1.233	1.222
6	400.0	1.572	1.530	1.485	1.446	1.404	1.359	1.313	1.276	1.233	1.222
7	500.0	1.575	1.533	1.494	1.452	1.411	1.364	1.323	1.276	1.233	1.228
8	600.0	1.576	1.535	1.496	1.454	1.412	1.366	1.322	1.280	1.235	1.231
9	700.0	1.577	1.535	1.495	1.451	1.409	1.367	1.321	1.276	1.236	1.229
10	800.0	1.577	1.540	1.497	1.453	1.414	1.371	1.327	1.286	1.244	1.236
11	900.0	1.579	1.541	1.502	1.460	1.420	1.373	1.329	1.289	1.250	1.241
12	1000.0	1.578	1.541	1.500	1.458	1.413	1.374	1.333	1.290	1.250	1.247
13	1100.0	1.580	1.542	1.502	1.462	1.419	1.381	1.341	1.297	1.260	1.254
14	1200.0	1.577	1.540	1.504	1.461	1.421	1.378	1.340	1.297	1.257	1.253
15	1300.0	1.581	1.541	1.506	1.464	1.425	1.387	1.344	1.303	1.267	1.261

Table 6.24. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels A, B, C, and D in element 3.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	2.138	2.029	1.954	1.893	1.839	1.790	1.744	1.700	1.657	1.613
1	25.0	2.108	2.001	1.929	1.870	1.818	1.772	1.729	1.688	1.647	1.606
2	50.0	2.107	2.001	1.930	1.871	1.820	1.774	1.731	1.689	1.648	1.607
3	100.0	2.121	2.011	1.938	1.878	1.825	1.778	1.734	1.692	1.650	1.609
4	200.0	2.138	2.026	1.951	1.889	1.836	1.788	1.743	1.699	1.657	1.614
5	300.0	2.147	2.033	1.957	1.895	1.841	1.792	1.747	1.703	1.660	1.617
6	400.0	2.150	2.036	1.960	1.897	1.844	1.795	1.749	1.706	1.663	1.619
7	500.0	2.150	2.035	1.960	1.898	1.844	1.796	1.751	1.707	1.664	1.621
8	600.0	2.147	2.033	1.958	1.896	1.843	1.795	1.750	1.707	1.665	1.622
9	700.0	2.140	2.028	1.954	1.894	1.842	1.794	1.750	1.708	1.666	1.624
10	800.0	2.137	2.025	1.951	1.891	1.839	1.792	1.749	1.707	1.665	1.623
11	900.0	2.127	2.017	1.945	1.886	1.836	1.790	1.747	1.706	1.666	1.625
12	1000.0	2.122	2.012	1.940	1.882	1.832	1.787	1.745	1.704	1.664	1.624
13	1100.0	2.110	2.003	1.934	1.877	1.828	1.784	1.743	1.703	1.664	1.625
14	1200.0	2.102	1.996	1.926	1.870	1.822	1.779	1.739	1.700	1.662	1.623
15	1300.0	2.090	1.987	1.919	1.865	1.818	1.776	1.737	1.699	1.662	1.624
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.569	1.524	1.479	1.433	1.387	1.341	1.295	1.250	1.208	1.179
1	25.0	1.565	1.523	1.480	1.436	1.393	1.349	1.305	1.263	1.224	1.198
2	50.0	1.566	1.524	1.481	1.437	1.393	1.349	1.305	1.262	1.222	1.196
3	100.0	1.566	1.524	1.480	1.436	1.391	1.346	1.302	1.260	1.220	1.194
4	200.0	1.571	1.527	1.482	1.437	1.391	1.345	1.300	1.257	1.216	1.189
5	300.0	1.573	1.529	1.484	1.438	1.392	1.346	1.300	1.256	1.215	1.188
6	400.0	1.575	1.531	1.486	1.440	1.393	1.347	1.301	1.257	1.216	1.189
7	500.0	1.577	1.533	1.488	1.442	1.395	1.349	1.303	1.259	1.219	1.192
8	600.0	1.579	1.535	1.490	1.444	1.398	1.352	1.306	1.263	1.222	1.196
9	700.0	1.581	1.537	1.492	1.447	1.401	1.355	1.310	1.266	1.225	1.199
10	800.0	1.581	1.538	1.494	1.449	1.403	1.358	1.313	1.270	1.230	1.205
11	900.0	1.583	1.540	1.497	1.452	1.407	1.362	1.318	1.275	1.235	1.209
12	1000.0	1.583	1.541	1.498	1.454	1.410	1.365	1.322	1.279	1.240	1.217
13	1100.0	1.584	1.543	1.501	1.457	1.414	1.370	1.326	1.284	1.245	1.221
14	1200.0	1.584	1.543	1.502	1.460	1.417	1.374	1.332	1.291	1.253	1.231
15	1300.0	1.585	1.546	1.505	1.463	1.421	1.378	1.336	1.295	1.258	1.235

Table 6.25. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels A, B, C, and D in element 4.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	1.051	0.935	0.866	0.806	0.754	0.708	0.669	0.633	0.599	0.570
1	25.0	1.069	0.952	0.884	0.824	0.773	0.730	0.689	0.654	0.624	0.594
2	50.0	1.065	0.949	0.879	0.821	0.772	0.728	0.688	0.653	0.623	0.590
3	100.0	1.060	0.942	0.872	0.814	0.765	0.722	0.681	0.646	0.615	0.586
4	200.0	1.052	0.935	0.863	0.806	0.756	0.713	0.673	0.638	0.605	0.572
5	300.0	1.054	0.937	0.864	0.802	0.754	0.710	0.669	0.633	0.600	0.572
6	400.0	1.050	0.932	0.859	0.802	0.749	0.707	0.665	0.632	0.598	0.565
7	500.0	1.057	0.934	0.864	0.804	0.753	0.710	0.669	0.633	0.598	0.567
8	600.0	1.059	0.939	0.870	0.808	0.757	0.711	0.670	0.633	0.603	0.573
9	700.0	1.058	0.941	0.866	0.808	0.756	0.713	0.673	0.636	0.605	0.575
10	800.0	1.067	0.946	0.875	0.815	0.761	0.715	0.677	0.641	0.608	0.577
11	900.0	1.073	0.951	0.880	0.819	0.769	0.722	0.681	0.646	0.614	0.584
12	1000.0	1.077	0.954	0.882	0.823	0.771	0.727	0.688	0.654	0.618	0.589
13	1100.0	1.089	0.965	0.894	0.833	0.781	0.735	0.695	0.658	0.627	0.596
14	1200.0	1.092	0.965	0.894	0.831	0.783	0.739	0.698	0.662	0.629	0.598
15	1300.0	1.096	0.972	0.903	0.841	0.792	0.747	0.706	0.670	0.640	0.609

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	11	12	13	14	15	16	17	18	19	20
0	0.0	0.543	0.516	0.492	0.468	0.447	0.428	0.412	0.397	0.385	0.383
1	25.0	0.566	0.540	0.518	0.495	0.473	0.455	0.439	0.423	0.411	0.410
2	50.0	0.563	0.538	0.514	0.491	0.472	0.451	0.434	0.421	0.411	0.412
3	100.0	0.556	0.530	0.509	0.484	0.465	0.447	0.429	0.414	0.402	0.403
4	200.0	0.545	0.519	0.493	0.475	0.454	0.431	0.417	0.401	0.388	0.388
5	300.0	0.543	0.519	0.492	0.469	0.449	0.430	0.413	0.397	0.384	0.382
6	400.0	0.538	0.514	0.490	0.465	0.443	0.425	0.407	0.391	0.379	0.381
7	500.0	0.540	0.515	0.487	0.466	0.444	0.424	0.407	0.392	0.379	0.380
8	600.0	0.543	0.518	0.493	0.469	0.447	0.427	0.409	0.397	0.382	0.382
9	700.0	0.545	0.517	0.494	0.471	0.450	0.431	0.411	0.397	0.384	0.382
10	800.0	0.548	0.521	0.498	0.473	0.451	0.431	0.416	0.400	0.386	0.387
11	900.0	0.553	0.527	0.500	0.480	0.458	0.438	0.418	0.405	0.393	0.391
12	1000.0	0.560	0.534	0.506	0.484	0.464	0.444	0.425	0.410	0.399	0.397
13	1100.0	0.566	0.542	0.514	0.490	0.467	0.449	0.431	0.414	0.404	0.403
14	1200.0	0.570	0.544	0.518	0.495	0.475	0.455	0.436	0.419	0.408	0.407
15	1300.0	0.579	0.549	0.526	0.501	0.479	0.459	0.441	0.427	0.414	0.416

Table 6.26. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels A, B, C, and D in element 4.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.999	0.894	0.816	0.753	0.700	0.654	0.613	0.577	0.544	0.513
1	25.0	1.021	0.916	0.839	0.776	0.724	0.679	0.639	0.603	0.570	0.540
2	50.0	1.019	0.914	0.838	0.775	0.723	0.678	0.638	0.603	0.570	0.540
3	100.0	1.016	0.911	0.834	0.771	0.718	0.673	0.633	0.597	0.565	0.535
4	200.0	1.010	0.904	0.826	0.763	0.710	0.664	0.624	0.588	0.555	0.525
5	300.0	1.008	0.901	0.823	0.760	0.707	0.661	0.620	0.584	0.551	0.520
6	400.0	1.009	0.901	0.823	0.759	0.706	0.659	0.619	0.582	0.549	0.519
7	500.0	1.011	0.903	0.824	0.761	0.707	0.661	0.620	0.583	0.550	0.519
8	600.0	1.015	0.906	0.828	0.764	0.710	0.663	0.622	0.585	0.552	0.521
9	700.0	1.017	0.909	0.831	0.767	0.713	0.667	0.626	0.589	0.555	0.524
10	800.0	1.025	0.916	0.836	0.772	0.718	0.671	0.630	0.593	0.559	0.528
11	900.0	1.029	0.920	0.841	0.777	0.723	0.677	0.635	0.598	0.565	0.534
12	1000.0	1.037	0.928	0.848	0.784	0.730	0.683	0.641	0.604	0.570	0.539
13	1100.0	1.042	0.933	0.854	0.790	0.736	0.689	0.648	0.611	0.577	0.546
14	1200.0	1.053	0.943	0.864	0.799	0.745	0.698	0.657	0.620	0.586	0.554
15	1300.0	1.058	0.948	0.869	0.805	0.751	0.704	0.663	0.626	0.592	0.561
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.485	0.459	0.434	0.411	0.391	0.372	0.355	0.340	0.329	0.324
1	25.0	0.512	0.486	0.462	0.440	0.419	0.400	0.383	0.369	0.359	0.354
2	50.0	0.512	0.487	0.462	0.440	0.419	0.400	0.384	0.370	0.359	0.355
3	100.0	0.507	0.481	0.457	0.435	0.414	0.395	0.379	0.365	0.354	0.350
4	200.0	0.497	0.471	0.447	0.424	0.404	0.385	0.368	0.354	0.343	0.339
5	300.0	0.492	0.466	0.442	0.419	0.398	0.379	0.363	0.348	0.338	0.333
6	400.0	0.490	0.464	0.439	0.417	0.396	0.377	0.360	0.345	0.334	0.330
7	500.0	0.490	0.464	0.439	0.416	0.395	0.376	0.359	0.345	0.334	0.329
8	600.0	0.492	0.466	0.441	0.418	0.397	0.377	0.360	0.346	0.335	0.330
9	700.0	0.495	0.469	0.444	0.421	0.399	0.380	0.362	0.348	0.336	0.331
10	800.0	0.499	0.472	0.447	0.424	0.403	0.383	0.366	0.351	0.340	0.335
11	900.0	0.505	0.478	0.452	0.429	0.407	0.388	0.370	0.355	0.344	0.338
12	1000.0	0.510	0.483	0.458	0.434	0.412	0.393	0.375	0.360	0.349	0.344
13	1100.0	0.517	0.489	0.464	0.440	0.418	0.398	0.381	0.366	0.354	0.349
14	1200.0	0.525	0.498	0.472	0.449	0.427	0.407	0.389	0.374	0.363	0.358
15	1300.0	0.532	0.504	0.479	0.455	0.433	0.413	0.395	0.380	0.368	0.363

Table 6.27. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels A, B, C, and D in element 5.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.344	0.312	0.291	0.273	0.259	0.244	0.230	0.217	0.206	0.195
1	25.0	0.373	0.338	0.318	0.300	0.283	0.269	0.254	0.241	0.231	0.218
2	50.0	0.371	0.339	0.317	0.300	0.282	0.266	0.253	0.242	0.229	0.219
3	100.0	0.363	0.329	0.309	0.290	0.275	0.260	0.246	0.233	0.222	0.211
4	200.0	0.350	0.317	0.296	0.279	0.262	0.247	0.235	0.223	0.212	0.202
5	300.0	0.345	0.313	0.293	0.274	0.257	0.243	0.230	0.217	0.209	0.198
6	400.0	0.340	0.308	0.287	0.270	0.253	0.238	0.227	0.214	0.204	0.193
7	500.0	0.342	0.308	0.287	0.269	0.254	0.238	0.225	0.213	0.203	0.191
8	600.0	0.343	0.308	0.288	0.270	0.254	0.241	0.227	0.214	0.204	0.192
9	700.0	0.345	0.310	0.289	0.271	0.255	0.239	0.227	0.216	0.205	0.193
10	800.0	0.348	0.312	0.291	0.274	0.258	0.244	0.230	0.217	0.205	0.194
11	900.0	0.354	0.317	0.296	0.279	0.263	0.247	0.233	0.221	0.210	0.199
12	1000.0	0.358	0.322	0.302	0.282	0.267	0.250	0.238	0.225	0.212	0.202
13	1100.0	0.364	0.328	0.305	0.285	0.269	0.253	0.241	0.228	0.216	0.205
14	1200.0	0.366	0.328	0.308	0.288	0.274	0.257	0.242	0.231	0.217	0.207
15	1300.0	0.374	0.338	0.315	0.295	0.281	0.264	0.250	0.236	0.225	0.213

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	11	12	13	14	15	16	17	18	19	20
0	0.0	0.186	0.176	0.167	0.161	0.152	0.145	0.140	0.134	0.129	0.129
1	25.0	0.208	0.200	0.191	0.182	0.174	0.167	0.161	0.154	0.151	0.150
2	50.0	0.210	0.199	0.189	0.181	0.173	0.165	0.160	0.153	0.149	0.149
3	100.0	0.200	0.193	0.185	0.175	0.168	0.162	0.154	0.149	0.144	0.144
4	200.0	0.192	0.182	0.173	0.166	0.158	0.151	0.143	0.140	0.135	0.134
5	300.0	0.186	0.177	0.170	0.161	0.154	0.148	0.141	0.137	0.131	0.130
6	400.0	0.183	0.173	0.166	0.157	0.149	0.145	0.137	0.132	0.127	0.128
7	500.0	0.183	0.173	0.165	0.157	0.150	0.143	0.137	0.131	0.127	0.126
8	600.0	0.182	0.173	0.165	0.157	0.149	0.144	0.138	0.131	0.127	0.126
9	700.0	0.184	0.176	0.167	0.159	0.150	0.144	0.138	0.132	0.127	0.127
10	800.0	0.186	0.175	0.169	0.160	0.152	0.143	0.138	0.132	0.127	0.128
11	900.0	0.188	0.179	0.169	0.162	0.154	0.147	0.140	0.135	0.130	0.130
12	1000.0	0.191	0.181	0.173	0.164	0.158	0.149	0.143	0.138	0.133	0.132
13	1100.0	0.195	0.184	0.175	0.167	0.159	0.152	0.146	0.140	0.135	0.134
14	1200.0	0.199	0.187	0.178	0.170	0.162	0.155	0.148	0.142	0.139	0.138
15	1300.0	0.202	0.193	0.183	0.175	0.167	0.158	0.151	0.147	0.141	0.141

Table 6.28. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels A, B, C, and D in element 5.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.287	0.261	0.241	0.224	0.209	0.196	0.184	0.173	0.163	0.154
1	25.0	0.316	0.289	0.268	0.250	0.234	0.220	0.208	0.196	0.186	0.176
2	50.0	0.317	0.289	0.269	0.251	0.235	0.222	0.209	0.198	0.187	0.178
3	100.0	0.313	0.285	0.265	0.247	0.232	0.218	0.206	0.195	0.184	0.175
4	200.0	0.302	0.275	0.255	0.238	0.222	0.209	0.197	0.186	0.176	0.166
5	300.0	0.295	0.269	0.249	0.232	0.217	0.204	0.192	0.181	0.171	0.161
6	400.0	0.292	0.266	0.246	0.228	0.214	0.200	0.188	0.177	0.167	0.158
7	500.0	0.291	0.264	0.244	0.227	0.212	0.199	0.187	0.176	0.166	0.156
8	600.0	0.291	0.265	0.245	0.227	0.212	0.199	0.187	0.176	0.166	0.156
9	700.0	0.293	0.266	0.246	0.228	0.213	0.200	0.188	0.177	0.166	0.157
10	800.0	0.296	0.269	0.248	0.231	0.215	0.202	0.189	0.178	0.168	0.158
11	900.0	0.299	0.272	0.251	0.234	0.218	0.204	0.192	0.181	0.170	0.160
12	1000.0	0.304	0.277	0.255	0.237	0.222	0.208	0.195	0.183	0.173	0.163
13	1100.0	0.309	0.281	0.260	0.242	0.226	0.212	0.199	0.187	0.176	0.166
14	1200.0	0.318	0.289	0.267	0.248	0.232	0.218	0.205	0.193	0.182	0.172
15	1300.0	0.322	0.294	0.272	0.253	0.236	0.222	0.209	0.197	0.185	0.175
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.145	0.137	0.130	0.123	0.116	0.110	0.105	0.101	0.097	0.095
1	25.0	0.167	0.158	0.150	0.143	0.136	0.129	0.124	0.119	0.115	0.113
2	50.0	0.168	0.160	0.152	0.144	0.137	0.131	0.125	0.121	0.117	0.115
3	100.0	0.166	0.157	0.149	0.142	0.135	0.129	0.123	0.118	0.115	0.113
4	200.0	0.158	0.149	0.142	0.134	0.128	0.122	0.116	0.112	0.108	0.106
5	300.0	0.153	0.144	0.137	0.130	0.123	0.117	0.112	0.107	0.104	0.102
6	400.0	0.149	0.141	0.134	0.127	0.120	0.114	0.109	0.104	0.101	0.099
7	500.0	0.148	0.140	0.132	0.125	0.119	0.113	0.107	0.103	0.099	0.097
8	600.0	0.148	0.139	0.132	0.125	0.118	0.112	0.107	0.102	0.099	0.097
9	700.0	0.148	0.140	0.132	0.125	0.119	0.113	0.107	0.103	0.099	0.097
10	800.0	0.149	0.141	0.133	0.126	0.119	0.113	0.108	0.103	0.100	0.098
11	900.0	0.151	0.143	0.135	0.128	0.121	0.115	0.110	0.105	0.101	0.099
12	1000.0	0.154	0.145	0.137	0.130	0.123	0.117	0.111	0.106	0.103	0.101
13	1100.0	0.157	0.148	0.140	0.133	0.126	0.120	0.114	0.109	0.105	0.103
14	1200.0	0.162	0.153	0.145	0.137	0.130	0.124	0.118	0.113	0.109	0.107
15	1300.0	0.166	0.157	0.148	0.140	0.133	0.126	0.121	0.115	0.111	0.110

Table 6.29. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels A, B, C, and D in element 6.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Power Peaking Factors 1	2	3	4	5	6	7	8	9	10
0	0.0	0.114	0.103	0.096	0.090	0.084	0.077	0.073	0.068	0.065	0.060
1	25.0	0.135	0.122	0.113	0.105	0.101	0.093	0.088	0.083	0.078	0.072
2	50.0	0.134	0.122	0.113	0.105	0.098	0.092	0.088	0.082	0.077	0.073
3	100.0	0.129	0.116	0.108	0.102	0.095	0.089	0.084	0.079	0.074	0.069
4	200.0	0.120	0.108	0.101	0.095	0.087	0.082	0.077	0.074	0.069	0.066
5	300.0	0.117	0.104	0.097	0.091	0.086	0.080	0.074	0.071	0.068	0.062
6	400.0	0.113	0.102	0.095	0.088	0.082	0.077	0.071	0.067	0.064	0.060
7	500.0	0.112	0.101	0.094	0.088	0.082	0.076	0.071	0.068	0.063	0.059
8	600.0	0.113	0.102	0.093	0.086	0.081	0.076	0.071	0.068	0.063	0.059
9	700.0	0.113	0.101	0.093	0.088	0.081	0.076	0.071	0.067	0.063	0.059
10	800.0	0.114	0.102	0.095	0.088	0.082	0.078	0.073	0.069	0.064	0.060
11	900.0	0.116	0.103	0.096	0.090	0.084	0.079	0.073	0.069	0.065	0.061
12	1000.0	0.117	0.106	0.098	0.091	0.086	0.080	0.075	0.070	0.065	0.062
13	1100.0	0.119	0.108	0.100	0.093	0.087	0.081	0.076	0.071	0.067	0.063
14	1200.0	0.122	0.110	0.102	0.096	0.088	0.084	0.077	0.072	0.069	0.064
15	1300.0	0.125	0.112	0.104	0.097	0.092	0.086	0.080	0.075	0.071	0.066
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.057	0.053	0.050	0.047	0.044	0.042	0.038	0.036	0.035	0.035
1	25.0	0.068	0.065	0.061	0.057	0.054	0.050	0.047	0.044	0.043	0.042
2	50.0	0.069	0.064	0.060	0.057	0.053	0.050	0.047	0.044	0.043	0.043
3	100.0	0.066	0.061	0.058	0.053	0.051	0.048	0.044	0.042	0.041	0.041
4	200.0	0.061	0.057	0.053	0.050	0.047	0.044	0.042	0.039	0.038	0.038
5	300.0	0.058	0.055	0.051	0.049	0.045	0.042	0.039	0.037	0.036	0.036
6	400.0	0.056	0.053	0.050	0.046	0.043	0.041	0.038	0.036	0.035	0.034
7	500.0	0.055	0.052	0.048	0.046	0.043	0.040	0.038	0.035	0.034	0.034
8	600.0	0.055	0.052	0.049	0.045	0.042	0.040	0.037	0.036	0.034	0.034
9	700.0	0.056	0.052	0.049	0.046	0.043	0.040	0.038	0.035	0.034	0.034
10	800.0	0.057	0.053	0.049	0.046	0.043	0.041	0.038	0.036	0.034	0.034
11	900.0	0.056	0.053	0.050	0.047	0.043	0.041	0.038	0.036	0.035	0.035
12	1000.0	0.058	0.055	0.050	0.048	0.044	0.042	0.039	0.037	0.036	0.035
13	1100.0	0.059	0.055	0.052	0.049	0.045	0.043	0.040	0.038	0.036	0.036
14	1200.0	0.061	0.056	0.052	0.050	0.046	0.043	0.041	0.039	0.037	0.037
15	1300.0	0.062	0.058	0.054	0.051	0.047	0.044	0.042	0.040	0.038	0.037

Table 6.30. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels A, B, C, and D in element 6.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.084	0.076	0.070	0.065	0.060	0.056	0.052	0.049	0.045	0.042
1	25.0	0.100	0.091	0.084	0.078	0.073	0.068	0.063	0.059	0.056	0.052
2	50.0	0.102	0.093	0.086	0.080	0.074	0.069	0.065	0.061	0.057	0.053
3	100.0	0.100	0.091	0.084	0.078	0.073	0.068	0.064	0.060	0.056	0.053
4	200.0	0.094	0.086	0.079	0.073	0.068	0.064	0.060	0.056	0.052	0.049
5	300.0	0.090	0.082	0.076	0.070	0.065	0.061	0.057	0.053	0.050	0.047
6	400.0	0.087	0.079	0.073	0.068	0.063	0.059	0.055	0.051	0.048	0.045
7	500.0	0.086	0.078	0.072	0.066	0.062	0.057	0.054	0.050	0.047	0.044
8	600.0	0.085	0.077	0.071	0.066	0.061	0.057	0.053	0.049	0.046	0.043
9	700.0	0.085	0.077	0.071	0.066	0.061	0.057	0.053	0.049	0.046	0.043
10	800.0	0.086	0.078	0.071	0.066	0.061	0.057	0.053	0.050	0.046	0.043
11	900.0	0.087	0.079	0.072	0.067	0.062	0.058	0.054	0.050	0.047	0.044
12	1000.0	0.088	0.080	0.074	0.068	0.063	0.059	0.055	0.051	0.048	0.045
13	1100.0	0.091	0.082	0.075	0.070	0.065	0.060	0.056	0.052	0.049	0.046
14	1200.0	0.094	0.085	0.078	0.072	0.067	0.063	0.058	0.054	0.051	0.048
15	1300.0	0.096	0.087	0.080	0.074	0.069	0.064	0.060	0.056	0.052	0.049
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.040	0.037	0.034	0.032	0.030	0.028	0.026	0.025	0.024	0.024
1	25.0	0.049	0.045	0.043	0.040	0.037	0.035	0.033	0.031	0.030	0.029
2	50.0	0.050	0.047	0.044	0.041	0.038	0.036	0.034	0.032	0.031	0.030
3	100.0	0.049	0.046	0.043	0.040	0.038	0.035	0.033	0.031	0.030	0.030
4	200.0	0.046	0.043	0.040	0.037	0.035	0.033	0.031	0.029	0.028	0.028
5	300.0	0.044	0.041	0.038	0.036	0.033	0.031	0.029	0.028	0.027	0.026
6	400.0	0.042	0.039	0.036	0.034	0.032	0.030	0.028	0.026	0.025	0.025
7	500.0	0.041	0.038	0.036	0.033	0.031	0.029	0.027	0.026	0.025	0.024
8	600.0	0.040	0.038	0.035	0.033	0.031	0.029	0.027	0.025	0.024	0.024
9	700.0	0.040	0.038	0.035	0.033	0.030	0.028	0.027	0.025	0.024	0.024
10	800.0	0.040	0.038	0.035	0.033	0.031	0.029	0.027	0.025	0.024	0.024
11	900.0	0.041	0.038	0.036	0.033	0.031	0.029	0.027	0.026	0.025	0.024
12	1000.0	0.042	0.039	0.036	0.034	0.031	0.029	0.028	0.026	0.025	0.025
13	1100.0	0.043	0.040	0.037	0.035	0.032	0.030	0.028	0.027	0.026	0.025
14	1200.0	0.044	0.041	0.039	0.036	0.034	0.031	0.029	0.028	0.027	0.026
15	1300.0	0.045	0.042	0.040	0.037	0.034	0.032	0.030	0.029	0.027	0.027

Fuel Channels E, F, G, H, J, K, L, and M

Table 6.31. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels E, F, G, H, J, K, L, and M in element 1.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	1.073	1.044	1.056	1.084	1.118	1.158	1.203	1.250	1.299	1.346
1	25.0	1.069	1.038	1.049	1.075	1.109	1.146	1.191	1.235	1.282	1.327
2	50.0	1.069	1.034	1.048	1.075	1.108	1.144	1.190	1.234	1.280	1.329
3	100.0	1.066	1.032	1.045	1.072	1.104	1.145	1.188	1.235	1.283	1.328
4	200.0	1.070	1.039	1.053	1.077	1.111	1.153	1.197	1.244	1.291	1.339
5	300.0	1.067	1.034	1.047	1.073	1.110	1.150	1.194	1.241	1.290	1.338
6	400.0	1.073	1.038	1.053	1.078	1.113	1.157	1.200	1.247	1.297	1.343
7	500.0	1.066	1.034	1.048	1.075	1.110	1.150	1.196	1.243	1.292	1.341
8	600.0	1.068	1.035	1.048	1.074	1.111	1.152	1.195	1.246	1.294	1.344
9	700.0	1.070	1.038	1.054	1.079	1.114	1.153	1.201	1.248	1.297	1.345
10	800.0	1.068	1.034	1.047	1.074	1.109	1.151	1.196	1.244	1.292	1.340
11	900.0	1.069	1.035	1.050	1.076	1.112	1.155	1.199	1.245	1.294	1.343
12	1000.0	1.071	1.038	1.054	1.079	1.116	1.155	1.201	1.248	1.296	1.344
13	1100.0	1.066	1.030	1.045	1.072	1.107	1.149	1.195	1.240	1.287	1.336
14	1200.0	1.069	1.038	1.050	1.077	1.114	1.153	1.197	1.245	1.290	1.336
15	1300.0	1.065	1.035	1.049	1.072	1.111	1.151	1.199	1.244	1.289	1.338
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.395	1.442	1.492	1.543	1.594	1.646	1.702	1.763	1.834	1.963
1	25.0	1.377	1.423	1.470	1.517	1.568	1.619	1.673	1.732	1.797	1.929
2	50.0	1.377	1.424	1.471	1.519	1.566	1.621	1.673	1.736	1.801	1.934
3	100.0	1.375	1.424	1.472	1.521	1.571	1.622	1.677	1.742	1.810	1.942
4	200.0	1.386	1.435	1.483	1.536	1.585	1.639	1.693	1.757	1.824	1.963
5	300.0	1.389	1.435	1.486	1.536	1.585	1.640	1.696	1.759	1.827	1.967
6	400.0	1.393	1.445	1.492	1.541	1.592	1.646	1.704	1.772	1.839	1.980
7	500.0	1.390	1.438	1.488	1.536	1.591	1.644	1.700	1.765	1.834	1.973
8	600.0	1.391	1.440	1.488	1.538	1.589	1.642	1.698	1.761	1.830	1.972
9	700.0	1.395	1.442	1.489	1.539	1.593	1.648	1.701	1.762	1.829	1.969
10	800.0	1.390	1.438	1.487	1.537	1.588	1.638	1.694	1.759	1.826	1.966
11	900.0	1.390	1.440	1.488	1.537	1.588	1.637	1.692	1.752	1.822	1.959
12	1000.0	1.389	1.438	1.485	1.533	1.580	1.633	1.687	1.747	1.815	1.953
13	1100.0	1.385	1.433	1.479	1.526	1.572	1.623	1.680	1.739	1.804	1.944
14	1200.0	1.388	1.433	1.480	1.527	1.574	1.626	1.677	1.736	1.802	1.935
15	1300.0	1.382	1.429	1.475	1.522	1.567	1.619	1.671	1.727	1.793	1.929

Table 6.32. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels E, F, G, H, J, K, L, and M in element 1.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	1.130	1.105	1.112	1.135	1.169	1.210	1.256	1.305	1.355	1.405
1	25.0	1.124	1.097	1.103	1.125	1.158	1.198	1.243	1.290	1.339	1.387
2	50.0	1.118	1.092	1.098	1.120	1.154	1.194	1.238	1.286	1.334	1.383
3	100.0	1.110	1.085	1.091	1.114	1.147	1.188	1.233	1.281	1.330	1.379
4	200.0	1.107	1.081	1.088	1.111	1.145	1.186	1.232	1.281	1.330	1.381
5	300.0	1.105	1.080	1.087	1.110	1.145	1.187	1.233	1.282	1.332	1.383
6	400.0	1.107	1.082	1.089	1.112	1.147	1.189	1.235	1.285	1.335	1.386
7	500.0	1.109	1.083	1.090	1.114	1.149	1.191	1.238	1.287	1.337	1.388
8	600.0	1.109	1.084	1.091	1.115	1.150	1.192	1.239	1.288	1.339	1.390
9	700.0	1.113	1.087	1.095	1.118	1.153	1.196	1.242	1.291	1.341	1.392
10	800.0	1.114	1.088	1.095	1.119	1.154	1.196	1.242	1.291	1.341	1.392
11	900.0	1.115	1.089	1.097	1.121	1.156	1.198	1.244	1.293	1.343	1.393
12	1000.0	1.116	1.091	1.098	1.122	1.156	1.198	1.244	1.293	1.342	1.392
13	1100.0	1.118	1.092	1.100	1.124	1.158	1.200	1.246	1.294	1.343	1.392
14	1200.0	1.116	1.091	1.098	1.121	1.156	1.197	1.243	1.291	1.339	1.388
15	1300.0	1.117	1.092	1.099	1.123	1.157	1.199	1.244	1.291	1.340	1.388

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	11	12	13	14	15	16	17	18	19	20
0	0.0	1.456	1.506	1.557	1.608	1.661	1.717	1.779	1.848	1.929	2.044
1	25.0	1.436	1.485	1.533	1.583	1.634	1.688	1.747	1.814	1.894	2.007
2	50.0	1.432	1.481	1.530	1.579	1.630	1.684	1.744	1.811	1.890	2.002
3	100.0	1.429	1.478	1.528	1.578	1.631	1.686	1.746	1.815	1.896	2.012
4	200.0	1.431	1.482	1.532	1.583	1.637	1.693	1.754	1.824	1.907	2.025
5	300.0	1.434	1.485	1.536	1.588	1.641	1.698	1.760	1.830	1.913	2.033
6	400.0	1.437	1.488	1.539	1.591	1.644	1.701	1.763	1.833	1.917	2.038
7	500.0	1.439	1.490	1.541	1.593	1.646	1.703	1.764	1.835	1.918	2.039
8	600.0	1.441	1.491	1.542	1.593	1.646	1.703	1.764	1.834	1.917	2.037
9	700.0	1.442	1.493	1.543	1.594	1.646	1.702	1.762	1.831	1.913	2.031
10	800.0	1.442	1.492	1.542	1.592	1.645	1.700	1.760	1.829	1.910	2.029
11	900.0	1.443	1.492	1.541	1.591	1.643	1.697	1.756	1.823	1.904	2.020
12	1000.0	1.441	1.490	1.539	1.589	1.640	1.693	1.752	1.819	1.899	2.016
13	1100.0	1.441	1.489	1.537	1.586	1.636	1.689	1.747	1.812	1.890	2.004
14	1200.0	1.436	1.484	1.532	1.580	1.629	1.682	1.739	1.804	1.882	1.995
15	1300.0	1.436	1.483	1.530	1.577	1.626	1.677	1.733	1.797	1.873	1.983

Table 6.33. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels E, F, G, H, J, K, L, and M in element 2.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	2.031	1.961	1.953	1.948	1.950	1.950	1.957	1.966	1.972	1.976
1	25.0	1.998	1.924	1.914	1.907	1.907	1.913	1.916	1.923	1.933	1.939
2	50.0	2.001	1.927	1.915	1.911	1.911	1.915	1.922	1.928	1.934	1.943
3	100.0	2.014	1.939	1.927	1.923	1.926	1.927	1.936	1.942	1.947	1.955
4	200.0	2.033	1.957	1.944	1.937	1.940	1.945	1.953	1.958	1.966	1.972
5	300.0	2.037	1.958	1.949	1.948	1.947	1.950	1.955	1.966	1.972	1.976
6	400.0	2.052	1.971	1.956	1.952	1.955	1.961	1.965	1.974	1.978	1.987
7	500.0	2.044	1.963	1.954	1.949	1.952	1.956	1.959	1.971	1.979	1.986
8	600.0	2.043	1.961	1.950	1.947	1.946	1.952	1.956	1.965	1.972	1.980
9	700.0	2.041	1.961	1.950	1.946	1.942	1.952	1.955	1.964	1.971	1.978
10	800.0	2.033	1.954	1.938	1.938	1.942	1.942	1.949	1.958	1.965	1.973
11	900.0	2.025	1.945	1.937	1.930	1.929	1.932	1.941	1.945	1.957	1.964
12	1000.0	2.020	1.939	1.925	1.922	1.921	1.928	1.935	1.943	1.950	1.955
13	1100.0	2.007	1.928	1.918	1.911	1.912	1.918	1.927	1.935	1.938	1.947
14	1200.0	2.000	1.923	1.913	1.908	1.907	1.910	1.916	1.926	1.934	1.940
15	1300.0	1.992	1.911	1.902	1.895	1.899	1.901	1.908	1.916	1.922	1.927

		11	12	13	14	15	16	17	18	19	20
0	0.0	1.985	1.990	1.998	2.005	2.011	2.017	2.030	2.049	2.072	2.163
1	25.0	1.947	1.948	1.952	1.960	1.970	1.980	1.993	2.011	2.038	2.129
2	50.0	1.946	1.958	1.961	1.968	1.974	1.982	1.992	2.019	2.041	2.135
3	100.0	1.962	1.969	1.974	1.983	1.990	1.998	2.011	2.032	2.054	2.149
4	200.0	1.979	1.985	1.989	1.997	2.002	2.013	2.023	2.045	2.069	2.166
5	300.0	1.983	1.990	1.994	2.003	2.010	2.017	2.033	2.051	2.077	2.176
6	400.0	1.993	1.999	2.004	2.008	2.014	2.025	2.035	2.052	2.078	2.175
7	500.0	1.992	1.999	2.005	2.012	2.015	2.023	2.037	2.054	2.080	2.184
8	600.0	1.986	1.991	1.995	2.003	2.011	2.021	2.031	2.050	2.076	2.176
9	700.0	1.985	1.988	1.993	2.002	2.006	2.016	2.025	2.046	2.073	2.175
10	800.0	1.981	1.984	1.991	1.993	2.000	2.011	2.021	2.037	2.066	2.168
11	900.0	1.972	1.975	1.981	1.985	1.990	2.000	2.016	2.030	2.057	2.156
12	1000.0	1.962	1.963	1.968	1.977	1.984	1.991	2.003	2.021	2.047	2.145
13	1100.0	1.950	1.957	1.962	1.969	1.975	1.984	1.999	2.016	2.041	2.140
14	1200.0	1.948	1.951	1.957	1.963	1.969	1.976	1.989	2.006	2.031	2.129
15	1300.0	1.933	1.939	1.944	1.949	1.959	1.964	1.980	1.993	2.021	2.121

Table 6.34. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels E, F, G, H, J, K, L, and M in element 2.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	2.116	2.059	2.036	2.025	2.022	2.023	2.027	2.032	2.038	2.043
1	25.0	2.075	2.018	1.995	1.983	1.980	1.981	1.984	1.990	1.995	2.000
2	50.0	2.071	2.016	1.993	1.983	1.980	1.981	1.986	1.991	1.997	2.003
3	100.0	2.082	2.025	2.001	1.991	1.987	1.989	1.994	1.999	2.005	2.011
4	200.0	2.098	2.039	2.016	2.005	2.003	2.005	2.010	2.016	2.022	2.028
5	300.0	2.107	2.047	2.024	2.013	2.010	2.013	2.018	2.024	2.030	2.036
6	400.0	2.111	2.051	2.027	2.016	2.014	2.016	2.021	2.027	2.034	2.040
7	500.0	2.112	2.051	2.027	2.016	2.013	2.015	2.020	2.026	2.033	2.039
8	600.0	2.109	2.048	2.024	2.013	2.010	2.012	2.017	2.023	2.029	2.035
9	700.0	2.102	2.042	2.019	2.008	2.006	2.008	2.013	2.019	2.025	2.031
10	800.0	2.099	2.038	2.013	2.002	1.999	2.001	2.005	2.011	2.017	2.023
11	900.0	2.088	2.029	2.005	1.994	1.992	1.994	1.998	2.004	2.010	2.016
12	1000.0	2.083	2.022	1.998	1.986	1.983	1.984	1.989	1.994	2.000	2.006
13	1100.0	2.070	2.011	1.988	1.977	1.974	1.975	1.980	1.985	1.991	1.997
14	1200.0	2.059	1.999	1.975	1.963	1.960	1.961	1.965	1.971	1.977	1.982
15	1300.0	2.046	1.988	1.965	1.954	1.951	1.953	1.957	1.962	1.968	1.974
		11	12	13	14	15	16	17	18	19	20
0	0.0	2.048	2.051	2.055	2.059	2.064	2.072	2.086	2.107	2.141	2.210
1	25.0	2.005	2.009	2.013	2.018	2.024	2.033	2.047	2.069	2.104	2.175
2	50.0	2.008	2.012	2.016	2.021	2.027	2.035	2.049	2.071	2.106	2.175
3	100.0	2.016	2.021	2.025	2.030	2.036	2.045	2.059	2.082	2.118	2.190
4	200.0	2.034	2.038	2.043	2.047	2.053	2.062	2.076	2.099	2.135	2.209
5	300.0	2.042	2.046	2.051	2.055	2.061	2.070	2.084	2.107	2.143	2.218
6	400.0	2.045	2.049	2.054	2.058	2.064	2.073	2.087	2.110	2.146	2.222
7	500.0	2.044	2.048	2.053	2.057	2.063	2.072	2.086	2.109	2.145	2.221
8	600.0	2.040	2.045	2.049	2.053	2.059	2.068	2.082	2.105	2.142	2.218
9	700.0	2.036	2.041	2.045	2.049	2.054	2.063	2.077	2.099	2.135	2.209
10	800.0	2.028	2.032	2.036	2.041	2.047	2.056	2.070	2.093	2.129	2.205
11	900.0	2.021	2.025	2.029	2.033	2.039	2.048	2.061	2.084	2.119	2.193
12	1000.0	2.011	2.015	2.019	2.023	2.029	2.038	2.052	2.075	2.112	2.187
13	1100.0	2.002	2.006	2.010	2.014	2.020	2.029	2.042	2.065	2.100	2.173
14	1200.0	1.987	1.991	1.995	2.000	2.006	2.015	2.030	2.052	2.089	2.163
15	1300.0	1.978	1.983	1.987	1.991	1.997	2.006	2.020	2.042	2.078	2.150

Table 6.35. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels E, F, G, H, J, K, L, and M in element 3.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	2.118	1.991	1.933	1.881	1.832	1.789	1.748	1.710	1.668	1.628
1	25.0	2.091	1.968	1.908	1.854	1.809	1.769	1.731	1.695	1.658	1.615
2	50.0	2.096	1.970	1.909	1.859	1.810	1.773	1.732	1.694	1.656	1.617
3	100.0	2.107	1.979	1.919	1.870	1.822	1.780	1.739	1.699	1.662	1.624
4	200.0	2.124	1.993	1.929	1.877	1.829	1.786	1.745	1.707	1.669	1.627
5	300.0	2.134	1.999	1.938	1.884	1.835	1.791	1.753	1.713	1.672	1.633
6	400.0	2.135	1.999	1.934	1.884	1.834	1.793	1.749	1.710	1.668	1.631
7	500.0	2.143	2.004	1.941	1.886	1.841	1.797	1.755	1.716	1.677	1.637
8	600.0	2.133	1.999	1.940	1.885	1.841	1.795	1.756	1.716	1.673	1.636
9	700.0	2.129	1.993	1.933	1.880	1.837	1.793	1.750	1.713	1.673	1.634
10	800.0	2.130	1.992	1.933	1.881	1.830	1.790	1.753	1.716	1.674	1.636
11	900.0	2.117	1.984	1.926	1.873	1.831	1.791	1.751	1.711	1.675	1.635
12	1000.0	2.109	1.974	1.919	1.870	1.824	1.785	1.745	1.710	1.673	1.635
13	1100.0	2.104	1.973	1.913	1.866	1.824	1.787	1.745	1.709	1.673	1.639
14	1200.0	2.095	1.967	1.910	1.858	1.819	1.779	1.741	1.706	1.670	1.635
15	1300.0	2.082	1.958	1.901	1.851	1.810	1.773	1.735	1.702	1.666	1.633
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.590	1.548	1.510	1.471	1.428	1.389	1.348	1.316	1.286	1.293
1	25.0	1.582	1.544	1.505	1.466	1.428	1.392	1.357	1.324	1.296	1.306
2	50.0	1.580	1.542	1.504	1.469	1.429	1.389	1.354	1.321	1.293	1.306
3	100.0	1.584	1.544	1.505	1.465	1.427	1.389	1.352	1.321	1.292	1.300
4	200.0	1.587	1.547	1.508	1.466	1.426	1.385	1.350	1.317	1.287	1.297
5	300.0	1.591	1.551	1.512	1.471	1.430	1.389	1.350	1.315	1.285	1.297
6	400.0	1.591	1.547	1.506	1.464	1.424	1.384	1.347	1.314	1.284	1.295
7	500.0	1.597	1.556	1.516	1.471	1.432	1.391	1.353	1.319	1.290	1.299
8	600.0	1.599	1.557	1.516	1.477	1.433	1.394	1.355	1.319	1.292	1.303
9	700.0	1.594	1.553	1.514	1.473	1.434	1.392	1.352	1.319	1.292	1.304
10	800.0	1.601	1.560	1.516	1.476	1.436	1.397	1.362	1.326	1.296	1.312
11	900.0	1.597	1.559	1.520	1.478	1.439	1.402	1.365	1.329	1.301	1.318
12	1000.0	1.598	1.560	1.522	1.481	1.440	1.399	1.365	1.334	1.306	1.318
13	1100.0	1.600	1.561	1.525	1.486	1.445	1.409	1.373	1.341	1.315	1.328
14	1200.0	1.596	1.560	1.522	1.482	1.442	1.406	1.371	1.337	1.312	1.329
15	1300.0	1.597	1.560	1.523	1.487	1.448	1.410	1.375	1.342	1.316	1.335

Table 6.36. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels E, F, G, H, J, K, L, and M in element 3.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	2.159	2.048	1.972	1.910	1.855	1.806	1.760	1.716	1.673	1.629
1	25.0	2.129	2.020	1.947	1.887	1.835	1.789	1.746	1.704	1.663	1.623
2	50.0	2.129	2.021	1.948	1.888	1.837	1.790	1.747	1.706	1.665	1.624
3	100.0	2.143	2.031	1.957	1.895	1.843	1.795	1.751	1.709	1.667	1.625
4	200.0	2.160	2.046	1.970	1.907	1.853	1.805	1.760	1.716	1.674	1.631
5	300.0	2.169	2.053	1.976	1.913	1.859	1.810	1.764	1.720	1.677	1.634
6	400.0	2.172	2.056	1.979	1.915	1.861	1.812	1.767	1.723	1.680	1.636
7	500.0	2.172	2.056	1.979	1.916	1.862	1.813	1.768	1.724	1.681	1.638
8	600.0	2.169	2.053	1.977	1.914	1.861	1.813	1.768	1.725	1.682	1.639
9	700.0	2.161	2.048	1.973	1.912	1.859	1.812	1.768	1.725	1.683	1.641
10	800.0	2.159	2.045	1.970	1.908	1.856	1.809	1.766	1.724	1.682	1.640
11	900.0	2.148	2.037	1.964	1.904	1.853	1.807	1.765	1.723	1.683	1.642
12	1000.0	2.143	2.032	1.959	1.899	1.849	1.804	1.762	1.721	1.681	1.641
13	1100.0	2.131	2.022	1.951	1.894	1.845	1.801	1.760	1.720	1.681	1.642
14	1200.0	2.123	2.014	1.944	1.887	1.839	1.796	1.756	1.717	1.679	1.640
15	1300.0	2.110	2.005	1.937	1.882	1.835	1.793	1.754	1.716	1.678	1.641
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.585	1.541	1.496	1.451	1.406	1.363	1.322	1.286	1.256	1.247
1	25.0	1.581	1.539	1.497	1.455	1.412	1.372	1.333	1.300	1.273	1.267
2	50.0	1.583	1.540	1.498	1.455	1.413	1.372	1.333	1.299	1.272	1.264
3	100.0	1.583	1.541	1.497	1.454	1.411	1.370	1.331	1.296	1.269	1.263
4	200.0	1.588	1.544	1.499	1.455	1.411	1.369	1.329	1.293	1.265	1.258
5	300.0	1.590	1.546	1.501	1.456	1.412	1.369	1.328	1.293	1.265	1.257
6	400.0	1.593	1.548	1.503	1.458	1.414	1.370	1.330	1.294	1.266	1.258
7	500.0	1.594	1.550	1.505	1.460	1.416	1.373	1.332	1.296	1.268	1.261
8	600.0	1.596	1.552	1.507	1.463	1.418	1.375	1.335	1.299	1.271	1.265
9	700.0	1.598	1.555	1.510	1.466	1.422	1.379	1.338	1.303	1.275	1.268
10	800.0	1.598	1.555	1.511	1.467	1.424	1.382	1.342	1.307	1.280	1.275
11	900.0	1.600	1.558	1.514	1.471	1.428	1.386	1.346	1.311	1.284	1.278
12	1000.0	1.600	1.558	1.516	1.473	1.430	1.389	1.350	1.316	1.290	1.286
13	1100.0	1.601	1.560	1.518	1.476	1.434	1.393	1.355	1.321	1.295	1.291
14	1200.0	1.601	1.561	1.520	1.479	1.438	1.398	1.360	1.328	1.303	1.301
15	1300.0	1.602	1.563	1.522	1.482	1.441	1.402	1.365	1.332	1.308	1.305

Table 6.37. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels E, F, G, H, J, K, L, and M in element 4.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	1.170	1.062	0.993	0.932	0.877	0.830	0.784	0.742	0.707	0.672
1	25.0	1.188	1.079	1.013	0.953	0.899	0.851	0.808	0.768	0.731	0.696
2	50.0	1.186	1.075	1.009	0.949	0.895	0.849	0.804	0.765	0.730	0.693
3	100.0	1.180	1.068	1.001	0.942	0.889	0.840	0.797	0.755	0.718	0.686
4	200.0	1.173	1.060	0.993	0.932	0.878	0.831	0.787	0.743	0.708	0.673
5	300.0	1.173	1.060	0.993	0.931	0.878	0.827	0.784	0.742	0.705	0.669
6	400.0	1.169	1.057	0.989	0.927	0.871	0.823	0.777	0.739	0.700	0.665
7	500.0	1.175	1.061	0.993	0.929	0.878	0.828	0.783	0.741	0.703	0.667
8	600.0	1.182	1.066	0.997	0.933	0.881	0.832	0.786	0.746	0.708	0.672
9	700.0	1.180	1.064	0.996	0.935	0.879	0.831	0.786	0.747	0.708	0.672
10	800.0	1.187	1.072	1.002	0.940	0.886	0.837	0.792	0.752	0.714	0.677
11	900.0	1.194	1.075	1.008	0.949	0.894	0.844	0.799	0.758	0.719	0.684
12	1000.0	1.196	1.081	1.015	0.953	0.899	0.849	0.806	0.764	0.727	0.692
13	1100.0	1.206	1.091	1.022	0.962	0.905	0.857	0.813	0.772	0.733	0.698
14	1200.0	1.209	1.092	1.026	0.966	0.909	0.862	0.817	0.774	0.739	0.702
15	1300.0	1.217	1.101	1.031	0.970	0.917	0.868	0.824	0.785	0.746	0.712
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.638	0.607	0.578	0.551	0.527	0.504	0.485	0.466	0.453	0.451
1	25.0	0.666	0.635	0.607	0.581	0.557	0.535	0.513	0.498	0.484	0.485
2	50.0	0.664	0.632	0.603	0.575	0.553	0.532	0.512	0.496	0.484	0.483
3	100.0	0.653	0.623	0.596	0.571	0.545	0.524	0.504	0.487	0.472	0.474
4	200.0	0.641	0.611	0.582	0.556	0.531	0.508	0.489	0.471	0.457	0.458
5	300.0	0.638	0.604	0.578	0.551	0.528	0.504	0.483	0.466	0.452	0.453
6	400.0	0.632	0.603	0.573	0.546	0.521	0.499	0.479	0.461	0.448	0.448
7	500.0	0.634	0.603	0.575	0.547	0.523	0.501	0.481	0.463	0.449	0.448
8	600.0	0.639	0.609	0.580	0.552	0.527	0.505	0.482	0.465	0.452	0.450
9	700.0	0.639	0.609	0.580	0.555	0.529	0.506	0.483	0.467	0.453	0.452
10	800.0	0.643	0.613	0.585	0.557	0.531	0.508	0.489	0.473	0.456	0.455
11	900.0	0.653	0.622	0.590	0.564	0.538	0.517	0.496	0.477	0.462	0.463
12	1000.0	0.658	0.626	0.597	0.571	0.545	0.522	0.501	0.484	0.467	0.469
13	1100.0	0.664	0.634	0.603	0.577	0.551	0.527	0.507	0.489	0.476	0.475
14	1200.0	0.669	0.638	0.608	0.581	0.556	0.534	0.512	0.493	0.480	0.479
15	1300.0	0.679	0.648	0.616	0.591	0.564	0.540	0.519	0.504	0.487	0.488

Table 6.38. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels E, F, G, H, J, K, L, and M in element 4.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	1.113	1.014	0.938	0.872	0.815	0.764	0.718	0.676	0.638	0.603
1	25.0	1.137	1.039	0.964	0.899	0.843	0.793	0.748	0.707	0.669	0.634
2	50.0	1.135	1.037	0.962	0.898	0.842	0.792	0.747	0.706	0.669	0.634
3	100.0	1.132	1.033	0.958	0.893	0.837	0.786	0.741	0.700	0.663	0.628
4	200.0	1.126	1.026	0.950	0.884	0.827	0.777	0.731	0.690	0.652	0.617
5	300.0	1.124	1.023	0.946	0.881	0.823	0.772	0.727	0.685	0.647	0.611
6	400.0	1.124	1.023	0.946	0.880	0.822	0.771	0.725	0.683	0.645	0.609
7	500.0	1.127	1.025	0.948	0.882	0.824	0.772	0.726	0.684	0.645	0.610
8	600.0	1.131	1.029	0.951	0.885	0.827	0.775	0.729	0.687	0.648	0.612
9	700.0	1.134	1.032	0.955	0.889	0.831	0.779	0.733	0.691	0.652	0.616
10	800.0	1.141	1.038	0.961	0.894	0.836	0.784	0.738	0.696	0.657	0.621
11	900.0	1.146	1.044	0.966	0.900	0.842	0.791	0.744	0.702	0.663	0.627
12	1000.0	1.154	1.051	0.974	0.907	0.849	0.797	0.751	0.708	0.669	0.633
13	1100.0	1.160	1.058	0.980	0.914	0.856	0.805	0.758	0.716	0.677	0.641
14	1200.0	1.171	1.068	0.991	0.924	0.866	0.815	0.768	0.726	0.687	0.651
15	1300.0	1.176	1.074	0.997	0.931	0.873	0.822	0.776	0.734	0.695	0.658
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.570	0.539	0.510	0.484	0.459	0.437	0.417	0.400	0.387	0.381
1	25.0	0.601	0.571	0.543	0.516	0.492	0.470	0.451	0.434	0.422	0.417
2	50.0	0.602	0.571	0.543	0.517	0.493	0.471	0.451	0.435	0.422	0.417
3	100.0	0.595	0.565	0.537	0.511	0.487	0.465	0.446	0.429	0.417	0.412
4	200.0	0.584	0.554	0.525	0.499	0.475	0.453	0.433	0.417	0.404	0.399
5	300.0	0.578	0.548	0.519	0.493	0.468	0.446	0.427	0.410	0.397	0.392
6	400.0	0.576	0.545	0.517	0.490	0.465	0.443	0.423	0.406	0.393	0.388
7	500.0	0.576	0.545	0.517	0.490	0.465	0.443	0.423	0.406	0.393	0.387
8	600.0	0.579	0.548	0.519	0.492	0.467	0.444	0.424	0.407	0.394	0.388
9	700.0	0.582	0.551	0.522	0.495	0.470	0.447	0.427	0.409	0.396	0.390
10	800.0	0.587	0.555	0.526	0.499	0.474	0.451	0.430	0.413	0.400	0.394
11	900.0	0.593	0.561	0.532	0.504	0.479	0.456	0.436	0.418	0.404	0.399
12	1000.0	0.599	0.568	0.538	0.510	0.485	0.462	0.441	0.424	0.410	0.405
13	1100.0	0.607	0.575	0.545	0.518	0.492	0.469	0.448	0.430	0.417	0.411
14	1200.0	0.617	0.585	0.555	0.527	0.502	0.478	0.458	0.440	0.427	0.422
15	1300.0	0.624	0.592	0.562	0.535	0.509	0.485	0.464	0.447	0.433	0.428

Table 6.39. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels E, F, G, H, J, K, L, and M in element 5.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.405	0.366	0.344	0.322	0.303	0.286	0.271	0.256	0.243	0.231
1	25.0	0.439	0.398	0.373	0.352	0.333	0.316	0.298	0.284	0.271	0.259
2	50.0	0.436	0.397	0.372	0.352	0.331	0.314	0.297	0.283	0.270	0.256
3	100.0	0.428	0.388	0.363	0.343	0.323	0.306	0.290	0.275	0.262	0.248
4	200.0	0.414	0.374	0.350	0.328	0.310	0.292	0.277	0.262	0.249	0.237
5	300.0	0.407	0.367	0.344	0.323	0.303	0.287	0.272	0.257	0.244	0.232
6	400.0	0.400	0.361	0.339	0.318	0.299	0.283	0.267	0.252	0.239	0.228
7	500.0	0.401	0.362	0.339	0.317	0.298	0.281	0.267	0.251	0.238	0.227
8	600.0	0.403	0.363	0.340	0.319	0.299	0.282	0.267	0.253	0.239	0.227
9	700.0	0.406	0.365	0.341	0.321	0.301	0.283	0.267	0.254	0.241	0.228
10	800.0	0.409	0.369	0.345	0.324	0.303	0.287	0.270	0.256	0.242	0.230
11	900.0	0.415	0.374	0.349	0.326	0.308	0.291	0.275	0.260	0.246	0.233
12	1000.0	0.421	0.379	0.355	0.333	0.312	0.295	0.279	0.265	0.251	0.238
13	1100.0	0.427	0.385	0.360	0.337	0.317	0.300	0.284	0.269	0.254	0.241
14	1200.0	0.433	0.388	0.364	0.342	0.321	0.303	0.288	0.271	0.258	0.244
15	1300.0	0.442	0.398	0.372	0.349	0.328	0.312	0.293	0.278	0.264	0.252
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.218	0.208	0.197	0.188	0.179	0.171	0.164	0.157	0.152	0.151
1	25.0	0.247	0.235	0.225	0.215	0.206	0.196	0.190	0.182	0.177	0.176
2	50.0	0.245	0.234	0.223	0.214	0.204	0.196	0.187	0.182	0.175	0.176
3	100.0	0.238	0.226	0.215	0.206	0.197	0.188	0.182	0.176	0.169	0.169
4	200.0	0.225	0.214	0.204	0.194	0.185	0.179	0.171	0.164	0.159	0.158
5	300.0	0.221	0.209	0.200	0.190	0.182	0.173	0.166	0.160	0.156	0.153
6	400.0	0.215	0.205	0.194	0.186	0.178	0.170	0.162	0.156	0.151	0.149
7	500.0	0.215	0.204	0.194	0.185	0.176	0.168	0.161	0.155	0.148	0.149
8	600.0	0.216	0.205	0.194	0.186	0.177	0.167	0.161	0.154	0.149	0.148
9	700.0	0.217	0.205	0.195	0.185	0.177	0.169	0.162	0.156	0.150	0.150
10	800.0	0.218	0.207	0.197	0.188	0.179	0.171	0.163	0.157	0.152	0.151
11	900.0	0.222	0.211	0.200	0.190	0.182	0.173	0.166	0.160	0.154	0.154
12	1000.0	0.227	0.214	0.204	0.193	0.185	0.177	0.168	0.162	0.156	0.155
13	1100.0	0.227	0.218	0.207	0.197	0.188	0.178	0.171	0.165	0.159	0.158
14	1200.0	0.233	0.222	0.210	0.200	0.190	0.183	0.174	0.168	0.163	0.161
15	1300.0	0.238	0.227	0.215	0.205	0.196	0.186	0.179	0.171	0.168	0.165

Table 6.40. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels E, F, G, H, J, K, L, and M in element 5.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.337	0.307	0.284	0.264	0.246	0.230	0.216	0.204	0.192	0.181
1	25.0	0.372	0.339	0.315	0.294	0.276	0.259	0.244	0.231	0.219	0.207
2	50.0	0.372	0.340	0.316	0.295	0.277	0.261	0.246	0.233	0.220	0.209
3	100.0	0.368	0.336	0.312	0.291	0.273	0.257	0.242	0.229	0.217	0.205
4	200.0	0.355	0.324	0.300	0.279	0.262	0.246	0.232	0.219	0.207	0.196
5	300.0	0.348	0.317	0.293	0.273	0.255	0.240	0.225	0.213	0.201	0.190
6	400.0	0.344	0.313	0.289	0.269	0.251	0.236	0.221	0.209	0.197	0.186
7	500.0	0.342	0.311	0.288	0.267	0.250	0.234	0.220	0.207	0.195	0.184
8	600.0	0.343	0.312	0.288	0.268	0.250	0.234	0.220	0.207	0.195	0.184
9	700.0	0.345	0.313	0.289	0.269	0.251	0.235	0.221	0.208	0.196	0.185
10	800.0	0.349	0.317	0.292	0.272	0.253	0.237	0.223	0.210	0.197	0.186
11	900.0	0.352	0.320	0.296	0.275	0.257	0.240	0.226	0.212	0.200	0.189
12	1000.0	0.358	0.326	0.301	0.280	0.261	0.244	0.230	0.216	0.203	0.192
13	1100.0	0.364	0.331	0.306	0.285	0.266	0.249	0.234	0.220	0.208	0.196
14	1200.0	0.374	0.340	0.315	0.293	0.273	0.256	0.241	0.227	0.214	0.202
15	1300.0	0.380	0.346	0.320	0.298	0.278	0.261	0.246	0.231	0.218	0.206
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.171	0.161	0.153	0.144	0.137	0.130	0.124	0.119	0.114	0.112
1	25.0	0.196	0.186	0.177	0.168	0.160	0.152	0.145	0.140	0.135	0.133
2	50.0	0.198	0.188	0.178	0.170	0.161	0.154	0.147	0.142	0.137	0.135
3	100.0	0.195	0.185	0.176	0.167	0.159	0.152	0.145	0.140	0.135	0.133
4	200.0	0.185	0.176	0.167	0.158	0.150	0.143	0.137	0.132	0.127	0.126
5	300.0	0.179	0.170	0.161	0.153	0.145	0.138	0.132	0.127	0.122	0.120
6	400.0	0.176	0.166	0.157	0.149	0.141	0.135	0.128	0.123	0.119	0.117
7	500.0	0.174	0.164	0.155	0.147	0.140	0.133	0.126	0.121	0.117	0.115
8	600.0	0.174	0.164	0.155	0.147	0.139	0.132	0.126	0.121	0.116	0.114
9	700.0	0.174	0.165	0.156	0.147	0.139	0.132	0.126	0.121	0.116	0.114
10	800.0	0.176	0.166	0.157	0.148	0.141	0.133	0.127	0.122	0.117	0.115
11	900.0	0.178	0.168	0.159	0.150	0.143	0.135	0.129	0.123	0.119	0.117
12	1000.0	0.181	0.171	0.162	0.153	0.145	0.138	0.131	0.125	0.121	0.119
13	1100.0	0.185	0.175	0.165	0.156	0.148	0.141	0.134	0.128	0.124	0.121
14	1200.0	0.191	0.181	0.171	0.162	0.153	0.146	0.139	0.133	0.128	0.126
15	1300.0	0.195	0.184	0.174	0.165	0.157	0.149	0.142	0.136	0.131	0.129

Table 6.41. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels E, F, G, H, J, K, L, and M in element 6.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Power Peaking Factors 1	2	3	4	5	6	7	8	9	10
0	0.0	0.135	0.121	0.113	0.105	0.099	0.092	0.086	0.081	0.076	0.071
1	25.0	0.159	0.143	0.134	0.125	0.118	0.110	0.104	0.098	0.091	0.086
2	50.0	0.158	0.142	0.133	0.125	0.116	0.110	0.103	0.097	0.092	0.086
3	100.0	0.152	0.137	0.127	0.120	0.112	0.105	0.099	0.093	0.088	0.082
4	200.0	0.141	0.128	0.120	0.111	0.105	0.098	0.092	0.086	0.081	0.076
5	300.0	0.138	0.124	0.115	0.107	0.100	0.095	0.089	0.083	0.078	0.073
6	400.0	0.133	0.120	0.112	0.104	0.097	0.090	0.085	0.080	0.075	0.070
7	500.0	0.132	0.119	0.111	0.103	0.096	0.090	0.084	0.079	0.075	0.070
8	600.0	0.132	0.118	0.110	0.103	0.096	0.090	0.084	0.079	0.074	0.069
9	700.0	0.132	0.119	0.110	0.103	0.097	0.091	0.085	0.079	0.074	0.070
10	800.0	0.134	0.120	0.113	0.104	0.097	0.091	0.085	0.080	0.075	0.071
11	900.0	0.136	0.122	0.113	0.106	0.098	0.093	0.086	0.081	0.076	0.071
12	1000.0	0.139	0.124	0.115	0.107	0.101	0.094	0.088	0.083	0.077	0.073
13	1100.0	0.140	0.126	0.117	0.109	0.103	0.096	0.090	0.084	0.079	0.074
14	1200.0	0.144	0.129	0.120	0.112	0.105	0.098	0.092	0.086	0.081	0.075
15	1300.0	0.148	0.132	0.123	0.115	0.107	0.101	0.094	0.089	0.084	0.078

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	11	12	13	14	15	16	17	18	19	20
0	0.0	0.067	0.063	0.059	0.055	0.051	0.049	0.046	0.043	0.041	0.041
1	25.0	0.081	0.076	0.071	0.067	0.062	0.059	0.056	0.053	0.050	0.051
2	50.0	0.081	0.076	0.071	0.067	0.063	0.059	0.055	0.053	0.051	0.050
3	100.0	0.077	0.072	0.067	0.064	0.060	0.056	0.053	0.050	0.048	0.048
4	200.0	0.071	0.067	0.063	0.059	0.055	0.052	0.049	0.046	0.044	0.044
5	300.0	0.068	0.065	0.060	0.057	0.053	0.050	0.047	0.044	0.043	0.043
6	400.0	0.067	0.062	0.058	0.054	0.051	0.048	0.045	0.042	0.041	0.041
7	500.0	0.066	0.061	0.057	0.053	0.050	0.047	0.044	0.042	0.040	0.040
8	600.0	0.065	0.061	0.057	0.053	0.050	0.047	0.044	0.042	0.041	0.040
9	700.0	0.066	0.061	0.058	0.054	0.050	0.047	0.044	0.042	0.040	0.040
10	800.0	0.066	0.062	0.058	0.054	0.051	0.048	0.045	0.042	0.040	0.040
11	900.0	0.067	0.062	0.058	0.054	0.051	0.048	0.045	0.043	0.041	0.041
12	1000.0	0.068	0.064	0.059	0.056	0.052	0.049	0.046	0.044	0.042	0.042
13	1100.0	0.069	0.065	0.061	0.057	0.053	0.050	0.047	0.044	0.043	0.042
14	1200.0	0.071	0.066	0.063	0.058	0.055	0.051	0.048	0.046	0.043	0.043
15	1300.0	0.073	0.068	0.064	0.060	0.056	0.052	0.050	0.047	0.045	0.045

Table 6.42. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels E, F, G, H, J, K, L, and M in element 6.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Power Peaking Factors 1	2	3	4	5	6	7	8	9	10
0	0.0	0.099	0.089	0.082	0.076	0.071	0.066	0.061	0.057	0.053	0.050
1	25.0	0.118	0.107	0.099	0.092	0.085	0.080	0.075	0.070	0.065	0.061
2	50.0	0.120	0.109	0.101	0.093	0.087	0.081	0.076	0.071	0.067	0.063
3	100.0	0.118	0.107	0.099	0.092	0.086	0.080	0.075	0.070	0.066	0.062
4	200.0	0.111	0.101	0.093	0.086	0.080	0.075	0.070	0.066	0.062	0.058
5	300.0	0.106	0.097	0.089	0.083	0.077	0.072	0.067	0.063	0.059	0.055
6	400.0	0.103	0.093	0.086	0.080	0.074	0.069	0.064	0.060	0.056	0.053
7	500.0	0.101	0.092	0.084	0.078	0.073	0.068	0.063	0.059	0.055	0.051
8	600.0	0.100	0.091	0.084	0.077	0.072	0.067	0.062	0.058	0.054	0.051
9	700.0	0.100	0.091	0.084	0.077	0.072	0.067	0.062	0.058	0.054	0.051
10	800.0	0.101	0.092	0.084	0.078	0.072	0.067	0.063	0.058	0.055	0.051
11	900.0	0.102	0.093	0.085	0.079	0.073	0.068	0.063	0.059	0.055	0.052
12	1000.0	0.104	0.094	0.087	0.080	0.074	0.069	0.065	0.060	0.056	0.052
13	1100.0	0.106	0.096	0.089	0.082	0.076	0.071	0.066	0.062	0.057	0.054
14	1200.0	0.111	0.100	0.092	0.085	0.079	0.074	0.069	0.064	0.060	0.056
15	1300.0	0.113	0.102	0.094	0.087	0.081	0.075	0.070	0.066	0.061	0.057
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.046	0.043	0.040	0.038	0.035	0.033	0.031	0.029	0.028	0.028
1	25.0	0.057	0.054	0.050	0.047	0.044	0.041	0.038	0.037	0.035	0.035
2	50.0	0.059	0.055	0.051	0.048	0.045	0.042	0.040	0.038	0.036	0.036
3	100.0	0.058	0.054	0.051	0.047	0.044	0.042	0.039	0.037	0.036	0.035
4	200.0	0.054	0.050	0.047	0.044	0.041	0.039	0.036	0.034	0.033	0.033
5	300.0	0.051	0.048	0.045	0.042	0.039	0.037	0.034	0.033	0.031	0.031
6	400.0	0.049	0.046	0.043	0.040	0.037	0.035	0.033	0.031	0.030	0.030
7	500.0	0.048	0.045	0.042	0.039	0.036	0.034	0.032	0.030	0.029	0.029
8	600.0	0.047	0.044	0.041	0.039	0.036	0.034	0.032	0.030	0.029	0.028
9	700.0	0.047	0.044	0.041	0.038	0.036	0.033	0.031	0.030	0.029	0.028
10	800.0	0.048	0.044	0.041	0.039	0.036	0.034	0.032	0.030	0.029	0.028
11	900.0	0.048	0.045	0.042	0.039	0.036	0.034	0.032	0.030	0.029	0.029
12	1000.0	0.049	0.046	0.043	0.040	0.037	0.035	0.032	0.031	0.030	0.029
13	1100.0	0.050	0.047	0.044	0.041	0.038	0.035	0.033	0.031	0.030	0.030
14	1200.0	0.052	0.049	0.045	0.042	0.040	0.037	0.035	0.033	0.032	0.031
15	1300.0	0.053	0.050	0.047	0.043	0.040	0.038	0.036	0.034	0.032	0.032

Fuel Channels P, Q, R, and S

Table 6.43. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels P, Q, R, and S in element 1.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Power Peaking Factors 1	2	3	4	5	6	7	8	9	10
0	0.0	1.077	1.046	1.063	1.085	1.120	1.160	1.202	1.252	1.299	1.344
1	25.0	1.070	1.038	1.052	1.077	1.110	1.146	1.188	1.236	1.279	1.330
2	50.0	1.072	1.035	1.049	1.075	1.109	1.149	1.191	1.236	1.284	1.332
3	100.0	1.064	1.034	1.046	1.073	1.106	1.147	1.190	1.234	1.283	1.330
4	200.0	1.076	1.038	1.052	1.077	1.113	1.150	1.200	1.244	1.296	1.340
5	300.0	1.067	1.036	1.047	1.077	1.110	1.151	1.198	1.246	1.289	1.341
6	400.0	1.072	1.041	1.055	1.082	1.116	1.161	1.204	1.250	1.299	1.347
7	500.0	1.067	1.031	1.044	1.069	1.107	1.152	1.199	1.243	1.292	1.339
8	600.0	1.069	1.035	1.050	1.079	1.113	1.154	1.201	1.245	1.298	1.341
9	700.0	1.073	1.040	1.055	1.079	1.118	1.159	1.204	1.250	1.300	1.348
10	800.0	1.066	1.033	1.049	1.073	1.111	1.153	1.200	1.247	1.294	1.346
11	900.0	1.071	1.039	1.052	1.078	1.115	1.157	1.202	1.247	1.296	1.347
12	1000.0	1.073	1.039	1.053	1.082	1.114	1.157	1.200	1.252	1.293	1.343
13	1100.0	1.067	1.031	1.045	1.074	1.109	1.151	1.196	1.247	1.291	1.337
14	1200.0	1.067	1.035	1.051	1.077	1.117	1.154	1.200	1.246	1.292	1.341
15	1300.0	1.066	1.033	1.048	1.073	1.110	1.155	1.195	1.243	1.290	1.338
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.393	1.442	1.494	1.547	1.594	1.647	1.704	1.771	1.835	1.970
1	25.0	1.377	1.429	1.470	1.520	1.567	1.619	1.673	1.734	1.807	1.934
2	50.0	1.379	1.425	1.472	1.522	1.572	1.623	1.677	1.737	1.803	1.938
3	100.0	1.381	1.429	1.474	1.524	1.575	1.627	1.682	1.744	1.815	1.947
4	200.0	1.391	1.440	1.490	1.536	1.588	1.644	1.697	1.760	1.830	1.966
5	300.0	1.393	1.442	1.487	1.540	1.592	1.642	1.701	1.764	1.833	1.966
6	400.0	1.396	1.449	1.498	1.546	1.597	1.652	1.708	1.772	1.841	1.984
7	500.0	1.392	1.444	1.492	1.544	1.597	1.648	1.704	1.765	1.840	1.978
8	600.0	1.396	1.442	1.488	1.539	1.590	1.646	1.700	1.764	1.835	1.975
9	700.0	1.397	1.449	1.495	1.549	1.593	1.647	1.701	1.765	1.837	1.972
10	800.0	1.393	1.442	1.490	1.538	1.586	1.638	1.698	1.758	1.831	1.972
11	900.0	1.390	1.438	1.490	1.533	1.583	1.639	1.696	1.751	1.826	1.968
12	1000.0	1.395	1.441	1.486	1.535	1.586	1.633	1.692	1.749	1.814	1.956
13	1100.0	1.384	1.432	1.485	1.527	1.575	1.626	1.684	1.740	1.810	1.944
14	1200.0	1.392	1.437	1.482	1.526	1.578	1.623	1.677	1.738	1.803	1.937
15	1300.0	1.384	1.432	1.479	1.524	1.573	1.620	1.671	1.733	1.794	1.928

Table 6.44. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels P, Q, R, and S in element 1.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Power Peaking Factors 1	2	3	4	5	6	7	8	9	10
0	0.0	1.131	1.106	1.113	1.136	1.171	1.212	1.258	1.307	1.357	1.407
1	25.0	1.125	1.098	1.104	1.126	1.160	1.200	1.245	1.292	1.340	1.389
2	50.0	1.120	1.093	1.099	1.122	1.155	1.195	1.240	1.287	1.336	1.385
3	100.0	1.112	1.086	1.092	1.115	1.149	1.189	1.235	1.282	1.332	1.381
4	200.0	1.108	1.082	1.089	1.112	1.146	1.188	1.234	1.282	1.332	1.382
5	300.0	1.107	1.081	1.088	1.112	1.146	1.188	1.235	1.284	1.334	1.385
6	400.0	1.108	1.082	1.090	1.113	1.148	1.190	1.237	1.286	1.337	1.388
7	500.0	1.109	1.083	1.091	1.115	1.150	1.192	1.239	1.288	1.339	1.390
8	600.0	1.111	1.085	1.092	1.116	1.152	1.194	1.241	1.290	1.341	1.392
9	700.0	1.113	1.088	1.095	1.119	1.154	1.197	1.243	1.293	1.343	1.394
10	800.0	1.115	1.089	1.096	1.120	1.155	1.197	1.244	1.293	1.343	1.394
11	900.0	1.117	1.091	1.098	1.122	1.157	1.200	1.246	1.295	1.345	1.395
12	1000.0	1.116	1.091	1.098	1.122	1.157	1.199	1.246	1.294	1.344	1.393
13	1100.0	1.118	1.093	1.100	1.124	1.159	1.201	1.247	1.295	1.344	1.394
14	1200.0	1.117	1.091	1.099	1.123	1.157	1.199	1.244	1.292	1.341	1.390
15	1300.0	1.118	1.093	1.100	1.124	1.159	1.200	1.245	1.293	1.341	1.390
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.458	1.508	1.559	1.610	1.663	1.719	1.781	1.850	1.931	2.047
1	25.0	1.438	1.487	1.535	1.585	1.636	1.690	1.750	1.817	1.896	2.010
2	50.0	1.434	1.483	1.531	1.581	1.632	1.687	1.746	1.813	1.892	2.005
3	100.0	1.431	1.480	1.530	1.580	1.633	1.688	1.748	1.817	1.898	2.014
4	200.0	1.433	1.483	1.534	1.585	1.639	1.695	1.756	1.826	1.909	2.028
5	300.0	1.436	1.487	1.538	1.590	1.643	1.700	1.762	1.832	1.916	2.036
6	400.0	1.439	1.490	1.541	1.593	1.646	1.703	1.765	1.836	1.919	2.040
7	500.0	1.441	1.492	1.543	1.594	1.648	1.705	1.766	1.837	1.920	2.041
8	600.0	1.442	1.493	1.544	1.595	1.648	1.705	1.766	1.836	1.919	2.040
9	700.0	1.444	1.494	1.545	1.595	1.648	1.703	1.764	1.833	1.915	2.033
10	800.0	1.444	1.494	1.544	1.594	1.647	1.702	1.762	1.831	1.913	2.032
11	900.0	1.444	1.494	1.543	1.593	1.644	1.699	1.758	1.826	1.906	2.022
12	1000.0	1.443	1.492	1.541	1.590	1.641	1.695	1.754	1.821	1.901	2.018
13	1100.0	1.443	1.491	1.539	1.588	1.638	1.691	1.749	1.814	1.893	2.006
14	1200.0	1.438	1.486	1.534	1.582	1.631	1.684	1.741	1.806	1.884	1.997
15	1300.0	1.437	1.485	1.532	1.579	1.628	1.679	1.735	1.799	1.875	1.986

Table 6.45. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels P, Q, R, and S in element 2.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	2.041	1.966	1.958	1.952	1.951	1.958	1.962	1.967	1.977	1.982
1	25.0	2.000	1.927	1.915	1.910	1.911	1.917	1.917	1.928	1.933	1.948
2	50.0	2.005	1.931	1.917	1.912	1.916	1.919	1.925	1.929	1.938	1.944
3	100.0	2.015	1.941	1.929	1.927	1.928	1.931	1.939	1.944	1.955	1.957
4	200.0	2.033	1.958	1.952	1.945	1.945	1.949	1.953	1.962	1.971	1.975
5	300.0	2.042	1.964	1.953	1.948	1.950	1.954	1.960	1.970	1.976	1.981
6	400.0	2.053	1.976	1.962	1.960	1.956	1.967	1.966	1.974	1.983	1.989
7	500.0	2.045	1.968	1.958	1.955	1.954	1.958	1.965	1.974	1.982	1.987
8	600.0	2.042	1.963	1.954	1.953	1.950	1.956	1.960	1.965	1.972	1.985
9	700.0	2.045	1.967	1.954	1.950	1.946	1.951	1.961	1.968	1.976	1.984
10	800.0	2.040	1.951	1.946	1.937	1.944	1.946	1.952	1.964	1.966	1.980
11	900.0	2.024	1.948	1.935	1.933	1.933	1.938	1.938	1.951	1.958	1.965
12	1000.0	2.024	1.945	1.925	1.924	1.925	1.932	1.936	1.940	1.953	1.958
13	1100.0	2.013	1.932	1.917	1.914	1.918	1.922	1.927	1.933	1.939	1.952
14	1200.0	2.006	1.926	1.918	1.909	1.907	1.917	1.923	1.930	1.938	1.942
15	1300.0	1.990	1.911	1.901	1.898	1.900	1.904	1.911	1.920	1.931	1.933
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.987	1.994	2.000	2.002	2.011	2.022	2.034	2.050	2.078	2.167
1	25.0	1.950	1.954	1.962	1.965	1.974	1.982	1.996	2.015	2.039	2.133
2	50.0	1.950	1.961	1.965	1.967	1.976	1.985	1.999	2.026	2.047	2.139
3	100.0	1.965	1.969	1.981	1.983	1.995	2.000	2.014	2.032	2.060	2.154
4	200.0	1.984	1.984	1.998	2.000	2.007	2.014	2.028	2.047	2.073	2.171
5	300.0	1.987	1.994	2.001	2.006	2.014	2.027	2.037	2.052	2.081	2.181
6	400.0	1.994	2.002	2.002	2.010	2.014	2.024	2.037	2.059	2.086	2.183
7	500.0	1.994	2.002	2.006	2.014	2.019	2.025	2.039	2.061	2.086	2.184
8	600.0	1.993	1.995	2.003	2.007	2.014	2.016	2.034	2.049	2.075	2.176
9	700.0	1.984	1.990	2.000	2.005	2.007	2.016	2.031	2.048	2.074	2.174
10	800.0	1.986	1.988	1.992	2.003	2.008	2.016	2.030	2.043	2.071	2.174
11	900.0	1.972	1.976	1.984	1.988	1.996	2.005	2.014	2.033	2.061	2.163
12	1000.0	1.964	1.971	1.977	1.980	1.983	1.992	2.006	2.024	2.051	2.150
13	1100.0	1.955	1.962	1.963	1.973	1.980	1.990	1.998	2.015	2.043	2.146
14	1200.0	1.950	1.952	1.953	1.965	1.972	1.982	1.996	2.010	2.036	2.131
15	1300.0	1.940	1.943	1.947	1.954	1.963	1.969	1.983	2.001	2.022	2.126

Table 6.46. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels P, Q, R, and S in element 2.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	2.118	2.062	2.039	2.028	2.024	2.026	2.030	2.035	2.041	2.046
1	25.0	2.078	2.021	1.997	1.986	1.982	1.983	1.987	1.992	1.998	2.003
2	50.0	2.074	2.018	1.996	1.985	1.982	1.984	1.988	1.994	2.000	2.005
3	100.0	2.085	2.027	2.004	1.993	1.990	1.992	1.996	2.002	2.008	2.014
4	200.0	2.101	2.042	2.019	2.008	2.005	2.007	2.012	2.018	2.025	2.031
5	300.0	2.110	2.050	2.026	2.016	2.013	2.015	2.020	2.026	2.033	2.039
6	400.0	2.114	2.053	2.029	2.019	2.016	2.018	2.023	2.030	2.036	2.042
7	500.0	2.114	2.053	2.029	2.018	2.016	2.018	2.023	2.029	2.035	2.041
8	600.0	2.112	2.051	2.026	2.015	2.012	2.014	2.019	2.025	2.032	2.038
9	700.0	2.104	2.045	2.021	2.011	2.008	2.010	2.015	2.021	2.028	2.034
10	800.0	2.102	2.040	2.016	2.004	2.001	2.003	2.008	2.014	2.020	2.025
11	900.0	2.091	2.031	2.008	1.997	1.994	1.996	2.001	2.007	2.013	2.018
12	1000.0	2.085	2.024	2.000	1.988	1.985	1.987	1.991	1.996	2.002	2.008
13	1100.0	2.072	2.013	1.990	1.979	1.976	1.977	1.982	1.988	1.994	1.999
14	1200.0	2.062	2.002	1.977	1.966	1.962	1.963	1.968	1.973	1.979	1.984
15	1300.0	2.049	1.991	1.967	1.956	1.953	1.955	1.959	1.965	1.970	1.976
		11	12	13	14	15	16	17	18	19	20
0	0.0	2.050	2.054	2.058	2.061	2.067	2.075	2.088	2.110	2.144	2.213
1	25.0	2.008	2.012	2.016	2.020	2.026	2.035	2.050	2.072	2.107	2.178
2	50.0	2.010	2.015	2.019	2.023	2.029	2.038	2.052	2.074	2.108	2.178
3	100.0	2.019	2.023	2.028	2.032	2.038	2.048	2.062	2.085	2.120	2.193
4	200.0	2.036	2.041	2.045	2.050	2.056	2.065	2.079	2.102	2.138	2.212
5	300.0	2.044	2.049	2.053	2.058	2.064	2.073	2.087	2.110	2.146	2.221
6	400.0	2.047	2.052	2.056	2.060	2.066	2.075	2.089	2.112	2.149	2.225
7	500.0	2.047	2.051	2.055	2.059	2.065	2.074	2.088	2.111	2.148	2.224
8	600.0	2.043	2.047	2.051	2.056	2.061	2.070	2.084	2.107	2.144	2.220
9	700.0	2.039	2.043	2.047	2.051	2.057	2.065	2.079	2.101	2.137	2.212
10	800.0	2.030	2.035	2.039	2.043	2.049	2.058	2.072	2.095	2.132	2.208
11	900.0	2.023	2.028	2.032	2.036	2.041	2.050	2.064	2.086	2.122	2.196
12	1000.0	2.013	2.017	2.021	2.026	2.032	2.040	2.055	2.078	2.114	2.189
13	1100.0	2.004	2.008	2.012	2.017	2.022	2.031	2.045	2.067	2.103	2.176
14	1200.0	1.989	1.994	1.998	2.002	2.008	2.017	2.032	2.055	2.091	2.166
15	1300.0	1.981	1.985	1.989	1.993	1.999	2.008	2.022	2.044	2.080	2.152

Table 6.47. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels P, Q, R, and S in element 3.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{MWd}{MtU}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	2.129	1.999	1.936	1.883	1.834	1.792	1.747	1.712	1.672	1.633
1	25.0	2.097	1.967	1.910	1.861	1.817	1.774	1.732	1.695	1.661	1.624
2	50.0	2.101	1.972	1.910	1.860	1.814	1.776	1.739	1.696	1.662	1.623
3	100.0	2.116	1.985	1.928	1.876	1.828	1.781	1.740	1.700	1.665	1.626
4	200.0	2.126	1.996	1.932	1.880	1.834	1.787	1.746	1.708	1.666	1.631
5	300.0	2.141	1.998	1.942	1.886	1.844	1.794	1.751	1.712	1.676	1.639
6	400.0	2.138	2.001	1.940	1.889	1.839	1.798	1.753	1.714	1.671	1.634
7	500.0	2.144	2.004	1.945	1.892	1.839	1.797	1.756	1.718	1.676	1.639
8	600.0	2.137	2.002	1.940	1.891	1.843	1.795	1.761	1.721	1.679	1.642
9	700.0	2.127	1.994	1.934	1.881	1.835	1.796	1.757	1.713	1.675	1.636
10	800.0	2.126	1.989	1.934	1.881	1.833	1.794	1.755	1.718	1.681	1.641
11	900.0	2.123	1.983	1.928	1.881	1.832	1.795	1.755	1.716	1.673	1.639
12	1000.0	2.113	1.983	1.922	1.873	1.831	1.784	1.753	1.717	1.677	1.637
13	1100.0	2.108	1.975	1.924	1.874	1.827	1.790	1.751	1.713	1.679	1.640
14	1200.0	2.099	1.969	1.915	1.865	1.821	1.785	1.742	1.707	1.672	1.638
15	1300.0	2.086	1.958	1.904	1.858	1.811	1.775	1.742	1.701	1.671	1.632
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.595	1.554	1.512	1.476	1.436	1.394	1.359	1.326	1.303	1.310
1	25.0	1.585	1.546	1.509	1.474	1.434	1.397	1.364	1.333	1.310	1.326
2	50.0	1.586	1.551	1.507	1.469	1.431	1.393	1.361	1.331	1.307	1.321
3	100.0	1.593	1.551	1.511	1.471	1.433	1.397	1.363	1.332	1.304	1.318
4	200.0	1.590	1.551	1.511	1.472	1.431	1.391	1.361	1.327	1.297	1.312
5	300.0	1.601	1.554	1.516	1.475	1.438	1.398	1.363	1.325	1.303	1.315
6	400.0	1.594	1.553	1.513	1.471	1.429	1.391	1.356	1.322	1.298	1.308
7	500.0	1.599	1.560	1.519	1.480	1.437	1.401	1.365	1.330	1.302	1.319
8	600.0	1.596	1.560	1.521	1.482	1.442	1.397	1.364	1.334	1.305	1.321
9	700.0	1.593	1.560	1.517	1.480	1.442	1.396	1.363	1.329	1.306	1.325
10	800.0	1.603	1.564	1.523	1.478	1.447	1.405	1.370	1.339	1.312	1.326
11	900.0	1.599	1.564	1.522	1.483	1.445	1.407	1.372	1.343	1.316	1.335
12	1000.0	1.600	1.564	1.523	1.485	1.446	1.408	1.374	1.344	1.317	1.338
13	1100.0	1.605	1.569	1.528	1.486	1.452	1.413	1.387	1.354	1.327	1.341
14	1200.0	1.599	1.564	1.525	1.486	1.449	1.414	1.377	1.349	1.327	1.345
15	1300.0	1.602	1.562	1.526	1.490	1.453	1.419	1.387	1.358	1.334	1.353

Table 6.48. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels P, Q, R, and S in element 3.

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Power Peaking Factors 1	2	3	4	5	6	7	8	9	10
0	0.0	2.162	2.051	1.975	1.912	1.858	1.809	1.763	1.719	1.675	1.632
1	25.0	2.132	2.023	1.949	1.889	1.838	1.791	1.748	1.707	1.666	1.625
2	50.0	2.131	2.023	1.951	1.891	1.839	1.793	1.750	1.708	1.667	1.626
3	100.0	2.145	2.034	1.959	1.898	1.845	1.798	1.753	1.711	1.670	1.628
4	200.0	2.163	2.048	1.972	1.910	1.856	1.807	1.762	1.719	1.676	1.633
5	300.0	2.171	2.056	1.978	1.915	1.861	1.812	1.767	1.723	1.680	1.637
6	400.0	2.175	2.058	1.981	1.918	1.863	1.815	1.769	1.725	1.682	1.639
7	500.0	2.175	2.058	1.981	1.918	1.864	1.815	1.770	1.726	1.684	1.641
8	600.0	2.172	2.056	1.979	1.917	1.863	1.815	1.770	1.727	1.684	1.642
9	700.0	2.164	2.050	1.975	1.914	1.861	1.814	1.770	1.727	1.685	1.643
10	800.0	2.161	2.047	1.972	1.911	1.858	1.812	1.768	1.726	1.684	1.643
11	900.0	2.150	2.039	1.966	1.906	1.855	1.809	1.767	1.726	1.685	1.644
12	1000.0	2.146	2.034	1.961	1.902	1.851	1.806	1.764	1.723	1.683	1.643
13	1100.0	2.133	2.025	1.954	1.896	1.847	1.803	1.762	1.722	1.683	1.644
14	1200.0	2.125	2.017	1.946	1.889	1.841	1.798	1.758	1.719	1.681	1.642
15	1300.0	2.112	2.007	1.939	1.884	1.837	1.795	1.756	1.718	1.681	1.643
		11	12	13	14	15	16	17	18	19	20
0	0.0	1.588	1.544	1.499	1.454	1.410	1.368	1.328	1.293	1.266	1.259
1	25.0	1.584	1.542	1.500	1.458	1.416	1.377	1.340	1.307	1.283	1.279
2	50.0	1.585	1.543	1.501	1.459	1.417	1.377	1.339	1.307	1.282	1.277
3	100.0	1.586	1.543	1.500	1.457	1.415	1.375	1.337	1.304	1.279	1.275
4	200.0	1.590	1.547	1.502	1.458	1.415	1.373	1.335	1.301	1.275	1.271
5	300.0	1.593	1.549	1.504	1.460	1.416	1.374	1.335	1.300	1.274	1.270
6	400.0	1.595	1.551	1.506	1.462	1.418	1.375	1.336	1.301	1.275	1.271
7	500.0	1.597	1.553	1.508	1.464	1.420	1.377	1.338	1.304	1.278	1.273
8	600.0	1.598	1.555	1.510	1.466	1.422	1.380	1.341	1.307	1.281	1.277
9	700.0	1.601	1.557	1.513	1.469	1.426	1.383	1.344	1.310	1.284	1.280
10	800.0	1.601	1.558	1.514	1.471	1.428	1.386	1.348	1.315	1.289	1.287
11	900.0	1.603	1.560	1.517	1.474	1.432	1.390	1.352	1.319	1.294	1.291
12	1000.0	1.602	1.561	1.518	1.476	1.434	1.394	1.356	1.324	1.300	1.299
13	1100.0	1.604	1.563	1.521	1.479	1.438	1.398	1.361	1.329	1.305	1.303
14	1200.0	1.603	1.563	1.523	1.482	1.442	1.403	1.367	1.336	1.313	1.313
15	1300.0	1.605	1.565	1.525	1.485	1.445	1.407	1.371	1.340	1.317	1.317

Table 6.49. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels P, Q, R, and S in element 4.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	1.193	1.085	1.020	0.958	0.905	0.855	0.810	0.769	0.728	0.692
1	25.0	1.212	1.101	1.038	0.976	0.925	0.878	0.831	0.794	0.754	0.721
2	50.0	1.208	1.097	1.033	0.974	0.922	0.873	0.830	0.790	0.750	0.717
3	100.0	1.206	1.098	1.031	0.969	0.913	0.866	0.824	0.782	0.743	0.706
4	200.0	1.195	1.085	1.019	0.959	0.906	0.856	0.810	0.770	0.730	0.693
5	300.0	1.199	1.086	1.018	0.958	0.901	0.852	0.809	0.769	0.730	0.692
6	400.0	1.196	1.082	1.011	0.953	0.897	0.850	0.803	0.762	0.724	0.686
7	500.0	1.196	1.083	1.014	0.956	0.902	0.852	0.807	0.764	0.727	0.688
8	600.0	1.202	1.088	1.023	0.963	0.909	0.857	0.811	0.768	0.730	0.695
9	700.0	1.205	1.089	1.022	0.959	0.904	0.857	0.812	0.770	0.731	0.696
10	800.0	1.210	1.096	1.029	0.967	0.914	0.861	0.820	0.776	0.736	0.701
11	900.0	1.220	1.099	1.033	0.973	0.919	0.870	0.823	0.783	0.745	0.707
12	1000.0	1.223	1.107	1.039	0.978	0.923	0.876	0.832	0.788	0.750	0.713
13	1100.0	1.229	1.114	1.046	0.987	0.936	0.885	0.838	0.797	0.758	0.721
14	1200.0	1.235	1.119	1.048	0.988	0.934	0.885	0.841	0.802	0.761	0.723
15	1300.0	1.239	1.126	1.057	0.998	0.940	0.897	0.852	0.809	0.771	0.735
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.661	0.630	0.599	0.569	0.545	0.522	0.500	0.483	0.469	0.468
1	25.0	0.687	0.655	0.627	0.602	0.575	0.553	0.533	0.515	0.500	0.503
2	50.0	0.682	0.652	0.625	0.595	0.571	0.550	0.530	0.514	0.499	0.502
3	100.0	0.675	0.643	0.613	0.589	0.562	0.541	0.521	0.502	0.489	0.489
4	200.0	0.663	0.631	0.601	0.572	0.550	0.528	0.507	0.487	0.475	0.473
5	300.0	0.658	0.628	0.597	0.569	0.545	0.523	0.503	0.485	0.468	0.469
6	400.0	0.654	0.623	0.591	0.563	0.540	0.516	0.495	0.476	0.463	0.463
7	500.0	0.658	0.623	0.594	0.569	0.540	0.517	0.496	0.478	0.463	0.463
8	600.0	0.661	0.628	0.598	0.571	0.544	0.521	0.498	0.481	0.467	0.466
9	700.0	0.663	0.630	0.599	0.573	0.547	0.521	0.502	0.483	0.468	0.466
10	800.0	0.666	0.633	0.605	0.579	0.548	0.527	0.504	0.487	0.472	0.471
11	900.0	0.673	0.640	0.611	0.587	0.559	0.532	0.512	0.494	0.478	0.476
12	1000.0	0.678	0.648	0.618	0.586	0.564	0.538	0.519	0.500	0.483	0.486
13	1100.0	0.686	0.656	0.625	0.595	0.570	0.549	0.524	0.507	0.491	0.493
14	1200.0	0.690	0.659	0.629	0.600	0.576	0.549	0.532	0.511	0.496	0.498
15	1300.0	0.700	0.671	0.639	0.609	0.584	0.562	0.539	0.520	0.504	0.506

Table 6.50. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels P, Q, R, and S in element 4.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	1.130	1.032	0.956	0.891	0.834	0.782	0.736	0.693	0.654	0.618
1	25.0	1.154	1.057	0.982	0.918	0.862	0.811	0.766	0.724	0.686	0.650
2	50.0	1.152	1.055	0.981	0.917	0.861	0.811	0.765	0.724	0.686	0.650
3	100.0	1.149	1.051	0.976	0.912	0.855	0.805	0.759	0.718	0.679	0.644
4	200.0	1.143	1.043	0.968	0.903	0.846	0.795	0.749	0.707	0.668	0.632
5	300.0	1.141	1.041	0.965	0.899	0.842	0.790	0.744	0.702	0.663	0.627
6	400.0	1.141	1.040	0.964	0.898	0.841	0.789	0.742	0.700	0.661	0.624
7	500.0	1.144	1.043	0.966	0.900	0.842	0.790	0.743	0.701	0.661	0.625
8	600.0	1.148	1.046	0.969	0.903	0.845	0.793	0.746	0.704	0.664	0.628
9	700.0	1.150	1.050	0.973	0.907	0.849	0.797	0.750	0.708	0.668	0.631
10	800.0	1.158	1.056	0.979	0.913	0.854	0.802	0.755	0.712	0.673	0.636
11	900.0	1.163	1.061	0.985	0.919	0.861	0.809	0.762	0.719	0.679	0.642
12	1000.0	1.171	1.069	0.992	0.926	0.868	0.816	0.769	0.726	0.686	0.649
13	1100.0	1.177	1.075	0.999	0.933	0.875	0.823	0.776	0.733	0.694	0.657
14	1200.0	1.188	1.086	1.009	0.943	0.885	0.833	0.786	0.743	0.704	0.667
15	1300.0	1.193	1.092	1.016	0.950	0.892	0.841	0.794	0.751	0.711	0.674
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.584	0.553	0.524	0.496	0.471	0.448	0.428	0.411	0.397	0.391
1	25.0	0.617	0.586	0.557	0.530	0.505	0.482	0.462	0.445	0.433	0.428
2	50.0	0.617	0.586	0.557	0.530	0.505	0.483	0.463	0.446	0.433	0.428
3	100.0	0.611	0.580	0.551	0.524	0.499	0.477	0.457	0.440	0.428	0.423
4	200.0	0.599	0.568	0.539	0.512	0.487	0.464	0.444	0.428	0.415	0.409
5	300.0	0.593	0.562	0.533	0.505	0.480	0.458	0.438	0.421	0.408	0.402
6	400.0	0.591	0.559	0.530	0.502	0.477	0.454	0.434	0.417	0.404	0.398
7	500.0	0.591	0.559	0.530	0.502	0.477	0.454	0.434	0.416	0.403	0.397
8	600.0	0.593	0.562	0.532	0.504	0.479	0.456	0.435	0.418	0.404	0.398
9	700.0	0.597	0.565	0.535	0.507	0.482	0.458	0.438	0.420	0.406	0.400
10	800.0	0.602	0.569	0.539	0.512	0.486	0.462	0.442	0.424	0.410	0.404
11	900.0	0.608	0.576	0.545	0.517	0.491	0.468	0.447	0.429	0.415	0.409
12	1000.0	0.614	0.582	0.552	0.523	0.497	0.474	0.453	0.435	0.421	0.415
13	1100.0	0.622	0.590	0.559	0.531	0.505	0.481	0.460	0.442	0.428	0.422
14	1200.0	0.632	0.600	0.569	0.541	0.515	0.491	0.470	0.452	0.438	0.433
15	1300.0	0.640	0.607	0.577	0.548	0.522	0.498	0.476	0.458	0.444	0.439

Table 6.51. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels P, Q, R, and S in element 5.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.420	0.379	0.354	0.331	0.311	0.295	0.279	0.264	0.251	0.239
1	25.0	0.455	0.411	0.386	0.364	0.345	0.325	0.309	0.294	0.280	0.267
2	50.0	0.452	0.408	0.384	0.362	0.344	0.324	0.309	0.292	0.277	0.265
3	100.0	0.443	0.400	0.377	0.354	0.333	0.317	0.299	0.285	0.271	0.258
4	200.0	0.427	0.384	0.362	0.338	0.319	0.301	0.285	0.272	0.258	0.244
5	300.0	0.421	0.381	0.357	0.333	0.315	0.295	0.281	0.266	0.251	0.240
6	400.0	0.415	0.375	0.352	0.330	0.309	0.290	0.275	0.263	0.248	0.235
7	500.0	0.415	0.374	0.351	0.328	0.307	0.290	0.276	0.260	0.248	0.233
8	600.0	0.418	0.379	0.352	0.331	0.309	0.292	0.276	0.262	0.247	0.234
9	700.0	0.419	0.377	0.353	0.329	0.312	0.293	0.276	0.263	0.248	0.235
10	800.0	0.423	0.383	0.356	0.335	0.316	0.297	0.280	0.267	0.251	0.239
11	900.0	0.431	0.388	0.363	0.339	0.319	0.301	0.285	0.270	0.257	0.241
12	1000.0	0.436	0.390	0.368	0.344	0.323	0.304	0.288	0.272	0.259	0.247
13	1100.0	0.442	0.398	0.371	0.348	0.329	0.311	0.292	0.277	0.263	0.248
14	1200.0	0.448	0.401	0.375	0.353	0.333	0.315	0.297	0.281	0.268	0.253
15	1300.0	0.458	0.413	0.384	0.360	0.340	0.321	0.304	0.287	0.272	0.260
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.225	0.214	0.204	0.193	0.185	0.177	0.170	0.163	0.157	0.156
1	25.0	0.255	0.241	0.232	0.223	0.213	0.203	0.197	0.188	0.183	0.183
2	50.0	0.252	0.241	0.232	0.221	0.210	0.203	0.194	0.187	0.181	0.182
3	100.0	0.244	0.235	0.225	0.214	0.203	0.195	0.188	0.182	0.176	0.175
4	200.0	0.234	0.221	0.211	0.202	0.192	0.183	0.174	0.169	0.165	0.164
5	300.0	0.229	0.216	0.206	0.197	0.189	0.180	0.171	0.165	0.161	0.161
6	400.0	0.224	0.213	0.201	0.193	0.183	0.176	0.168	0.162	0.155	0.155
7	500.0	0.222	0.209	0.200	0.190	0.182	0.175	0.166	0.158	0.154	0.153
8	600.0	0.224	0.212	0.202	0.190	0.183	0.174	0.167	0.160	0.154	0.154
9	700.0	0.223	0.212	0.201	0.193	0.184	0.175	0.166	0.159	0.155	0.155
10	800.0	0.226	0.214	0.204	0.195	0.185	0.177	0.170	0.162	0.157	0.156
11	900.0	0.230	0.217	0.207	0.197	0.188	0.178	0.172	0.164	0.160	0.158
12	1000.0	0.233	0.220	0.210	0.200	0.189	0.183	0.175	0.167	0.161	0.160
13	1100.0	0.236	0.225	0.213	0.204	0.194	0.184	0.176	0.171	0.164	0.163
14	1200.0	0.241	0.229	0.218	0.208	0.198	0.189	0.180	0.173	0.167	0.165
15	1300.0	0.246	0.233	0.224	0.212	0.202	0.194	0.185	0.178	0.172	0.171

Table 6.52. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels P, Q, R, and S in element 5.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.346	0.315	0.291	0.271	0.253	0.237	0.222	0.209	0.197	0.186
1	25.0	0.382	0.348	0.323	0.302	0.283	0.266	0.251	0.237	0.224	0.212
2	50.0	0.382	0.349	0.324	0.303	0.284	0.267	0.252	0.239	0.226	0.214
3	100.0	0.377	0.345	0.320	0.299	0.280	0.263	0.248	0.235	0.222	0.211
4	200.0	0.364	0.332	0.308	0.287	0.268	0.252	0.238	0.224	0.212	0.201
5	300.0	0.357	0.325	0.301	0.280	0.262	0.246	0.231	0.218	0.206	0.195
6	400.0	0.353	0.321	0.297	0.276	0.258	0.242	0.227	0.214	0.202	0.191
7	500.0	0.351	0.319	0.295	0.274	0.256	0.240	0.226	0.212	0.200	0.189
8	600.0	0.352	0.320	0.296	0.275	0.256	0.240	0.226	0.212	0.200	0.189
9	700.0	0.354	0.321	0.297	0.276	0.258	0.241	0.227	0.213	0.201	0.189
10	800.0	0.358	0.325	0.300	0.279	0.260	0.244	0.229	0.215	0.203	0.191
11	900.0	0.362	0.329	0.304	0.282	0.263	0.247	0.232	0.218	0.205	0.194
12	1000.0	0.368	0.334	0.309	0.287	0.268	0.251	0.235	0.222	0.209	0.197
13	1100.0	0.374	0.340	0.314	0.292	0.273	0.255	0.240	0.226	0.213	0.201
14	1200.0	0.384	0.349	0.323	0.300	0.281	0.263	0.247	0.233	0.220	0.207
15	1300.0	0.390	0.355	0.328	0.305	0.286	0.268	0.252	0.237	0.224	0.211
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.175	0.166	0.157	0.148	0.141	0.133	0.127	0.122	0.117	0.115
1	25.0	0.201	0.191	0.181	0.172	0.164	0.156	0.149	0.143	0.139	0.137
2	50.0	0.203	0.193	0.183	0.174	0.166	0.158	0.151	0.145	0.141	0.139
3	100.0	0.200	0.190	0.180	0.171	0.163	0.156	0.149	0.143	0.139	0.137
4	200.0	0.190	0.180	0.171	0.162	0.154	0.147	0.141	0.135	0.131	0.129
5	300.0	0.184	0.174	0.165	0.157	0.149	0.142	0.135	0.130	0.126	0.124
6	400.0	0.180	0.171	0.161	0.153	0.145	0.138	0.132	0.126	0.122	0.120
7	500.0	0.178	0.169	0.159	0.151	0.143	0.136	0.130	0.124	0.120	0.118
8	600.0	0.178	0.168	0.159	0.151	0.143	0.136	0.129	0.124	0.119	0.117
9	700.0	0.179	0.169	0.160	0.151	0.143	0.136	0.129	0.124	0.119	0.117
10	800.0	0.180	0.170	0.161	0.152	0.144	0.137	0.130	0.125	0.120	0.118
11	900.0	0.183	0.173	0.163	0.154	0.146	0.139	0.132	0.126	0.122	0.120
12	1000.0	0.186	0.176	0.166	0.157	0.149	0.141	0.134	0.129	0.124	0.122
13	1100.0	0.190	0.179	0.169	0.160	0.152	0.144	0.137	0.131	0.127	0.124
14	1200.0	0.196	0.185	0.175	0.166	0.157	0.149	0.142	0.136	0.132	0.129
15	1300.0	0.200	0.189	0.179	0.169	0.161	0.153	0.145	0.139	0.134	0.132

Table 6.53. Problem 5.2.1 reference solution Shift power peaking factors for axial segments in fuel channels P, Q, R, and S in element 6.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.140	0.126	0.118	0.108	0.102	0.095	0.089	0.083	0.079	0.074
1	25.0	0.163	0.148	0.138	0.128	0.120	0.114	0.107	0.101	0.095	0.089
2	50.0	0.163	0.147	0.138	0.128	0.121	0.114	0.106	0.101	0.094	0.089
3	100.0	0.157	0.142	0.131	0.123	0.115	0.108	0.103	0.096	0.090	0.085
4	200.0	0.145	0.132	0.122	0.115	0.107	0.100	0.095	0.090	0.084	0.079
5	300.0	0.142	0.128	0.119	0.111	0.103	0.098	0.092	0.086	0.080	0.076
6	400.0	0.138	0.123	0.115	0.108	0.100	0.095	0.088	0.083	0.079	0.073
7	500.0	0.137	0.122	0.115	0.106	0.099	0.093	0.087	0.081	0.077	0.072
8	600.0	0.136	0.122	0.112	0.106	0.099	0.092	0.087	0.082	0.077	0.072
9	700.0	0.137	0.122	0.115	0.107	0.100	0.093	0.086	0.082	0.077	0.073
10	800.0	0.139	0.124	0.115	0.108	0.100	0.095	0.088	0.083	0.078	0.072
11	900.0	0.141	0.126	0.117	0.109	0.102	0.095	0.089	0.084	0.079	0.074
12	1000.0	0.143	0.128	0.119	0.112	0.104	0.097	0.092	0.086	0.080	0.076
13	1100.0	0.145	0.130	0.121	0.113	0.105	0.099	0.092	0.086	0.082	0.076
14	1200.0	0.148	0.134	0.125	0.115	0.109	0.102	0.096	0.088	0.084	0.079
15	1300.0	0.153	0.137	0.128	0.119	0.110	0.104	0.098	0.091	0.085	0.081
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.069	0.065	0.060	0.057	0.053	0.051	0.048	0.045	0.043	0.043
1	25.0	0.084	0.078	0.074	0.070	0.066	0.061	0.058	0.054	0.052	0.052
2	50.0	0.084	0.078	0.074	0.069	0.065	0.061	0.057	0.055	0.052	0.052
3	100.0	0.079	0.074	0.070	0.066	0.062	0.058	0.054	0.051	0.050	0.049
4	200.0	0.074	0.070	0.066	0.061	0.058	0.054	0.050	0.048	0.046	0.045
5	300.0	0.071	0.066	0.063	0.058	0.054	0.051	0.048	0.046	0.045	0.044
6	400.0	0.068	0.065	0.059	0.057	0.053	0.049	0.047	0.044	0.042	0.042
7	500.0	0.067	0.063	0.059	0.055	0.052	0.049	0.045	0.044	0.042	0.042
8	600.0	0.068	0.064	0.059	0.055	0.052	0.049	0.045	0.043	0.042	0.042
9	700.0	0.068	0.064	0.059	0.056	0.052	0.049	0.046	0.044	0.042	0.042
10	800.0	0.069	0.064	0.060	0.056	0.053	0.049	0.046	0.043	0.042	0.042
11	900.0	0.069	0.064	0.060	0.056	0.053	0.050	0.046	0.044	0.043	0.042
12	1000.0	0.071	0.066	0.063	0.058	0.054	0.051	0.048	0.045	0.044	0.044
13	1100.0	0.072	0.067	0.063	0.059	0.055	0.052	0.049	0.046	0.044	0.043
14	1200.0	0.073	0.068	0.065	0.060	0.057	0.053	0.050	0.047	0.045	0.045
15	1300.0	0.075	0.070	0.066	0.063	0.060	0.055	0.052	0.049	0.046	0.047

Table 6.54. Problem 5.2.1 reference solution MPACT power peaking factors for axial segments in fuel channels P, Q, R, and S in element 6.

Step	Burnup	Power Peaking Factors									
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	1	2	3	4	5	6	7	8	9	10
0	0.0	0.101	0.092	0.084	0.078	0.072	0.067	0.063	0.059	0.055	0.051
1	25.0	0.121	0.110	0.102	0.094	0.088	0.082	0.077	0.072	0.067	0.063
2	50.0	0.123	0.112	0.103	0.096	0.089	0.083	0.078	0.073	0.069	0.064
3	100.0	0.121	0.110	0.102	0.095	0.088	0.082	0.077	0.072	0.068	0.063
4	200.0	0.114	0.104	0.096	0.089	0.083	0.077	0.072	0.067	0.063	0.059
5	300.0	0.109	0.099	0.091	0.085	0.079	0.073	0.069	0.064	0.060	0.056
6	400.0	0.106	0.096	0.088	0.082	0.076	0.071	0.066	0.062	0.058	0.054
7	500.0	0.104	0.094	0.087	0.080	0.074	0.069	0.065	0.060	0.056	0.053
8	600.0	0.103	0.093	0.086	0.079	0.074	0.069	0.064	0.060	0.056	0.052
9	700.0	0.103	0.093	0.086	0.079	0.074	0.069	0.064	0.060	0.056	0.052
10	800.0	0.104	0.094	0.086	0.080	0.074	0.069	0.064	0.060	0.056	0.052
11	900.0	0.105	0.095	0.087	0.081	0.075	0.070	0.065	0.061	0.057	0.053
12	1000.0	0.107	0.097	0.089	0.082	0.076	0.071	0.066	0.062	0.058	0.054
13	1100.0	0.109	0.099	0.091	0.084	0.078	0.073	0.068	0.063	0.059	0.055
14	1200.0	0.114	0.103	0.095	0.088	0.081	0.076	0.071	0.066	0.061	0.057
15	1300.0	0.116	0.105	0.097	0.089	0.083	0.077	0.072	0.067	0.063	0.059
		11	12	13	14	15	16	17	18	19	20
0	0.0	0.048	0.045	0.042	0.039	0.036	0.034	0.032	0.030	0.029	0.029
1	25.0	0.059	0.055	0.051	0.048	0.045	0.042	0.040	0.037	0.036	0.036
2	50.0	0.060	0.056	0.053	0.049	0.046	0.043	0.041	0.039	0.037	0.037
3	100.0	0.059	0.056	0.052	0.049	0.045	0.043	0.040	0.038	0.037	0.036
4	200.0	0.055	0.052	0.048	0.045	0.042	0.040	0.037	0.035	0.034	0.034
5	300.0	0.053	0.049	0.046	0.043	0.040	0.038	0.035	0.033	0.032	0.032
6	400.0	0.051	0.047	0.044	0.041	0.038	0.036	0.034	0.032	0.031	0.030
7	500.0	0.049	0.046	0.043	0.040	0.037	0.035	0.033	0.031	0.030	0.030
8	600.0	0.049	0.045	0.042	0.040	0.037	0.034	0.032	0.031	0.029	0.029
9	700.0	0.049	0.045	0.042	0.039	0.037	0.034	0.032	0.031	0.029	0.029
10	800.0	0.049	0.045	0.042	0.040	0.037	0.034	0.032	0.031	0.029	0.029
11	900.0	0.049	0.046	0.043	0.040	0.037	0.035	0.033	0.031	0.030	0.029
12	1000.0	0.050	0.047	0.044	0.041	0.038	0.035	0.033	0.032	0.030	0.030
13	1100.0	0.051	0.048	0.045	0.042	0.039	0.036	0.034	0.032	0.031	0.031
14	1200.0	0.054	0.050	0.047	0.043	0.041	0.038	0.036	0.034	0.032	0.032
15	1300.0	0.055	0.051	0.048	0.044	0.042	0.039	0.036	0.035	0.033	0.033

7. PROBLEM 6: 2×2 MINI-CORE 3D

Problem 6 is a mini-core with four charge-pans. Two are controlled, and one contains fuel stacks that are only five elements high. The top and bottom problem edges have vacuum (zero-return) boundary conditions, and the north, south, east, and west boundaries are fully reflected. Problem 6 is more complex than previous problems because it has both five-element and six-element fuel stacks, and it has control rods inserted in two of the four charge pans.

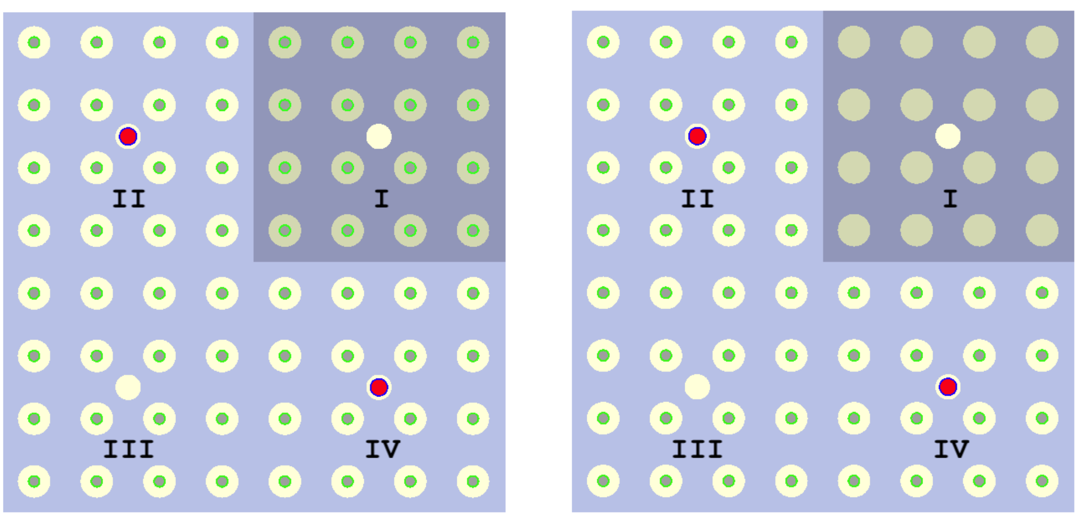
7.1 BEGINNING-OF-CYCLE

7.1.1 Problem 6.1.1

7.1.1.1 Description

Figure 26 shows the transverse mini-core geometry for Problem 6.1.1 at two different axial locations. Each charge-pan has been labeled with Roman numerals corresponding to its quadrant. The charge-pan in the upper right of Figure 26 (quadrant I, shown in dark grey) has fuel channels with five-element-high stacks, whereas all other charge-pans (quadrants II, III, and IV, shown in light grey) have six-element-high stacks. The axial geometry of the six-element stacks are shown in Figure 20, and the five-element high stacks are shown in Figure 27. Charge-pans in quadrants II and IV have control rods inserted halfway into the the fuel from the top (shown in red in Figure 26). The bottom of the control rods coincide with the bottom of fuel element four and the top of fuel element three.

Zone A coolant channel radius is used for all charge-pans in this problem. Geometric dimensions are listed in Table 1.2. Owing to the five-element and six-element stacks and the presence of control rods, the problem is asymmetric in the radial and axial dimensions. Material densities are listed in Table 1.4. Temperatures are listed in Table 2.4.



(a) At 5th fuel element height and below. **(b) Above 5th element height**

Figure 26. 2×2 **mini-core 3D.**

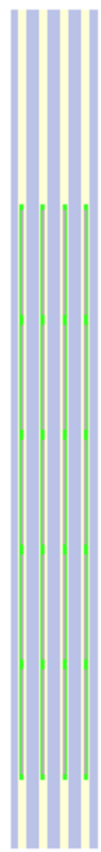


Figure 27. 3D charge-pan with five fuel element stacks.

7.1.1.2 Reference Solution

The neutron multiplication factor results are shown in Table 7.1. The timing variables for Shift and MPACT are shown in Table 7.2. It can be seen that the MPACT problem took significantly longer than Shift. This can be attributed to the ray spacing of 0.01 and a high convergence criteria, both of which exacerbate the issue with the end caps, i.e. non-fueled regions, in between the elements.

In the reference solution for Problem 6.1.1, each fuel element is divided into axial segments as the two previous problems. Figure 28 shows the assembly-average power peaking factors for each axial segment in all four assemblies (I-IV) and their absolute difference between MPACT and Shift. It can be seen that the power peaking factors look to match up Tables 7.3-7.48 show the power peaking factors for each of the pins for all axial locations in mini-core.

The peaking factors agree decently between the two codes.

Table 7.1. Neutron multiplication factor for the reference solution of Problem 6.1.1.

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift k_{eff} (1σ)	MPACT k_{eff} (1σ)	Difference [pcm]
0	0.0	1.02722(5)	1.02518(10)	-205(11)

Table 7.2. Timing variables for the reference solution of Problem 6.1.1

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1500	1200	200000	2	48	1.74
MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
1	1.0×10^{-04}	3.0×10^{-04}	0.01	12	128	4.12

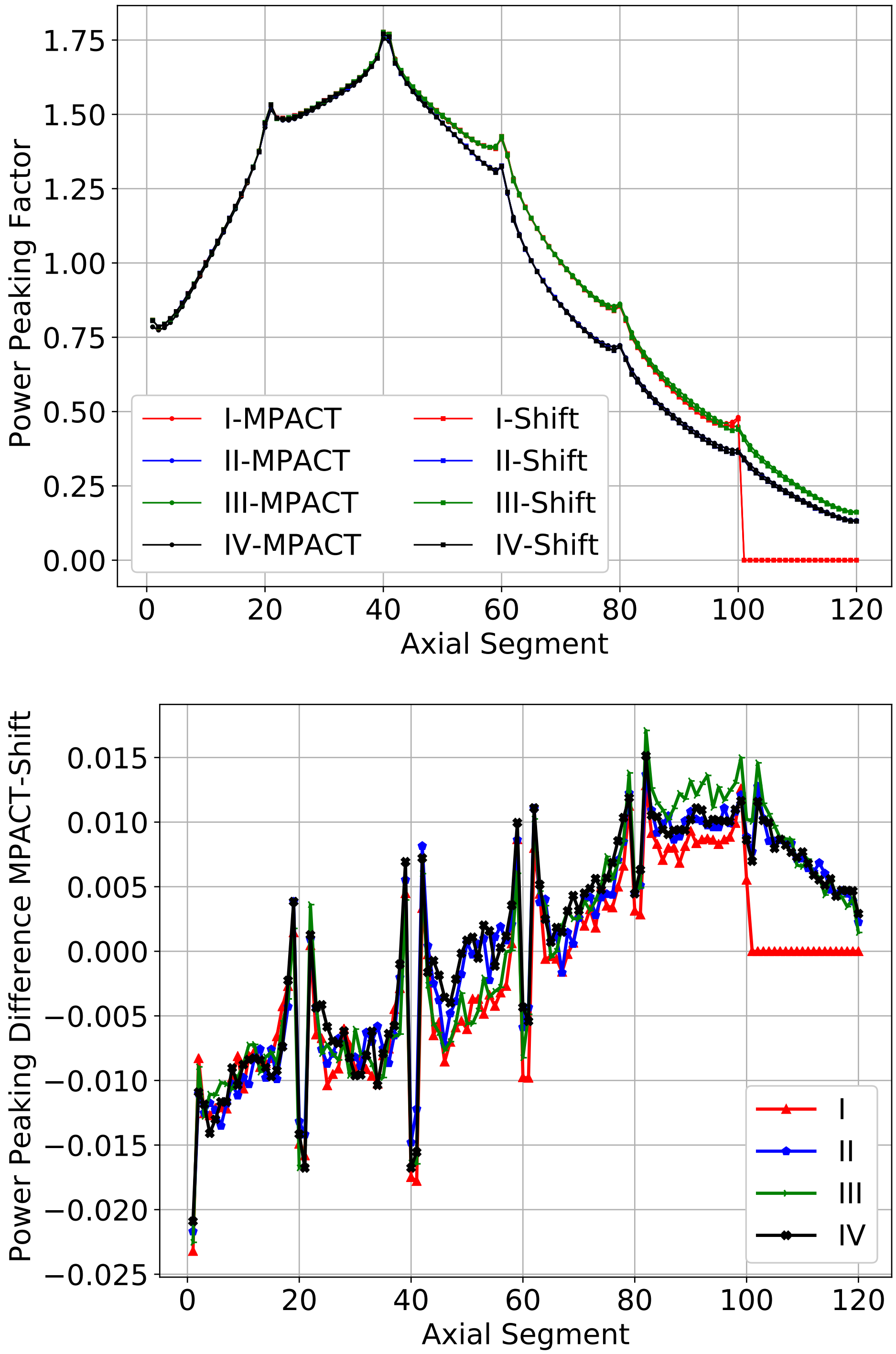


Figure 28. Power peaking factors for Problem 6.1.1 for Shift and MPACT (top) and their absolute difference (bottom). The three series correspond to charge-pans I-IV. Charge-pan I is the 5-element high stack, and charge-pans II and IV have the control rod inserted halfway.

Charge-Pan I

Table 7.3. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 1 for charge-pan I.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.805	0.781	0.794	0.806	0.837	0.859	0.895	0.926	0.959	0.993
B	0.802	0.778	0.790	0.805	0.834	0.867	0.890	0.923	0.950	0.991
C	0.805	0.774	0.787	0.810	0.839	0.867	0.892	0.922	0.953	1.000
D	0.796	0.787	0.787	0.805	0.830	0.856	0.891	0.923	0.953	0.993
E	0.816	0.784	0.798	0.813	0.836	0.864	0.896	0.932	0.968	1.008
F	0.810	0.776	0.798	0.809	0.833	0.862	0.896	0.928	0.965	0.998
G	0.807	0.781	0.790	0.818	0.838	0.863	0.895	0.935	0.959	1.007
H	0.805	0.787	0.797	0.817	0.831	0.861	0.899	0.928	0.966	1.006
J	0.811	0.788	0.800	0.816	0.843	0.869	0.900	0.938	0.965	1.008
K	0.807	0.788	0.797	0.814	0.846	0.874	0.902	0.939	0.970	1.000
L	0.816	0.782	0.794	0.817	0.834	0.863	0.902	0.927	0.957	0.997
M	0.808	0.779	0.796	0.811	0.831	0.869	0.905	0.925	0.968	1.005
P	0.812	0.790	0.798	0.817	0.834	0.864	0.898	0.931	0.966	1.004
Q	0.814	0.776	0.794	0.812	0.837	0.870	0.892	0.928	0.970	1.002
R	0.812	0.786	0.795	0.812	0.837	0.865	0.904	0.933	0.972	1.013
S	0.806	0.786	0.801	0.813	0.836	0.867	0.902	0.929	0.970	1.011
Channels	11	12	13	14	15	16	17	18	19	20
A	1.017	1.055	1.099	1.139	1.179	1.215	1.263	1.306	1.362	1.448
B	1.033	1.074	1.099	1.151	1.181	1.216	1.265	1.311	1.366	1.465
C	1.032	1.056	1.090	1.139	1.182	1.218	1.267	1.312	1.371	1.467
D	1.029	1.061	1.102	1.138	1.175	1.227	1.267	1.316	1.363	1.453
E	1.039	1.074	1.111	1.157	1.191	1.227	1.280	1.318	1.367	1.473
F	1.041	1.074	1.116	1.158	1.200	1.230	1.275	1.328	1.384	1.472
G	1.040	1.084	1.118	1.150	1.192	1.235	1.278	1.321	1.380	1.474
H	1.039	1.075	1.116	1.159	1.194	1.234	1.268	1.330	1.378	1.471
J	1.037	1.077	1.119	1.151	1.193	1.242	1.266	1.327	1.373	1.474
K	1.037	1.075	1.127	1.152	1.191	1.235	1.280	1.330	1.378	1.479
L	1.037	1.075	1.121	1.151	1.192	1.239	1.277	1.321	1.383	1.465
M	1.035	1.084	1.112	1.149	1.189	1.233	1.277	1.333	1.370	1.479
P	1.035	1.072	1.120	1.152	1.198	1.235	1.278	1.323	1.381	1.481
Q	1.040	1.073	1.116	1.150	1.189	1.238	1.277	1.328	1.389	1.475
R	1.045	1.078	1.109	1.160	1.196	1.233	1.279	1.328	1.388	1.484
S	1.047	1.084	1.121	1.151	1.200	1.229	1.279	1.328	1.392	1.484

Table 7.4. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 1 for charge-pan I.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.782	0.771	0.778	0.795	0.819	0.847	0.879	0.913	0.948	0.984
B	0.781	0.771	0.778	0.795	0.819	0.847	0.879	0.913	0.948	0.984
C	0.781	0.771	0.778	0.795	0.819	0.847	0.879	0.913	0.948	0.984
D	0.781	0.770	0.778	0.795	0.819	0.847	0.879	0.913	0.948	0.984
E	0.786	0.776	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
F	0.786	0.775	0.783	0.801	0.825	0.855	0.887	0.922	0.957	0.994
G	0.786	0.776	0.783	0.801	0.825	0.855	0.887	0.922	0.957	0.994
H	0.786	0.775	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
J	0.786	0.775	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.994
K	0.786	0.776	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
L	0.785	0.775	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
M	0.786	0.776	0.783	0.801	0.825	0.855	0.887	0.921	0.957	0.993
P	0.786	0.776	0.784	0.802	0.826	0.856	0.888	0.923	0.958	0.995
Q	0.787	0.777	0.785	0.802	0.827	0.856	0.888	0.923	0.959	0.995
R	0.787	0.776	0.784	0.802	0.826	0.856	0.888	0.923	0.959	0.995
S	0.787	0.776	0.784	0.802	0.826	0.856	0.888	0.923	0.958	0.995
Channels	11	12	13	14	15	16	17	18	19	20
A	1.020	1.057	1.095	1.133	1.173	1.215	1.260	1.310	1.367	1.445
B	1.020	1.057	1.095	1.133	1.173	1.214	1.259	1.309	1.367	1.445
C	1.020	1.057	1.095	1.133	1.173	1.214	1.259	1.309	1.367	1.445
D	1.020	1.057	1.094	1.133	1.172	1.214	1.259	1.309	1.367	1.445
E	1.030	1.068	1.105	1.144	1.184	1.226	1.272	1.323	1.381	1.460
F	1.031	1.068	1.106	1.145	1.185	1.227	1.273	1.323	1.382	1.461
G	1.031	1.068	1.106	1.145	1.185	1.227	1.273	1.323	1.382	1.461
H	1.030	1.068	1.106	1.144	1.184	1.226	1.272	1.323	1.381	1.460
J	1.031	1.068	1.106	1.144	1.184	1.227	1.272	1.323	1.381	1.461
K	1.030	1.068	1.105	1.144	1.184	1.226	1.272	1.322	1.381	1.460
L	1.030	1.068	1.105	1.144	1.184	1.226	1.272	1.322	1.381	1.460
M	1.030	1.068	1.105	1.144	1.184	1.226	1.272	1.322	1.381	1.460
P	1.032	1.069	1.107	1.146	1.186	1.228	1.273	1.324	1.382	1.460
Q	1.032	1.070	1.108	1.146	1.186	1.229	1.274	1.325	1.383	1.461
R	1.032	1.069	1.107	1.146	1.186	1.228	1.274	1.324	1.382	1.461
S	1.032	1.069	1.107	1.146	1.186	1.228	1.273	1.324	1.382	1.461

Table 7.5. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 2 for charge-pan I.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.518	1.475	1.474	1.474	1.481	1.487	1.497	1.508	1.522	1.534
B	1.513	1.478	1.473	1.474	1.477	1.492	1.497	1.517	1.524	1.537
C	1.514	1.469	1.479	1.484	1.482	1.492	1.502	1.509	1.506	1.535
D	1.525	1.474	1.476	1.474	1.479	1.486	1.499	1.497	1.513	1.542
E	1.538	1.494	1.485	1.492	1.498	1.505	1.513	1.524	1.535	1.550
F	1.538	1.489	1.483	1.490	1.496	1.507	1.512	1.516	1.535	1.546
G	1.529	1.485	1.497	1.492	1.503	1.512	1.521	1.531	1.537	1.545
H	1.540	1.494	1.493	1.495	1.502	1.500	1.508	1.520	1.547	1.551
J	1.539	1.506	1.493	1.484	1.499	1.516	1.518	1.527	1.535	1.551
K	1.528	1.490	1.484	1.492	1.497	1.506	1.520	1.525	1.537	1.550
L	1.540	1.485	1.496	1.495	1.504	1.505	1.517	1.518	1.541	1.549
M	1.529	1.493	1.488	1.485	1.505	1.511	1.513	1.530	1.538	1.555
P	1.543	1.496	1.493	1.491	1.503	1.503	1.519	1.523	1.545	1.549
Q	1.548	1.500	1.498	1.491	1.507	1.511	1.523	1.523	1.540	1.556
R	1.537	1.497	1.493	1.496	1.509	1.516	1.517	1.531	1.538	1.551
S	1.539	1.492	1.499	1.498	1.500	1.503	1.525	1.528	1.539	1.547
Channels	11	12	13	14	15	16	17	18	19	20
A	1.545	1.546	1.565	1.590	1.602	1.613	1.618	1.646	1.679	1.754
B	1.549	1.558	1.570	1.588	1.605	1.613	1.633	1.653	1.682	1.760
C	1.547	1.561	1.567	1.583	1.584	1.610	1.628	1.645	1.687	1.770
D	1.545	1.556	1.572	1.584	1.593	1.613	1.635	1.666	1.681	1.764
E	1.561	1.577	1.589	1.597	1.609	1.634	1.640	1.662	1.701	1.772
F	1.559	1.573	1.585	1.605	1.617	1.620	1.651	1.673	1.690	1.764
G	1.558	1.579	1.587	1.597	1.613	1.619	1.646	1.663	1.701	1.784
H	1.561	1.568	1.589	1.595	1.607	1.637	1.639	1.673	1.705	1.782
J	1.556	1.570	1.590	1.604	1.605	1.628	1.651	1.676	1.701	1.783
K	1.564	1.574	1.587	1.588	1.612	1.624	1.645	1.678	1.708	1.785
L	1.565	1.583	1.593	1.600	1.606	1.632	1.648	1.662	1.703	1.770
M	1.560	1.575	1.584	1.600	1.616	1.627	1.648	1.680	1.696	1.787
P	1.569	1.575	1.583	1.602	1.615	1.633	1.646	1.669	1.691	1.793
Q	1.563	1.578	1.586	1.602	1.612	1.627	1.650	1.669	1.693	1.785
R	1.563	1.573	1.593	1.605	1.623	1.625	1.644	1.675	1.707	1.793
S	1.554	1.576	1.582	1.600	1.611	1.636	1.651	1.682	1.702	1.788

Table 7.6. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 2 for charge-pan I.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.505	1.478	1.470	1.470	1.475	1.482	1.492	1.503	1.514	1.526
B	1.504	1.477	1.470	1.470	1.474	1.482	1.491	1.502	1.513	1.525
C	1.504	1.477	1.470	1.469	1.474	1.482	1.491	1.502	1.514	1.525
D	1.504	1.477	1.469	1.469	1.474	1.482	1.491	1.502	1.513	1.525
E	1.520	1.492	1.484	1.484	1.489	1.497	1.507	1.518	1.529	1.541
F	1.521	1.493	1.485	1.485	1.490	1.498	1.508	1.519	1.530	1.542
G	1.521	1.493	1.485	1.485	1.490	1.498	1.508	1.519	1.530	1.542
H	1.520	1.492	1.485	1.484	1.489	1.497	1.507	1.518	1.529	1.541
J	1.521	1.493	1.485	1.485	1.489	1.497	1.507	1.518	1.529	1.541
K	1.520	1.492	1.484	1.484	1.489	1.497	1.506	1.517	1.529	1.540
L	1.520	1.492	1.484	1.484	1.489	1.496	1.506	1.517	1.529	1.540
M	1.520	1.492	1.484	1.484	1.489	1.497	1.506	1.517	1.529	1.540
P	1.521	1.493	1.486	1.486	1.491	1.499	1.509	1.520	1.531	1.543
Q	1.522	1.494	1.487	1.487	1.492	1.500	1.510	1.521	1.533	1.544
R	1.521	1.494	1.486	1.486	1.491	1.499	1.509	1.520	1.532	1.543
S	1.521	1.493	1.486	1.486	1.491	1.499	1.509	1.520	1.531	1.543
Channels	11	12	13	14	15	16	17	18	19	20
A	1.537	1.549	1.561	1.574	1.588	1.605	1.626	1.652	1.688	1.747
B	1.537	1.548	1.560	1.573	1.587	1.604	1.625	1.651	1.686	1.745
C	1.537	1.548	1.560	1.573	1.587	1.604	1.624	1.650	1.685	1.743
D	1.537	1.548	1.560	1.573	1.587	1.604	1.625	1.651	1.686	1.745
E	1.553	1.565	1.577	1.590	1.604	1.621	1.642	1.669	1.705	1.765
F	1.554	1.565	1.578	1.591	1.605	1.622	1.643	1.670	1.706	1.767
G	1.554	1.566	1.578	1.591	1.605	1.622	1.643	1.670	1.706	1.766
H	1.553	1.565	1.577	1.590	1.604	1.621	1.642	1.668	1.704	1.765
J	1.552	1.564	1.576	1.589	1.603	1.620	1.640	1.667	1.702	1.762
K	1.552	1.564	1.576	1.588	1.603	1.619	1.640	1.667	1.702	1.762
L	1.552	1.564	1.576	1.589	1.603	1.619	1.640	1.667	1.702	1.762
M	1.552	1.564	1.576	1.589	1.603	1.620	1.640	1.667	1.703	1.763
P	1.554	1.566	1.578	1.591	1.605	1.622	1.642	1.668	1.704	1.763
Q	1.556	1.568	1.580	1.593	1.608	1.625	1.646	1.673	1.709	1.770
R	1.555	1.567	1.579	1.591	1.606	1.622	1.643	1.670	1.706	1.766
S	1.554	1.566	1.578	1.591	1.605	1.621	1.642	1.668	1.704	1.762

Table 7.7. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 3 for charge-pan I.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.750	1.667	1.627	1.614	1.584	1.556	1.544	1.521	1.505	1.493
B	1.764	1.678	1.634	1.608	1.573	1.564	1.542	1.527	1.505	1.492
C	1.760	1.671	1.643	1.601	1.577	1.561	1.545	1.521	1.509	1.499
D	1.761	1.670	1.630	1.608	1.577	1.556	1.534	1.522	1.498	1.480
E	1.771	1.678	1.656	1.619	1.588	1.576	1.550	1.533	1.515	1.493
F	1.764	1.683	1.639	1.625	1.583	1.565	1.555	1.526	1.505	1.486
G	1.778	1.685	1.642	1.623	1.606	1.577	1.548	1.534	1.519	1.492
H	1.775	1.691	1.658	1.622	1.599	1.581	1.567	1.541	1.524	1.507
J	1.779	1.695	1.655	1.637	1.601	1.583	1.568	1.540	1.528	1.512
K	1.772	1.692	1.644	1.631	1.609	1.583	1.558	1.533	1.520	1.508
L	1.780	1.688	1.650	1.623	1.589	1.574	1.547	1.525	1.510	1.492
M	1.768	1.674	1.645	1.611	1.591	1.565	1.548	1.528	1.511	1.493
P	1.772	1.689	1.650	1.622	1.590	1.569	1.551	1.535	1.512	1.495
Q	1.768	1.692	1.652	1.624	1.599	1.584	1.546	1.534	1.520	1.494
R	1.789	1.701	1.654	1.627	1.602	1.587	1.565	1.554	1.525	1.520
S	1.773	1.682	1.648	1.616	1.602	1.578	1.549	1.532	1.516	1.504

Channels	11	12	13	14	15	16	17	18	19	20
A	1.463	1.450	1.437	1.421	1.420	1.399	1.385	1.390	1.376	1.426
B	1.471	1.459	1.447	1.435	1.417	1.416	1.402	1.402	1.393	1.430
C	1.471	1.456	1.442	1.420	1.409	1.406	1.385	1.384	1.379	1.420
D	1.462	1.447	1.443	1.416	1.404	1.391	1.381	1.373	1.363	1.407
E	1.479	1.455	1.431	1.420	1.404	1.389	1.378	1.369	1.361	1.404
F	1.475	1.457	1.438	1.418	1.405	1.395	1.382	1.365	1.366	1.400
G	1.488	1.475	1.462	1.443	1.425	1.415	1.403	1.409	1.401	1.448
H	1.489	1.479	1.457	1.450	1.433	1.426	1.423	1.411	1.410	1.460
J	1.489	1.484	1.466	1.452	1.440	1.422	1.420	1.416	1.412	1.452
K	1.489	1.478	1.459	1.444	1.434	1.414	1.412	1.403	1.396	1.447
L	1.477	1.454	1.436	1.417	1.410	1.385	1.379	1.377	1.374	1.413
M	1.476	1.456	1.439	1.413	1.403	1.388	1.388	1.372	1.371	1.400
P	1.477	1.453	1.436	1.425	1.399	1.390	1.384	1.377	1.365	1.407
Q	1.473	1.454	1.438	1.429	1.413	1.396	1.393	1.369	1.380	1.422
R	1.496	1.478	1.469	1.455	1.442	1.438	1.426	1.420	1.426	1.469
S	1.482	1.460	1.454	1.428	1.416	1.399	1.382	1.377	1.374	1.409

Table 7.8. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 3 for charge-pan I.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.741	1.676	1.635	1.603	1.578	1.556	1.536	1.519	1.502	1.486
B	1.738	1.673	1.632	1.601	1.574	1.552	1.533	1.515	1.497	1.481
C	1.736	1.672	1.631	1.599	1.573	1.551	1.531	1.513	1.495	1.478
D	1.738	1.673	1.633	1.601	1.575	1.552	1.533	1.515	1.497	1.481
E	1.758	1.692	1.650	1.618	1.591	1.569	1.549	1.531	1.514	1.498
F	1.760	1.694	1.653	1.621	1.595	1.573	1.553	1.536	1.519	1.503
G	1.760	1.694	1.653	1.621	1.595	1.573	1.554	1.536	1.520	1.504
H	1.758	1.692	1.650	1.618	1.591	1.569	1.549	1.531	1.514	1.498
J	1.755	1.688	1.646	1.613	1.587	1.564	1.543	1.525	1.507	1.489
K	1.755	1.688	1.646	1.613	1.586	1.563	1.543	1.524	1.506	1.488
L	1.755	1.688	1.646	1.613	1.586	1.563	1.543	1.524	1.506	1.488
M	1.755	1.689	1.646	1.614	1.587	1.564	1.543	1.525	1.507	1.489
P	1.755	1.690	1.648	1.616	1.589	1.566	1.546	1.527	1.509	1.492
Q	1.764	1.698	1.656	1.625	1.599	1.577	1.558	1.541	1.525	1.509
R	1.758	1.692	1.649	1.617	1.590	1.567	1.547	1.528	1.510	1.492
S	1.755	1.689	1.647	1.614	1.587	1.564	1.544	1.525	1.507	1.489
Channels	11	12	13	14	15	16	17	18	19	20
A	1.470	1.455	1.440	1.426	1.414	1.403	1.396	1.394	1.400	1.425
B	1.465	1.449	1.433	1.419	1.405	1.394	1.386	1.383	1.388	1.412
C	1.462	1.445	1.429	1.414	1.400	1.388	1.380	1.376	1.380	1.402
D	1.465	1.449	1.433	1.418	1.405	1.394	1.386	1.383	1.388	1.411
E	1.481	1.465	1.450	1.435	1.422	1.411	1.403	1.400	1.405	1.430
F	1.488	1.472	1.458	1.444	1.431	1.421	1.415	1.413	1.420	1.446
G	1.488	1.473	1.458	1.444	1.432	1.422	1.415	1.414	1.420	1.447
H	1.481	1.465	1.450	1.435	1.422	1.411	1.403	1.400	1.406	1.430
J	1.472	1.454	1.437	1.421	1.406	1.392	1.382	1.377	1.379	1.401
K	1.470	1.453	1.436	1.419	1.403	1.390	1.380	1.374	1.376	1.397
L	1.470	1.453	1.435	1.419	1.403	1.389	1.379	1.373	1.375	1.395
M	1.472	1.454	1.437	1.421	1.405	1.392	1.382	1.377	1.379	1.400
P	1.475	1.458	1.441	1.424	1.409	1.396	1.387	1.382	1.384	1.405
Q	1.494	1.479	1.464	1.451	1.439	1.429	1.423	1.422	1.429	1.455
R	1.475	1.458	1.441	1.425	1.409	1.396	1.387	1.382	1.384	1.405
S	1.471	1.453	1.436	1.419	1.403	1.389	1.378	1.372	1.373	1.393

Table 7.9. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 4 for charge-pan I.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.361	1.268	1.225	1.184	1.151	1.105	1.083	1.056	1.034	1.007
B	1.386	1.285	1.247	1.196	1.172	1.133	1.103	1.070	1.050	1.023
C	1.374	1.277	1.231	1.195	1.151	1.118	1.090	1.052	1.017	1.001
D	1.345	1.263	1.212	1.179	1.133	1.107	1.078	1.040	1.014	0.991
E	1.343	1.244	1.208	1.159	1.122	1.082	1.057	1.029	1.004	0.972
F	1.352	1.255	1.197	1.165	1.127	1.089	1.062	1.034	1.008	0.969
G	1.378	1.297	1.235	1.206	1.175	1.134	1.099	1.077	1.048	1.018
H	1.413	1.315	1.263	1.227	1.184	1.156	1.125	1.090	1.057	1.035
J	1.394	1.307	1.266	1.222	1.181	1.159	1.124	1.096	1.064	1.038
K	1.381	1.299	1.250	1.209	1.173	1.133	1.104	1.076	1.046	1.020
L	1.347	1.257	1.210	1.176	1.117	1.093	1.057	1.031	0.999	0.977
M	1.338	1.256	1.200	1.161	1.122	1.085	1.053	1.025	0.996	0.965
P	1.342	1.250	1.197	1.156	1.119	1.084	1.056	1.018	0.996	0.967
Q	1.354	1.268	1.211	1.166	1.138	1.098	1.072	1.039	1.013	0.985
R	1.410	1.317	1.283	1.236	1.196	1.170	1.140	1.112	1.083	1.049
S	1.359	1.271	1.211	1.182	1.136	1.107	1.068	1.044	1.016	0.987
Channels	11	12	13	14	15	16	17	18	19	20
A	0.979	0.948	0.934	0.913	0.894	0.875	0.861	0.844	0.839	0.857
B	1.000	0.976	0.959	0.936	0.908	0.900	0.887	0.867	0.855	0.876
C	0.981	0.952	0.938	0.913	0.896	0.883	0.860	0.848	0.836	0.859
D	0.959	0.945	0.926	0.900	0.878	0.865	0.848	0.834	0.824	0.847
E	0.944	0.921	0.900	0.875	0.861	0.844	0.833	0.821	0.809	0.830
F	0.946	0.931	0.905	0.879	0.866	0.848	0.834	0.828	0.823	0.835
G	1.000	0.965	0.951	0.923	0.908	0.890	0.875	0.867	0.850	0.874
H	1.023	0.989	0.965	0.950	0.928	0.916	0.900	0.892	0.882	0.890
J	1.024	0.999	0.969	0.951	0.932	0.913	0.902	0.891	0.882	0.888
K	0.993	0.971	0.954	0.926	0.914	0.891	0.881	0.867	0.856	0.870
L	0.949	0.924	0.909	0.888	0.866	0.852	0.837	0.824	0.810	0.830
M	0.938	0.925	0.897	0.877	0.863	0.852	0.826	0.820	0.813	0.822
P	0.950	0.915	0.891	0.871	0.860	0.835	0.831	0.814	0.807	0.814
Q	0.962	0.942	0.924	0.897	0.867	0.856	0.840	0.835	0.829	0.839
R	1.024	1.008	0.990	0.964	0.945	0.926	0.909	0.895	0.890	0.906
S	0.962	0.936	0.909	0.884	0.885	0.864	0.842	0.831	0.818	0.830

Table 7.10. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 4 for charge-pan I.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.371	1.299	1.248	1.205	1.167	1.133	1.103	1.074	1.048	1.023
B	1.355	1.283	1.232	1.188	1.150	1.116	1.085	1.056	1.030	1.005
C	1.344	1.272	1.220	1.176	1.138	1.104	1.073	1.044	1.017	0.992
D	1.355	1.283	1.231	1.188	1.150	1.116	1.085	1.056	1.030	1.004
E	1.374	1.301	1.249	1.205	1.166	1.132	1.101	1.073	1.046	1.021
F	1.392	1.319	1.267	1.224	1.186	1.152	1.122	1.094	1.067	1.042
G	1.392	1.320	1.268	1.224	1.187	1.153	1.122	1.094	1.068	1.042
H	1.374	1.301	1.249	1.205	1.166	1.132	1.101	1.073	1.046	1.021
J	1.339	1.265	1.212	1.166	1.127	1.092	1.060	1.031	1.004	0.979
K	1.334	1.261	1.207	1.162	1.122	1.087	1.056	1.026	0.999	0.974
L	1.333	1.260	1.206	1.161	1.122	1.087	1.055	1.026	0.999	0.974
M	1.339	1.265	1.211	1.166	1.127	1.092	1.060	1.031	1.004	0.978
P	1.344	1.272	1.219	1.174	1.135	1.100	1.068	1.039	1.012	0.986
Q	1.402	1.330	1.278	1.235	1.197	1.164	1.134	1.106	1.079	1.054
R	1.344	1.272	1.218	1.174	1.134	1.100	1.068	1.039	1.012	0.986
S	1.330	1.257	1.203	1.158	1.119	1.083	1.052	1.022	0.995	0.969
Channels	11	12	13	14	15	16	17	18	19	20
A	0.999	0.976	0.955	0.935	0.916	0.900	0.886	0.876	0.871	0.878
B	0.981	0.958	0.936	0.916	0.898	0.881	0.867	0.857	0.852	0.860
C	0.968	0.945	0.923	0.903	0.885	0.869	0.855	0.845	0.840	0.847
D	0.980	0.958	0.936	0.916	0.897	0.881	0.867	0.857	0.852	0.859
E	0.997	0.974	0.952	0.932	0.913	0.896	0.882	0.872	0.868	0.875
F	1.018	0.995	0.973	0.953	0.934	0.917	0.903	0.893	0.889	0.897
G	1.019	0.996	0.974	0.953	0.935	0.918	0.904	0.894	0.889	0.897
H	0.997	0.974	0.952	0.932	0.913	0.896	0.882	0.872	0.868	0.875
J	0.955	0.932	0.910	0.890	0.871	0.855	0.841	0.831	0.826	0.833
K	0.950	0.927	0.905	0.885	0.866	0.850	0.836	0.826	0.821	0.827
L	0.950	0.927	0.905	0.885	0.866	0.850	0.836	0.826	0.822	0.829
M	0.954	0.931	0.910	0.889	0.871	0.854	0.841	0.830	0.825	0.832
P	0.962	0.939	0.917	0.897	0.878	0.862	0.848	0.837	0.832	0.839
Q	1.030	1.007	0.985	0.965	0.946	0.929	0.915	0.905	0.900	0.908
R	0.962	0.939	0.917	0.897	0.878	0.862	0.848	0.838	0.833	0.840
S	0.945	0.922	0.900	0.880	0.862	0.845	0.831	0.821	0.816	0.823

Table 7.11. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 5 for charge-pan I.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.807	0.749	0.715	0.688	0.661	0.631	0.612	0.594	0.567	0.548
B	0.822	0.771	0.740	0.700	0.669	0.643	0.620	0.601	0.581	0.564
C	0.811	0.749	0.726	0.689	0.660	0.632	0.612	0.598	0.575	0.554
D	0.792	0.744	0.706	0.674	0.652	0.627	0.608	0.583	0.562	0.544
E	0.771	0.722	0.687	0.658	0.637	0.614	0.588	0.565	0.553	0.531
F	0.781	0.726	0.692	0.667	0.641	0.618	0.590	0.571	0.551	0.533
G	0.820	0.761	0.724	0.695	0.675	0.646	0.625	0.604	0.580	0.565
H	0.844	0.776	0.749	0.718	0.697	0.666	0.642	0.618	0.593	0.573
J	0.849	0.789	0.747	0.716	0.686	0.664	0.643	0.617	0.597	0.573
K	0.820	0.757	0.725	0.700	0.669	0.645	0.623	0.603	0.584	0.555
L	0.783	0.727	0.694	0.670	0.640	0.614	0.588	0.571	0.556	0.533
M	0.779	0.716	0.685	0.664	0.635	0.609	0.589	0.565	0.547	0.531
P	0.771	0.717	0.691	0.653	0.628	0.611	0.584	0.569	0.542	0.521
Q	0.794	0.731	0.699	0.667	0.645	0.621	0.594	0.575	0.555	0.538
R	0.861	0.793	0.762	0.725	0.696	0.671	0.651	0.628	0.602	0.582
S	0.789	0.730	0.695	0.669	0.645	0.612	0.590	0.577	0.555	0.534
Channels	11	12	13	14	15	16	17	18	19	20
A	0.532	0.515	0.509	0.485	0.474	0.463	0.457	0.454	0.459	0.483
B	0.545	0.527	0.510	0.493	0.481	0.472	0.471	0.468	0.470	0.493
C	0.533	0.520	0.500	0.490	0.473	0.465	0.457	0.456	0.459	0.486
D	0.528	0.509	0.495	0.474	0.465	0.457	0.448	0.449	0.451	0.480
E	0.516	0.498	0.484	0.465	0.459	0.444	0.442	0.431	0.433	0.449
F	0.515	0.500	0.477	0.470	0.455	0.448	0.439	0.437	0.436	0.455
G	0.541	0.523	0.504	0.495	0.484	0.471	0.464	0.464	0.464	0.486
H	0.554	0.535	0.519	0.509	0.493	0.487	0.476	0.472	0.476	0.504
J	0.555	0.531	0.518	0.505	0.489	0.482	0.476	0.474	0.479	0.502
K	0.544	0.531	0.507	0.491	0.481	0.469	0.462	0.462	0.466	0.486
L	0.514	0.500	0.485	0.471	0.457	0.446	0.439	0.434	0.434	0.459
M	0.516	0.503	0.482	0.466	0.456	0.441	0.437	0.432	0.430	0.450
P	0.514	0.495	0.481	0.467	0.453	0.435	0.432	0.424	0.427	0.441
Q	0.516	0.500	0.489	0.471	0.460	0.450	0.443	0.439	0.439	0.463
R	0.562	0.538	0.525	0.509	0.501	0.489	0.477	0.476	0.471	0.509
S	0.519	0.500	0.486	0.480	0.462	0.453	0.441	0.434	0.440	0.463

Table 7.12. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 5 for charge-pan I.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.829	0.779	0.742	0.710	0.682	0.656	0.633	0.611	0.591	0.571
B	0.811	0.762	0.726	0.695	0.667	0.642	0.620	0.598	0.578	0.559
C	0.799	0.751	0.715	0.685	0.657	0.633	0.611	0.590	0.570	0.551
D	0.811	0.762	0.726	0.695	0.667	0.642	0.619	0.598	0.578	0.559
E	0.826	0.776	0.739	0.707	0.679	0.654	0.630	0.609	0.588	0.569
F	0.846	0.795	0.757	0.725	0.696	0.670	0.646	0.624	0.603	0.583
G	0.847	0.796	0.758	0.725	0.696	0.670	0.646	0.624	0.603	0.583
H	0.826	0.776	0.739	0.707	0.679	0.654	0.630	0.609	0.588	0.569
J	0.786	0.738	0.703	0.673	0.646	0.622	0.600	0.580	0.560	0.542
K	0.780	0.733	0.699	0.669	0.642	0.619	0.597	0.577	0.558	0.540
L	0.781	0.734	0.699	0.669	0.643	0.619	0.597	0.577	0.558	0.540
M	0.784	0.737	0.702	0.672	0.646	0.622	0.600	0.579	0.560	0.542
P	0.791	0.744	0.708	0.678	0.651	0.627	0.605	0.584	0.564	0.546
Q	0.857	0.806	0.767	0.734	0.705	0.679	0.655	0.632	0.611	0.590
R	0.792	0.744	0.708	0.678	0.651	0.627	0.605	0.584	0.565	0.546
S	0.776	0.730	0.695	0.665	0.639	0.616	0.594	0.574	0.556	0.538
Channels	11	12	13	14	15	16	17	18	19	20
A	0.553	0.535	0.519	0.504	0.492	0.482	0.476	0.475	0.482	0.501
B	0.541	0.524	0.508	0.494	0.482	0.472	0.466	0.465	0.471	0.489
C	0.534	0.517	0.502	0.488	0.476	0.466	0.460	0.459	0.464	0.481
D	0.541	0.524	0.508	0.494	0.482	0.472	0.466	0.465	0.471	0.489
E	0.550	0.533	0.517	0.502	0.489	0.479	0.472	0.471	0.477	0.495
F	0.563	0.545	0.529	0.513	0.500	0.490	0.483	0.482	0.488	0.508
G	0.564	0.546	0.529	0.513	0.500	0.490	0.483	0.482	0.488	0.508
H	0.550	0.533	0.516	0.502	0.489	0.479	0.472	0.471	0.477	0.495
J	0.525	0.508	0.492	0.478	0.466	0.455	0.448	0.445	0.448	0.461
K	0.522	0.506	0.491	0.477	0.464	0.454	0.446	0.443	0.446	0.459
L	0.523	0.506	0.491	0.477	0.464	0.454	0.447	0.443	0.446	0.459
M	0.524	0.508	0.492	0.478	0.465	0.455	0.448	0.445	0.447	0.461
P	0.528	0.511	0.496	0.481	0.468	0.458	0.450	0.447	0.450	0.464
Q	0.571	0.552	0.535	0.520	0.506	0.495	0.489	0.488	0.494	0.514
R	0.528	0.512	0.496	0.481	0.469	0.458	0.451	0.447	0.450	0.464
S	0.521	0.505	0.489	0.475	0.462	0.451	0.443	0.438	0.439	0.449

Charge-Pan II

Table 7.13. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 1 for charge-pan II.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.801	0.781	0.794	0.807	0.830	0.871	0.894	0.920	0.959	0.994
B	0.800	0.784	0.791	0.810	0.827	0.856	0.887	0.931	0.968	0.998
C	0.803	0.787	0.788	0.805	0.823	0.858	0.898	0.924	0.956	0.996
D	0.804	0.778	0.796	0.809	0.831	0.861	0.890	0.923	0.961	1.000
E	0.805	0.784	0.798	0.808	0.845	0.873	0.898	0.935	0.968	1.005
F	0.808	0.789	0.793	0.814	0.835	0.861	0.898	0.927	0.971	1.005
G	0.805	0.789	0.797	0.810	0.844	0.869	0.901	0.933	0.962	0.999
H	0.810	0.786	0.794	0.815	0.839	0.869	0.898	0.934	0.966	1.005
J	0.807	0.783	0.795	0.816	0.848	0.871	0.894	0.924	0.970	1.004
K	0.812	0.784	0.798	0.812	0.833	0.870	0.898	0.936	0.969	1.007
L	0.810	0.790	0.789	0.820	0.829	0.862	0.896	0.928	0.968	1.000
M	0.806	0.785	0.795	0.802	0.833	0.865	0.899	0.931	0.969	0.998
P	0.807	0.787	0.798	0.813	0.835	0.867	0.900	0.932	0.964	1.005
Q	0.806	0.792	0.792	0.811	0.843	0.875	0.903	0.935	0.969	1.002
R	0.806	0.781	0.795	0.809	0.840	0.866	0.896	0.934	0.972	0.997
S	0.815	0.786	0.801	0.819	0.839	0.867	0.898	0.926	0.965	1.000
Channels	11	12	13	14	15	16	17	18	19	20
A	1.026	1.065	1.104	1.138	1.185	1.229	1.267	1.310	1.364	1.446
B	1.027	1.061	1.096	1.147	1.175	1.231	1.275	1.319	1.369	1.450
C	1.027	1.067	1.106	1.137	1.183	1.226	1.267	1.308	1.360	1.462
D	1.032	1.061	1.099	1.143	1.186	1.215	1.267	1.317	1.367	1.459
E	1.045	1.076	1.121	1.159	1.191	1.231	1.275	1.336	1.374	1.466
F	1.042	1.075	1.118	1.150	1.185	1.237	1.281	1.329	1.382	1.476
G	1.030	1.078	1.108	1.152	1.198	1.236	1.277	1.327	1.381	1.472
H	1.037	1.073	1.109	1.155	1.195	1.235	1.277	1.323	1.374	1.470
J	1.045	1.073	1.110	1.151	1.187	1.237	1.280	1.320	1.372	1.473
K	1.045	1.077	1.115	1.151	1.184	1.234	1.275	1.327	1.376	1.476
L	1.046	1.076	1.112	1.145	1.188	1.234	1.284	1.329	1.387	1.469
M	1.045	1.076	1.110	1.155	1.199	1.234	1.275	1.316	1.372	1.480
P	1.039	1.080	1.110	1.159	1.186	1.239	1.284	1.325	1.373	1.477
Q	1.042	1.081	1.122	1.154	1.197	1.242	1.283	1.332	1.365	1.473
R	1.040	1.076	1.115	1.161	1.183	1.233	1.271	1.329	1.381	1.476
S	1.043	1.078	1.112	1.160	1.200	1.238	1.278	1.325	1.375	1.477

Table 7.14. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 1 for charge-pan II.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.781	0.771	0.778	0.795	0.819	0.847	0.879	0.913	0.948	0.984
B	0.781	0.770	0.778	0.795	0.818	0.847	0.879	0.912	0.948	0.983
C	0.781	0.770	0.778	0.795	0.818	0.847	0.879	0.912	0.948	0.983
D	0.781	0.770	0.778	0.795	0.818	0.847	0.879	0.912	0.948	0.984
E	0.786	0.775	0.783	0.800	0.825	0.854	0.886	0.921	0.956	0.993
F	0.786	0.775	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
G	0.786	0.776	0.783	0.801	0.825	0.855	0.887	0.921	0.957	0.994
H	0.786	0.775	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
J	0.786	0.775	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.994
K	0.786	0.775	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
L	0.786	0.775	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
M	0.786	0.775	0.783	0.800	0.825	0.854	0.886	0.921	0.956	0.993
P	0.787	0.776	0.784	0.802	0.826	0.855	0.888	0.922	0.958	0.995
Q	0.787	0.777	0.784	0.802	0.826	0.856	0.888	0.923	0.958	0.995
R	0.786	0.776	0.784	0.802	0.826	0.855	0.888	0.922	0.958	0.995
S	0.787	0.776	0.784	0.802	0.826	0.856	0.888	0.923	0.958	0.995
Channels	11	12	13	14	15	16	17	18	19	20
A	1.020	1.057	1.094	1.133	1.172	1.214	1.259	1.309	1.366	1.444
B	1.020	1.057	1.094	1.132	1.172	1.214	1.259	1.309	1.366	1.444
C	1.020	1.057	1.094	1.132	1.172	1.214	1.259	1.309	1.366	1.444
D	1.020	1.057	1.094	1.133	1.172	1.214	1.259	1.309	1.366	1.444
E	1.029	1.067	1.104	1.143	1.183	1.225	1.270	1.320	1.378	1.456
F	1.030	1.067	1.105	1.144	1.184	1.226	1.271	1.322	1.380	1.460
G	1.031	1.068	1.106	1.144	1.184	1.226	1.272	1.323	1.381	1.460
H	1.030	1.068	1.105	1.144	1.184	1.226	1.272	1.322	1.381	1.460
J	1.030	1.068	1.106	1.144	1.184	1.226	1.272	1.323	1.381	1.460
K	1.030	1.067	1.105	1.144	1.184	1.226	1.271	1.322	1.380	1.459
L	1.030	1.067	1.105	1.144	1.184	1.226	1.271	1.322	1.380	1.459
M	1.030	1.067	1.105	1.143	1.183	1.225	1.271	1.321	1.380	1.459
P	1.032	1.069	1.107	1.145	1.185	1.227	1.273	1.323	1.381	1.459
Q	1.032	1.069	1.107	1.146	1.186	1.228	1.273	1.324	1.382	1.460
R	1.032	1.069	1.107	1.146	1.186	1.228	1.273	1.324	1.383	1.462
S	1.032	1.069	1.107	1.146	1.186	1.228	1.273	1.324	1.382	1.460

Table 7.15. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 2 for charge-pan II.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.517	1.474	1.479	1.476	1.480	1.487	1.492	1.511	1.521	1.532
B	1.509	1.474	1.471	1.473	1.482	1.485	1.491	1.510	1.519	1.523
C	1.518	1.482	1.472	1.481	1.486	1.490	1.498	1.507	1.517	1.529
D	1.521	1.473	1.473	1.487	1.485	1.491	1.485	1.512	1.526	1.527
E	1.523	1.491	1.487	1.491	1.494	1.499	1.508	1.527	1.537	1.552
F	1.537	1.484	1.484	1.486	1.495	1.501	1.525	1.530	1.534	1.546
G	1.532	1.490	1.486	1.487	1.499	1.510	1.520	1.517	1.545	1.549
H	1.533	1.496	1.498	1.496	1.491	1.503	1.514	1.514	1.528	1.553
J	1.528	1.489	1.482	1.483	1.492	1.496	1.512	1.518	1.533	1.542
K	1.534	1.489	1.487	1.492	1.497	1.507	1.509	1.519	1.530	1.549
L	1.531	1.488	1.490	1.484	1.488	1.507	1.520	1.525	1.537	1.538
M	1.527	1.480	1.496	1.492	1.498	1.501	1.516	1.523	1.542	1.553
P	1.535	1.492	1.488	1.494	1.497	1.509	1.513	1.523	1.542	1.556
Q	1.537	1.495	1.488	1.490	1.504	1.508	1.507	1.526	1.536	1.550
R	1.546	1.506	1.486	1.496	1.503	1.509	1.522	1.533	1.542	1.548
S	1.544	1.489	1.486	1.496	1.505	1.507	1.515	1.532	1.537	1.561

Channels	11	12	13	14	15	16	17	18	19	20
A	1.539	1.554	1.565	1.583	1.583	1.614	1.626	1.643	1.667	1.751
B	1.548	1.554	1.567	1.583	1.595	1.619	1.616	1.644	1.672	1.751
C	1.535	1.547	1.555	1.573	1.600	1.622	1.627	1.661	1.683	1.753
D	1.549	1.550	1.568	1.576	1.586	1.608	1.630	1.635	1.672	1.754
E	1.558	1.573	1.581	1.603	1.611	1.626	1.649	1.666	1.697	1.777
F	1.558	1.571	1.573	1.589	1.609	1.627	1.646	1.684	1.704	1.782
G	1.555	1.564	1.591	1.595	1.615	1.620	1.643	1.667	1.695	1.766
H	1.568	1.566	1.584	1.591	1.608	1.627	1.645	1.672	1.697	1.780
J	1.556	1.562	1.572	1.590	1.608	1.630	1.651	1.660	1.690	1.782
K	1.566	1.564	1.590	1.588	1.610	1.626	1.641	1.659	1.699	1.769
L	1.556	1.573	1.582	1.591	1.604	1.627	1.645	1.655	1.682	1.765
M	1.566	1.569	1.575	1.594	1.618	1.619	1.641	1.664	1.686	1.770
P	1.561	1.571	1.588	1.590	1.606	1.624	1.654	1.678	1.701	1.776
Q	1.558	1.581	1.590	1.592	1.613	1.627	1.644	1.675	1.706	1.785
R	1.565	1.583	1.584	1.599	1.604	1.623	1.650	1.678	1.697	1.786
S	1.566	1.564	1.585	1.594	1.613	1.628	1.648	1.660	1.697	1.770

Table 7.16. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 2 for charge-pan II.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.503	1.476	1.469	1.469	1.473	1.481	1.490	1.501	1.512	1.523
B	1.503	1.476	1.469	1.469	1.473	1.481	1.490	1.501	1.512	1.524
C	1.503	1.476	1.469	1.468	1.473	1.481	1.490	1.501	1.512	1.524
D	1.503	1.476	1.468	1.468	1.473	1.481	1.490	1.501	1.512	1.523
E	1.516	1.489	1.482	1.482	1.487	1.495	1.504	1.515	1.527	1.538
F	1.520	1.492	1.484	1.483	1.488	1.496	1.506	1.517	1.528	1.539
G	1.520	1.492	1.484	1.484	1.489	1.497	1.506	1.517	1.529	1.540
H	1.520	1.492	1.484	1.484	1.489	1.496	1.506	1.517	1.529	1.540
J	1.520	1.492	1.484	1.484	1.489	1.497	1.506	1.517	1.529	1.540
K	1.519	1.491	1.483	1.483	1.488	1.496	1.506	1.517	1.528	1.540
L	1.518	1.491	1.483	1.483	1.488	1.496	1.505	1.516	1.528	1.539
M	1.519	1.491	1.483	1.483	1.487	1.495	1.505	1.516	1.527	1.538
P	1.519	1.492	1.485	1.485	1.489	1.497	1.507	1.518	1.529	1.541
Q	1.520	1.493	1.486	1.486	1.491	1.498	1.508	1.519	1.531	1.543
R	1.522	1.494	1.486	1.486	1.491	1.499	1.508	1.519	1.531	1.543
S	1.521	1.493	1.486	1.486	1.491	1.499	1.508	1.519	1.531	1.542

Channels	11	12	13	14	15	16	17	18	19	20
A	1.535	1.546	1.558	1.571	1.585	1.601	1.621	1.647	1.681	1.739
B	1.535	1.547	1.558	1.571	1.585	1.601	1.622	1.647	1.682	1.740
C	1.535	1.546	1.558	1.571	1.585	1.601	1.621	1.647	1.682	1.740
D	1.535	1.546	1.558	1.570	1.584	1.601	1.621	1.646	1.681	1.739
E	1.550	1.561	1.573	1.586	1.600	1.616	1.636	1.662	1.697	1.756
F	1.551	1.563	1.574	1.587	1.601	1.617	1.638	1.664	1.699	1.758
G	1.552	1.563	1.575	1.588	1.602	1.619	1.639	1.666	1.701	1.761
H	1.552	1.563	1.575	1.588	1.602	1.619	1.639	1.666	1.701	1.761
J	1.552	1.564	1.575	1.588	1.602	1.619	1.639	1.666	1.701	1.761
K	1.551	1.563	1.575	1.588	1.602	1.619	1.639	1.666	1.701	1.761
L	1.551	1.562	1.574	1.587	1.601	1.617	1.638	1.664	1.699	1.759
M	1.550	1.561	1.573	1.586	1.599	1.616	1.636	1.662	1.697	1.756
P	1.552	1.564	1.576	1.588	1.602	1.618	1.638	1.664	1.698	1.756
Q	1.554	1.566	1.578	1.590	1.605	1.621	1.642	1.668	1.704	1.764
R	1.554	1.566	1.578	1.590	1.605	1.621	1.642	1.668	1.704	1.764
S	1.554	1.566	1.578	1.590	1.604	1.621	1.641	1.668	1.703	1.763

Table 7.17. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 3 for charge-pan II.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.739	1.663	1.628	1.589	1.568	1.551	1.523	1.506	1.482	1.452
B	1.738	1.657	1.627	1.584	1.551	1.535	1.528	1.496	1.478	1.452
C	1.746	1.663	1.623	1.591	1.567	1.543	1.521	1.492	1.473	1.446
D	1.755	1.654	1.623	1.603	1.571	1.547	1.522	1.501	1.481	1.460
E	1.767	1.675	1.638	1.605	1.592	1.574	1.541	1.524	1.505	1.485
F	1.767	1.675	1.643	1.609	1.587	1.574	1.543	1.526	1.501	1.483
G	1.766	1.693	1.641	1.609	1.588	1.558	1.532	1.527	1.505	1.477
H	1.766	1.680	1.654	1.608	1.586	1.570	1.534	1.514	1.505	1.480
J	1.758	1.669	1.634	1.609	1.585	1.559	1.539	1.511	1.498	1.463
K	1.754	1.670	1.631	1.614	1.578	1.553	1.542	1.505	1.483	1.464
L	1.755	1.666	1.637	1.603	1.586	1.562	1.532	1.511	1.487	1.460
M	1.759	1.680	1.638	1.608	1.581	1.561	1.532	1.512	1.496	1.481
P	1.766	1.669	1.636	1.623	1.593	1.562	1.551	1.535	1.499	1.485
Q	1.761	1.688	1.651	1.619	1.590	1.565	1.550	1.527	1.508	1.489
R	1.774	1.668	1.648	1.619	1.579	1.575	1.550	1.520	1.494	1.485
S	1.762	1.675	1.637	1.607	1.575	1.561	1.525	1.520	1.487	1.470
Channels	11	12	13	14	15	16	17	18	19	20
A	1.447	1.421	1.388	1.386	1.350	1.323	1.315	1.294	1.261	1.272
B	1.440	1.410	1.388	1.374	1.352	1.323	1.305	1.282	1.258	1.254
C	1.432	1.408	1.379	1.358	1.341	1.312	1.293	1.274	1.244	1.238
D	1.436	1.423	1.392	1.370	1.354	1.331	1.307	1.282	1.247	1.260
E	1.465	1.447	1.422	1.398	1.389	1.378	1.357	1.345	1.333	1.357
F	1.457	1.448	1.433	1.416	1.382	1.381	1.356	1.343	1.328	1.366
G	1.460	1.453	1.425	1.409	1.384	1.368	1.353	1.350	1.343	1.366
H	1.462	1.437	1.424	1.403	1.381	1.364	1.359	1.338	1.327	1.351
J	1.452	1.423	1.413	1.388	1.373	1.350	1.335	1.320	1.311	1.338
K	1.438	1.422	1.407	1.381	1.360	1.337	1.325	1.304	1.288	1.316
L	1.446	1.418	1.405	1.383	1.357	1.334	1.328	1.302	1.301	1.312
M	1.453	1.423	1.403	1.393	1.370	1.344	1.326	1.317	1.303	1.333
P	1.467	1.443	1.424	1.408	1.393	1.373	1.357	1.347	1.339	1.379
Q	1.465	1.452	1.439	1.422	1.393	1.383	1.366	1.358	1.361	1.382
R	1.471	1.445	1.432	1.414	1.394	1.374	1.358	1.358	1.343	1.382
S	1.441	1.425	1.396	1.393	1.355	1.340	1.324	1.309	1.298	1.328

Table 7.18. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 3 for charge-pan II.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.730	1.665	1.623	1.590	1.562	1.538	1.517	1.496	1.476	1.457
B	1.731	1.666	1.624	1.591	1.564	1.540	1.519	1.499	1.479	1.460
C	1.731	1.666	1.624	1.590	1.563	1.539	1.517	1.497	1.477	1.457
D	1.730	1.664	1.622	1.588	1.560	1.536	1.514	1.493	1.472	1.452
E	1.747	1.680	1.637	1.603	1.574	1.550	1.528	1.507	1.486	1.466
F	1.749	1.682	1.639	1.606	1.578	1.554	1.532	1.511	1.491	1.471
G	1.753	1.686	1.643	1.610	1.583	1.559	1.538	1.518	1.499	1.480
H	1.753	1.686	1.644	1.610	1.583	1.560	1.538	1.519	1.500	1.481
J	1.753	1.686	1.644	1.611	1.583	1.560	1.539	1.519	1.500	1.482
K	1.753	1.686	1.643	1.610	1.583	1.559	1.538	1.518	1.499	1.481
L	1.750	1.683	1.640	1.606	1.578	1.554	1.532	1.511	1.491	1.471
M	1.747	1.680	1.636	1.602	1.574	1.550	1.527	1.506	1.486	1.466
P	1.747	1.680	1.638	1.604	1.575	1.551	1.528	1.507	1.487	1.466
Q	1.755	1.688	1.646	1.612	1.585	1.561	1.540	1.521	1.502	1.483
R	1.756	1.689	1.647	1.614	1.586	1.563	1.542	1.523	1.505	1.486
S	1.755	1.688	1.645	1.612	1.585	1.561	1.540	1.520	1.502	1.483

Channels	11	12	13	14	15	16	17	18	19	20
A	1.436	1.416	1.394	1.373	1.350	1.328	1.305	1.284	1.264	1.254
B	1.440	1.420	1.399	1.378	1.356	1.334	1.313	1.292	1.272	1.264
C	1.437	1.416	1.395	1.373	1.351	1.328	1.306	1.284	1.264	1.255
D	1.431	1.410	1.388	1.365	1.342	1.319	1.296	1.273	1.252	1.241
E	1.445	1.424	1.402	1.381	1.360	1.340	1.322	1.308	1.300	1.308
F	1.451	1.431	1.410	1.390	1.369	1.350	1.334	1.320	1.313	1.323
G	1.462	1.443	1.423	1.405	1.386	1.370	1.355	1.345	1.341	1.355
H	1.463	1.444	1.425	1.406	1.388	1.372	1.358	1.348	1.344	1.359
J	1.463	1.444	1.425	1.406	1.388	1.372	1.358	1.348	1.344	1.358
K	1.462	1.443	1.424	1.405	1.386	1.370	1.355	1.345	1.341	1.354
L	1.451	1.431	1.410	1.390	1.370	1.351	1.334	1.321	1.314	1.325
M	1.445	1.424	1.402	1.381	1.360	1.340	1.322	1.308	1.300	1.309
P	1.445	1.424	1.403	1.382	1.361	1.342	1.325	1.313	1.307	1.318
Q	1.464	1.445	1.427	1.408	1.390	1.375	1.362	1.353	1.351	1.368
R	1.468	1.450	1.432	1.414	1.397	1.382	1.370	1.363	1.362	1.380
S	1.464	1.445	1.427	1.408	1.391	1.375	1.362	1.353	1.352	1.368

Table 7.19. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 4 for charge-pan II.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.137	1.045	0.989	0.940	0.899	0.862	0.834	0.811	0.792	0.764
B	1.133	1.029	0.977	0.930	0.890	0.850	0.833	0.796	0.771	0.751
C	1.113	1.021	0.958	0.901	0.866	0.833	0.803	0.778	0.753	0.730
D	1.129	1.031	0.974	0.924	0.890	0.851	0.829	0.796	0.772	0.745
E	1.282	1.183	1.142	1.097	1.057	1.019	0.989	0.960	0.939	0.904
F	1.288	1.193	1.157	1.106	1.071	1.031	1.004	0.972	0.944	0.912
G	1.294	1.204	1.147	1.112	1.066	1.029	1.003	0.963	0.939	0.921
H	1.287	1.190	1.151	1.105	1.057	1.022	0.999	0.959	0.935	0.907
J	1.255	1.155	1.107	1.059	1.019	0.986	0.947	0.920	0.892	0.866
K	1.231	1.142	1.085	1.030	0.996	0.960	0.926	0.900	0.870	0.840
L	1.232	1.131	1.074	1.029	1.000	0.962	0.931	0.902	0.875	0.843
M	1.245	1.157	1.104	1.058	1.022	0.979	0.953	0.914	0.888	0.862
P	1.305	1.211	1.163	1.113	1.082	1.045	1.015	0.982	0.954	0.935
Q	1.320	1.235	1.191	1.137	1.100	1.067	1.035	1.001	0.977	0.950
R	1.296	1.211	1.163	1.127	1.088	1.056	1.018	0.991	0.960	0.937
S	1.249	1.157	1.107	1.053	1.017	0.986	0.956	0.917	0.893	0.860
Channels	11	12	13	14	15	16	17	18	19	20
A	0.746	0.721	0.707	0.694	0.679	0.666	0.647	0.638	0.633	0.645
B	0.728	0.709	0.684	0.679	0.656	0.644	0.629	0.620	0.610	0.623
C	0.705	0.687	0.678	0.653	0.637	0.625	0.612	0.603	0.598	0.608
D	0.731	0.710	0.693	0.675	0.658	0.646	0.629	0.619	0.620	0.633
E	0.880	0.863	0.840	0.821	0.803	0.792	0.770	0.763	0.748	0.765
F	0.890	0.871	0.851	0.822	0.808	0.793	0.780	0.768	0.761	0.773
G	0.886	0.865	0.844	0.821	0.810	0.797	0.776	0.766	0.751	0.767
H	0.882	0.863	0.844	0.824	0.804	0.787	0.771	0.766	0.751	0.769
J	0.845	0.820	0.799	0.778	0.758	0.742	0.734	0.719	0.704	0.726
K	0.819	0.796	0.780	0.756	0.737	0.725	0.702	0.695	0.689	0.690
L	0.816	0.792	0.775	0.749	0.735	0.721	0.708	0.700	0.684	0.696
M	0.836	0.817	0.791	0.777	0.757	0.742	0.728	0.715	0.710	0.725
P	0.897	0.878	0.865	0.839	0.825	0.804	0.794	0.776	0.766	0.782
Q	0.929	0.904	0.877	0.860	0.830	0.817	0.805	0.795	0.785	0.798
R	0.904	0.880	0.866	0.844	0.825	0.807	0.785	0.769	0.770	0.788
S	0.838	0.811	0.789	0.767	0.757	0.731	0.723	0.709	0.706	0.708

Table 7.20. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 4 for charge-pan II.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.126	1.040	0.979	0.930	0.890	0.856	0.826	0.799	0.775	0.753
B	1.137	1.052	0.991	0.943	0.903	0.869	0.839	0.813	0.789	0.767
C	1.127	1.041	0.980	0.931	0.890	0.856	0.826	0.799	0.775	0.753
D	1.111	1.025	0.963	0.913	0.872	0.838	0.807	0.780	0.756	0.734
E	1.226	1.149	1.091	1.042	1.000	0.963	0.929	0.899	0.872	0.846
F	1.243	1.167	1.110	1.061	1.020	0.983	0.950	0.920	0.893	0.868
G	1.281	1.204	1.148	1.101	1.060	1.024	0.992	0.963	0.936	0.911
H	1.285	1.209	1.152	1.105	1.065	1.029	0.997	0.968	0.941	0.916
J	1.284	1.208	1.152	1.106	1.065	1.029	0.997	0.968	0.942	0.917
K	1.280	1.204	1.148	1.101	1.061	1.025	0.993	0.964	0.937	0.912
L	1.245	1.168	1.110	1.062	1.020	0.984	0.951	0.921	0.894	0.868
M	1.227	1.149	1.091	1.043	1.000	0.963	0.930	0.900	0.872	0.847
P	1.241	1.166	1.110	1.061	1.020	0.982	0.949	0.918	0.890	0.864
Q	1.299	1.224	1.169	1.123	1.083	1.047	1.014	0.985	0.957	0.932
R	1.314	1.240	1.185	1.139	1.100	1.064	1.032	1.003	0.976	0.950
S	1.299	1.225	1.170	1.124	1.083	1.048	1.015	0.986	0.959	0.933

Channels	11	12	13	14	15	16	17	18	19	20
A	0.732	0.713	0.695	0.678	0.663	0.649	0.638	0.630	0.625	0.630
B	0.746	0.727	0.709	0.692	0.677	0.663	0.652	0.644	0.640	0.645
C	0.733	0.713	0.695	0.679	0.663	0.650	0.639	0.631	0.626	0.631
D	0.713	0.694	0.676	0.659	0.644	0.630	0.619	0.611	0.606	0.610
E	0.822	0.800	0.779	0.760	0.742	0.726	0.713	0.704	0.699	0.704
F	0.844	0.822	0.801	0.782	0.764	0.748	0.735	0.726	0.720	0.726
G	0.887	0.865	0.844	0.824	0.806	0.791	0.777	0.768	0.763	0.769
H	0.892	0.870	0.849	0.830	0.812	0.796	0.783	0.773	0.768	0.774
J	0.893	0.871	0.850	0.830	0.813	0.797	0.784	0.775	0.770	0.776
K	0.888	0.866	0.845	0.826	0.808	0.792	0.779	0.770	0.765	0.771
L	0.845	0.822	0.802	0.782	0.765	0.749	0.736	0.727	0.722	0.727
M	0.823	0.800	0.780	0.760	0.743	0.727	0.714	0.705	0.700	0.705
P	0.839	0.817	0.795	0.775	0.757	0.741	0.728	0.718	0.713	0.718
Q	0.908	0.885	0.863	0.843	0.825	0.809	0.795	0.785	0.780	0.786
R	0.926	0.903	0.882	0.862	0.844	0.828	0.814	0.805	0.800	0.807
S	0.909	0.886	0.865	0.845	0.827	0.811	0.797	0.788	0.783	0.789

Table 7.21. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 5 for charge-pan II.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.607	0.560	0.534	0.511	0.489	0.473	0.457	0.439	0.429	0.416
B	0.591	0.545	0.519	0.498	0.480	0.459	0.444	0.431	0.414	0.405
C	0.567	0.529	0.502	0.485	0.462	0.449	0.429	0.418	0.404	0.388
D	0.589	0.549	0.520	0.498	0.480	0.459	0.443	0.433	0.417	0.401
E	0.723	0.671	0.641	0.617	0.590	0.566	0.546	0.531	0.509	0.494
F	0.722	0.676	0.642	0.620	0.590	0.572	0.560	0.533	0.513	0.496
G	0.729	0.672	0.642	0.615	0.593	0.569	0.551	0.533	0.517	0.498
H	0.723	0.670	0.639	0.614	0.590	0.568	0.545	0.528	0.506	0.491
J	0.679	0.621	0.607	0.585	0.554	0.536	0.511	0.495	0.479	0.463
K	0.647	0.606	0.587	0.557	0.535	0.508	0.496	0.480	0.464	0.451
L	0.659	0.610	0.577	0.560	0.536	0.515	0.500	0.482	0.464	0.452
M	0.676	0.627	0.603	0.573	0.549	0.531	0.522	0.494	0.482	0.462
P	0.740	0.684	0.657	0.629	0.600	0.581	0.560	0.544	0.527	0.504
Q	0.756	0.701	0.670	0.636	0.616	0.597	0.572	0.549	0.531	0.510
R	0.741	0.685	0.651	0.625	0.605	0.573	0.562	0.545	0.516	0.499
S	0.671	0.619	0.592	0.572	0.547	0.524	0.511	0.490	0.474	0.455

Channels	11	12	13	14	15	16	17	18	19	20
A	0.397	0.387	0.372	0.360	0.353	0.340	0.331	0.326	0.321	0.321
B	0.390	0.378	0.367	0.353	0.340	0.326	0.328	0.315	0.310	0.311
C	0.376	0.361	0.352	0.343	0.331	0.318	0.312	0.306	0.299	0.301
D	0.395	0.380	0.367	0.355	0.342	0.332	0.325	0.316	0.313	0.318
E	0.480	0.463	0.450	0.441	0.428	0.415	0.407	0.391	0.387	0.387
F	0.487	0.474	0.456	0.437	0.427	0.411	0.402	0.394	0.388	0.391
G	0.479	0.465	0.451	0.435	0.426	0.414	0.401	0.396	0.391	0.394
H	0.472	0.457	0.448	0.431	0.418	0.414	0.401	0.393	0.387	0.393
J	0.447	0.432	0.423	0.405	0.396	0.384	0.374	0.367	0.354	0.360
K	0.437	0.421	0.408	0.396	0.379	0.366	0.362	0.353	0.342	0.345
L	0.435	0.419	0.403	0.395	0.383	0.370	0.363	0.354	0.347	0.344
M	0.448	0.435	0.420	0.406	0.401	0.388	0.374	0.368	0.358	0.363
P	0.489	0.476	0.460	0.451	0.433	0.425	0.413	0.402	0.390	0.398
Q	0.497	0.484	0.468	0.457	0.440	0.431	0.424	0.413	0.408	0.413
R	0.486	0.475	0.457	0.447	0.436	0.411	0.404	0.397	0.399	0.403
S	0.441	0.425	0.415	0.402	0.389	0.379	0.365	0.356	0.349	0.354

Table 7.22. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 5 for charge-pan II.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.593	0.558	0.531	0.508	0.488	0.470	0.454	0.439	0.424	0.411
B	0.608	0.571	0.544	0.521	0.501	0.482	0.466	0.450	0.436	0.422
C	0.595	0.559	0.532	0.510	0.490	0.472	0.456	0.441	0.427	0.413
D	0.575	0.540	0.514	0.492	0.473	0.456	0.440	0.425	0.411	0.398
E	0.662	0.622	0.592	0.567	0.544	0.524	0.506	0.489	0.473	0.458
F	0.683	0.642	0.611	0.585	0.562	0.541	0.522	0.505	0.488	0.472
G	0.724	0.681	0.648	0.621	0.596	0.574	0.554	0.535	0.518	0.501
H	0.730	0.686	0.654	0.626	0.601	0.579	0.559	0.540	0.523	0.506
J	0.732	0.689	0.656	0.628	0.604	0.582	0.562	0.543	0.526	0.509
K	0.728	0.684	0.652	0.624	0.600	0.578	0.559	0.540	0.523	0.507
L	0.685	0.644	0.614	0.588	0.565	0.544	0.525	0.508	0.492	0.476
M	0.664	0.623	0.593	0.568	0.546	0.526	0.507	0.490	0.475	0.459
P	0.675	0.634	0.604	0.578	0.555	0.535	0.516	0.499	0.482	0.467
Q	0.740	0.696	0.663	0.634	0.609	0.587	0.566	0.547	0.529	0.512
R	0.761	0.715	0.681	0.652	0.627	0.604	0.583	0.563	0.545	0.528
S	0.744	0.700	0.667	0.639	0.614	0.592	0.572	0.553	0.536	0.519
Channels	11	12	13	14	15	16	17	18	19	20
A	0.398	0.385	0.373	0.362	0.351	0.341	0.333	0.325	0.320	0.320
B	0.408	0.396	0.383	0.372	0.361	0.351	0.342	0.335	0.330	0.330
C	0.400	0.388	0.376	0.365	0.354	0.345	0.336	0.329	0.323	0.323
D	0.386	0.374	0.362	0.351	0.341	0.331	0.323	0.316	0.310	0.309
E	0.443	0.430	0.416	0.404	0.392	0.381	0.371	0.363	0.357	0.356
F	0.457	0.443	0.429	0.416	0.403	0.392	0.382	0.374	0.368	0.367
G	0.485	0.469	0.455	0.441	0.429	0.417	0.408	0.401	0.398	0.400
H	0.490	0.475	0.460	0.446	0.434	0.422	0.413	0.406	0.402	0.405
J	0.493	0.478	0.464	0.450	0.437	0.425	0.415	0.406	0.400	0.400
K	0.491	0.476	0.462	0.448	0.435	0.423	0.413	0.404	0.398	0.397
L	0.462	0.447	0.434	0.421	0.409	0.398	0.388	0.379	0.373	0.372
M	0.445	0.431	0.418	0.405	0.394	0.383	0.373	0.365	0.359	0.358
P	0.452	0.438	0.425	0.412	0.400	0.389	0.379	0.371	0.365	0.364
Q	0.495	0.479	0.465	0.450	0.438	0.426	0.416	0.409	0.405	0.408
R	0.511	0.495	0.480	0.466	0.453	0.441	0.431	0.423	0.419	0.421
S	0.503	0.488	0.473	0.459	0.446	0.434	0.424	0.415	0.409	0.408

Table 7.23. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 6 for charge-pan II.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.300	0.272	0.258	0.248	0.233	0.222	0.206	0.200	0.188	0.179
B	0.288	0.262	0.250	0.240	0.226	0.215	0.202	0.192	0.184	0.175
C	0.278	0.253	0.242	0.229	0.215	0.206	0.193	0.182	0.173	0.165
D	0.287	0.266	0.249	0.235	0.222	0.211	0.205	0.193	0.183	0.176
E	0.356	0.329	0.313	0.295	0.278	0.263	0.257	0.240	0.226	0.217
F	0.361	0.327	0.312	0.296	0.277	0.267	0.253	0.240	0.234	0.216
G	0.373	0.347	0.333	0.320	0.305	0.288	0.276	0.261	0.255	0.238
H	0.374	0.341	0.329	0.318	0.303	0.287	0.274	0.262	0.248	0.239
J	0.332	0.304	0.290	0.272	0.258	0.241	0.232	0.220	0.210	0.199
K	0.319	0.295	0.273	0.262	0.249	0.234	0.222	0.207	0.201	0.188
L	0.325	0.290	0.277	0.265	0.250	0.238	0.223	0.211	0.204	0.187
M	0.336	0.308	0.287	0.273	0.258	0.246	0.232	0.222	0.208	0.198
P	0.367	0.337	0.322	0.300	0.286	0.269	0.255	0.245	0.230	0.220
Q	0.388	0.357	0.339	0.324	0.315	0.295	0.278	0.268	0.260	0.245
R	0.381	0.351	0.338	0.319	0.303	0.293	0.282	0.267	0.253	0.245
S	0.323	0.295	0.277	0.265	0.251	0.239	0.226	0.215	0.202	0.192
Channels	11	12	13	14	15	16	17	18	19	20
A	0.172	0.161	0.156	0.147	0.138	0.130	0.122	0.116	0.116	0.116
B	0.164	0.156	0.146	0.141	0.132	0.126	0.119	0.114	0.111	0.112
C	0.156	0.150	0.140	0.133	0.128	0.119	0.115	0.112	0.108	0.106
D	0.163	0.155	0.148	0.140	0.136	0.126	0.123	0.119	0.114	0.114
E	0.203	0.194	0.181	0.173	0.166	0.157	0.148	0.143	0.142	0.141
F	0.207	0.196	0.184	0.175	0.167	0.162	0.150	0.144	0.141	0.142
G	0.229	0.214	0.203	0.193	0.184	0.176	0.165	0.160	0.153	0.151
H	0.226	0.213	0.202	0.191	0.184	0.175	0.164	0.151	0.147	0.148
J	0.189	0.181	0.167	0.157	0.149	0.143	0.138	0.132	0.129	0.130
K	0.183	0.172	0.160	0.152	0.146	0.138	0.131	0.125	0.123	0.125
L	0.182	0.174	0.163	0.154	0.146	0.142	0.133	0.127	0.121	0.122
M	0.192	0.180	0.173	0.165	0.154	0.146	0.138	0.132	0.129	0.127
P	0.210	0.197	0.188	0.178	0.170	0.158	0.158	0.146	0.144	0.143
Q	0.228	0.220	0.207	0.199	0.188	0.178	0.167	0.161	0.153	0.151
R	0.231	0.221	0.204	0.193	0.183	0.174	0.165	0.159	0.151	0.151
S	0.185	0.173	0.165	0.151	0.148	0.140	0.131	0.127	0.123	0.126

Table 7.24. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 6 for charge-pan II.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.296	0.275	0.259	0.245	0.232	0.221	0.210	0.199	0.189	0.180
B	0.305	0.284	0.267	0.253	0.240	0.228	0.217	0.206	0.196	0.186
C	0.297	0.276	0.260	0.245	0.232	0.221	0.210	0.199	0.189	0.180
D	0.285	0.265	0.249	0.235	0.223	0.211	0.200	0.190	0.181	0.172
E	0.327	0.304	0.286	0.270	0.255	0.242	0.230	0.218	0.207	0.197
F	0.339	0.315	0.297	0.281	0.266	0.252	0.240	0.228	0.216	0.206
G	0.379	0.357	0.340	0.325	0.311	0.297	0.284	0.271	0.258	0.246
H	0.384	0.361	0.344	0.328	0.313	0.300	0.286	0.273	0.260	0.248
J	0.369	0.343	0.323	0.306	0.290	0.275	0.262	0.249	0.236	0.225
K	0.366	0.340	0.320	0.303	0.287	0.272	0.259	0.246	0.233	0.222
L	0.343	0.319	0.300	0.284	0.269	0.255	0.242	0.230	0.219	0.207
M	0.329	0.306	0.288	0.272	0.258	0.244	0.232	0.220	0.209	0.199
P	0.335	0.311	0.292	0.276	0.261	0.248	0.235	0.223	0.212	0.201
Q	0.386	0.364	0.346	0.330	0.316	0.302	0.288	0.275	0.262	0.250
R	0.396	0.371	0.352	0.335	0.320	0.305	0.291	0.277	0.264	0.251
S	0.376	0.350	0.329	0.311	0.295	0.280	0.266	0.253	0.240	0.228
Channels	11	12	13	14	15	16	17	18	19	20
A	0.171	0.162	0.153	0.145	0.137	0.130	0.124	0.119	0.115	0.114
B	0.176	0.167	0.158	0.150	0.142	0.135	0.128	0.123	0.119	0.118
C	0.170	0.161	0.153	0.145	0.137	0.130	0.124	0.119	0.115	0.114
D	0.163	0.154	0.146	0.138	0.131	0.124	0.118	0.113	0.110	0.109
E	0.186	0.177	0.167	0.158	0.150	0.142	0.135	0.130	0.126	0.124
F	0.195	0.185	0.175	0.166	0.157	0.149	0.142	0.136	0.131	0.130
G	0.233	0.222	0.210	0.199	0.188	0.178	0.169	0.161	0.155	0.152
H	0.235	0.223	0.212	0.201	0.190	0.180	0.171	0.163	0.156	0.153
J	0.213	0.202	0.192	0.181	0.172	0.163	0.155	0.149	0.145	0.143
K	0.210	0.200	0.189	0.179	0.170	0.161	0.153	0.147	0.143	0.142
L	0.197	0.187	0.177	0.167	0.158	0.150	0.143	0.137	0.133	0.132
M	0.189	0.179	0.169	0.160	0.152	0.144	0.137	0.131	0.127	0.126
P	0.191	0.181	0.171	0.162	0.153	0.146	0.139	0.133	0.129	0.128
Q	0.237	0.225	0.213	0.202	0.191	0.181	0.172	0.164	0.157	0.154
R	0.239	0.227	0.215	0.203	0.193	0.183	0.173	0.166	0.160	0.157
S	0.216	0.205	0.194	0.184	0.174	0.165	0.158	0.151	0.147	0.145

Charge-Pan III

Table 7.25. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 1 for charge-pan III.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.805	0.783	0.790	0.811	0.828	0.860	0.887	0.929	0.957	0.996
B	0.801	0.778	0.791	0.809	0.829	0.858	0.894	0.928	0.958	0.994
C	0.808	0.781	0.786	0.802	0.825	0.862	0.887	0.923	0.957	0.988
D	0.809	0.773	0.792	0.807	0.827	0.852	0.885	0.920	0.960	0.997
E	0.804	0.783	0.795	0.812	0.837	0.861	0.898	0.928	0.973	0.997
F	0.809	0.784	0.793	0.810	0.840	0.867	0.891	0.928	0.966	1.004
G	0.803	0.787	0.800	0.812	0.836	0.857	0.896	0.934	0.965	1.005
H	0.812	0.786	0.798	0.810	0.839	0.869	0.894	0.932	0.965	0.998
J	0.809	0.786	0.797	0.809	0.834	0.865	0.905	0.933	0.964	1.002
K	0.811	0.782	0.795	0.817	0.833	0.864	0.894	0.937	0.967	1.007
L	0.811	0.784	0.794	0.814	0.842	0.860	0.897	0.932	0.965	1.002
M	0.814	0.788	0.799	0.810	0.843	0.867	0.900	0.924	0.965	1.001
P	0.808	0.789	0.799	0.812	0.845	0.873	0.896	0.938	0.971	1.001
Q	0.802	0.786	0.797	0.811	0.832	0.860	0.894	0.929	0.966	1.005
R	0.811	0.784	0.796	0.811	0.837	0.871	0.905	0.933	0.970	1.006
S	0.805	0.781	0.795	0.815	0.833	0.863	0.905	0.935	0.969	0.999
Channels	11	12	13	14	15	16	17	18	19	20
A	1.037	1.069	1.105	1.142	1.176	1.220	1.268	1.302	1.366	1.465
B	1.023	1.061	1.099	1.142	1.180	1.224	1.268	1.310	1.364	1.456
C	1.024	1.059	1.104	1.151	1.183	1.213	1.263	1.316	1.364	1.463
D	1.037	1.069	1.106	1.143	1.182	1.227	1.266	1.323	1.368	1.451
E	1.042	1.078	1.111	1.144	1.195	1.239	1.279	1.336	1.379	1.474
F	1.031	1.080	1.118	1.143	1.201	1.233	1.272	1.325	1.374	1.472
G	1.034	1.074	1.108	1.154	1.194	1.242	1.277	1.327	1.373	1.485
H	1.044	1.074	1.118	1.153	1.190	1.231	1.286	1.328	1.378	1.482
J	1.038	1.073	1.110	1.156	1.188	1.233	1.282	1.329	1.384	1.474
K	1.033	1.074	1.124	1.155	1.190	1.228	1.279	1.322	1.378	1.473
L	1.041	1.075	1.116	1.153	1.197	1.242	1.274	1.325	1.390	1.478
M	1.032	1.065	1.108	1.146	1.184	1.233	1.276	1.323	1.376	1.475
P	1.034	1.077	1.125	1.157	1.198	1.238	1.277	1.323	1.386	1.484
Q	1.038	1.081	1.114	1.150	1.188	1.234	1.282	1.322	1.383	1.480
R	1.037	1.079	1.117	1.156	1.194	1.246	1.277	1.336	1.375	1.479
S	1.043	1.076	1.116	1.154	1.193	1.236	1.271	1.327	1.380	1.479

Table 7.26. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 1 for charge-pan III.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.781	0.770	0.778	0.795	0.818	0.847	0.879	0.913	0.948	0.984
B	0.781	0.771	0.778	0.795	0.819	0.847	0.879	0.913	0.948	0.984
C	0.781	0.771	0.778	0.795	0.819	0.847	0.879	0.913	0.948	0.984
D	0.781	0.771	0.778	0.795	0.819	0.847	0.879	0.913	0.948	0.984
E	0.786	0.776	0.783	0.801	0.825	0.855	0.887	0.921	0.957	0.994
F	0.786	0.776	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
G	0.786	0.776	0.783	0.801	0.825	0.855	0.887	0.921	0.957	0.994
H	0.786	0.776	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
J	0.786	0.776	0.783	0.801	0.825	0.855	0.887	0.922	0.957	0.994
K	0.787	0.776	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
L	0.786	0.775	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
M	0.786	0.775	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
P	0.787	0.776	0.784	0.802	0.826	0.856	0.888	0.923	0.958	0.995
Q	0.786	0.776	0.784	0.802	0.826	0.855	0.888	0.922	0.958	0.995
R	0.787	0.776	0.784	0.802	0.826	0.855	0.888	0.923	0.958	0.995
S	0.787	0.777	0.785	0.802	0.827	0.856	0.889	0.923	0.959	0.995
Channels	11	12	13	14	15	16	17	18	19	20
A	1.020	1.057	1.094	1.133	1.172	1.214	1.259	1.309	1.367	1.445
B	1.020	1.057	1.095	1.133	1.173	1.215	1.260	1.310	1.367	1.445
C	1.020	1.057	1.095	1.133	1.173	1.215	1.260	1.310	1.367	1.445
D	1.020	1.057	1.095	1.133	1.173	1.214	1.259	1.309	1.367	1.445
E	1.031	1.068	1.106	1.144	1.184	1.227	1.272	1.323	1.381	1.460
F	1.030	1.068	1.106	1.144	1.184	1.226	1.272	1.323	1.381	1.460
G	1.030	1.068	1.106	1.144	1.184	1.226	1.272	1.323	1.381	1.460
H	1.030	1.068	1.105	1.144	1.184	1.226	1.272	1.322	1.381	1.460
J	1.031	1.068	1.106	1.145	1.185	1.227	1.272	1.323	1.382	1.461
K	1.030	1.068	1.105	1.144	1.184	1.226	1.272	1.322	1.380	1.458
L	1.030	1.068	1.105	1.144	1.184	1.226	1.272	1.322	1.381	1.460
M	1.030	1.067	1.105	1.144	1.184	1.226	1.272	1.322	1.381	1.460
P	1.032	1.069	1.107	1.146	1.186	1.228	1.273	1.324	1.382	1.460
Q	1.032	1.069	1.107	1.146	1.186	1.228	1.274	1.324	1.383	1.462
R	1.032	1.069	1.107	1.146	1.186	1.228	1.274	1.324	1.382	1.461
S	1.032	1.070	1.108	1.146	1.186	1.228	1.274	1.325	1.383	1.461

Table 7.27. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 2 for charge-pan III.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.522	1.475	1.474	1.481	1.483	1.490	1.495	1.498	1.525	1.529
B	1.519	1.466	1.475	1.479	1.487	1.495	1.502	1.512	1.525	1.535
C	1.530	1.481	1.483	1.477	1.482	1.499	1.503	1.514	1.520	1.533
D	1.525	1.464	1.466	1.486	1.473	1.486	1.501	1.522	1.527	1.532
E	1.533	1.483	1.490	1.486	1.487	1.515	1.514	1.526	1.545	1.549
F	1.532	1.491	1.489	1.495	1.497	1.509	1.513	1.523	1.539	1.555
G	1.531	1.498	1.489	1.492	1.496	1.499	1.515	1.529	1.537	1.542
H	1.533	1.487	1.493	1.490	1.501	1.506	1.522	1.521	1.539	1.544
J	1.534	1.486	1.490	1.487	1.501	1.502	1.523	1.530	1.537	1.539
K	1.542	1.499	1.486	1.489	1.490	1.499	1.518	1.514	1.529	1.544
L	1.531	1.479	1.490	1.490	1.497	1.505	1.508	1.519	1.549	1.541
M	1.537	1.485	1.483	1.495	1.496	1.507	1.507	1.529	1.538	1.540
P	1.531	1.494	1.485	1.498	1.504	1.513	1.534	1.528	1.542	1.551
Q	1.540	1.497	1.492	1.490	1.494	1.497	1.506	1.536	1.535	1.550
R	1.545	1.490	1.488	1.494	1.495	1.501	1.521	1.522	1.535	1.558
S	1.541	1.490	1.491	1.495	1.508	1.504	1.511	1.523	1.549	1.556

Channels	11	12	13	14	15	16	17	18	19	20
A	1.542	1.556	1.568	1.576	1.590	1.610	1.636	1.656	1.678	1.753
B	1.551	1.562	1.562	1.582	1.597	1.602	1.634	1.658	1.686	1.769
C	1.546	1.544	1.566	1.592	1.596	1.617	1.629	1.648	1.686	1.768
D	1.554	1.565	1.576	1.578	1.602	1.607	1.632	1.654	1.683	1.764
E	1.563	1.573	1.591	1.607	1.614	1.626	1.650	1.687	1.701	1.783
F	1.559	1.569	1.582	1.596	1.612	1.629	1.640	1.681	1.702	1.772
G	1.564	1.562	1.591	1.604	1.608	1.625	1.649	1.672	1.700	1.783
H	1.557	1.571	1.583	1.606	1.607	1.629	1.650	1.671	1.699	1.768
J	1.560	1.568	1.586	1.590	1.626	1.631	1.646	1.679	1.697	1.777
K	1.557	1.578	1.583	1.601	1.613	1.632	1.650	1.671	1.697	1.781
L	1.548	1.585	1.589	1.605	1.615	1.625	1.642	1.675	1.698	1.780
M	1.562	1.581	1.578	1.591	1.611	1.626	1.655	1.681	1.704	1.789
P	1.570	1.572	1.598	1.606	1.622	1.636	1.656	1.686	1.705	1.786
Q	1.556	1.571	1.588	1.604	1.621	1.638	1.650	1.680	1.702	1.785
R	1.558	1.577	1.591	1.610	1.613	1.622	1.647	1.669	1.701	1.783
S	1.570	1.570	1.580	1.587	1.618	1.627	1.647	1.667	1.706	1.784

Table 7.28. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 2 for charge-pan III.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.504	1.477	1.469	1.469	1.474	1.482	1.491	1.502	1.513	1.525
B	1.504	1.477	1.470	1.470	1.474	1.482	1.492	1.502	1.514	1.525
C	1.505	1.478	1.470	1.470	1.475	1.482	1.492	1.503	1.514	1.526
D	1.504	1.477	1.469	1.469	1.474	1.482	1.492	1.502	1.514	1.525
E	1.520	1.493	1.485	1.484	1.489	1.497	1.507	1.518	1.529	1.541
F	1.520	1.492	1.484	1.484	1.489	1.496	1.506	1.517	1.529	1.540
G	1.520	1.492	1.484	1.484	1.489	1.497	1.507	1.517	1.529	1.541
H	1.520	1.492	1.484	1.484	1.489	1.497	1.506	1.517	1.529	1.540
J	1.521	1.493	1.485	1.485	1.490	1.498	1.507	1.518	1.530	1.542
K	1.519	1.492	1.484	1.484	1.489	1.497	1.507	1.518	1.530	1.542
L	1.520	1.492	1.484	1.484	1.489	1.497	1.507	1.518	1.530	1.542
M	1.520	1.492	1.484	1.484	1.489	1.497	1.507	1.518	1.529	1.541
P	1.521	1.493	1.486	1.486	1.491	1.499	1.509	1.520	1.531	1.543
Q	1.522	1.494	1.486	1.486	1.491	1.499	1.509	1.520	1.531	1.543
R	1.521	1.494	1.486	1.486	1.491	1.499	1.509	1.520	1.531	1.543
S	1.521	1.494	1.487	1.487	1.492	1.500	1.510	1.521	1.533	1.545
Channels	11	12	13	14	15	16	17	18	19	20
A	1.537	1.548	1.560	1.573	1.588	1.604	1.625	1.651	1.686	1.745
B	1.537	1.549	1.561	1.574	1.588	1.605	1.625	1.651	1.686	1.744
C	1.537	1.549	1.561	1.574	1.589	1.606	1.626	1.653	1.688	1.748
D	1.537	1.549	1.561	1.574	1.588	1.605	1.625	1.652	1.687	1.746
E	1.553	1.564	1.576	1.589	1.603	1.620	1.641	1.667	1.703	1.763
F	1.552	1.563	1.575	1.588	1.602	1.619	1.639	1.666	1.701	1.761
G	1.552	1.564	1.576	1.589	1.603	1.620	1.640	1.667	1.703	1.763
H	1.552	1.564	1.576	1.589	1.603	1.620	1.640	1.667	1.703	1.763
J	1.553	1.565	1.577	1.590	1.605	1.622	1.642	1.669	1.705	1.766
K	1.554	1.565	1.578	1.591	1.605	1.622	1.643	1.670	1.707	1.767
L	1.554	1.565	1.578	1.591	1.605	1.622	1.643	1.670	1.707	1.767
M	1.553	1.565	1.577	1.590	1.604	1.621	1.642	1.669	1.705	1.765
P	1.555	1.567	1.579	1.591	1.606	1.622	1.643	1.670	1.705	1.766
Q	1.555	1.566	1.578	1.591	1.605	1.622	1.643	1.669	1.705	1.765
R	1.555	1.567	1.579	1.591	1.606	1.622	1.643	1.670	1.706	1.766
S	1.556	1.568	1.581	1.594	1.608	1.625	1.646	1.673	1.710	1.770

Table 7.29. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 3 for charge-pan III.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.752	1.666	1.631	1.609	1.583	1.560	1.546	1.517	1.506	1.485
B	1.747	1.669	1.632	1.611	1.578	1.564	1.538	1.520	1.495	1.488
C	1.752	1.672	1.633	1.612	1.585	1.562	1.540	1.525	1.505	1.485
D	1.752	1.671	1.637	1.606	1.583	1.563	1.541	1.533	1.510	1.495
E	1.774	1.690	1.655	1.630	1.605	1.580	1.563	1.545	1.516	1.511
F	1.778	1.692	1.654	1.619	1.590	1.573	1.561	1.534	1.515	1.502
G	1.774	1.682	1.646	1.621	1.604	1.569	1.543	1.522	1.507	1.494
H	1.764	1.676	1.653	1.622	1.592	1.570	1.542	1.531	1.514	1.502
J	1.775	1.684	1.647	1.606	1.585	1.570	1.544	1.519	1.502	1.489
K	1.769	1.679	1.651	1.620	1.587	1.572	1.544	1.533	1.510	1.492
L	1.779	1.692	1.651	1.628	1.605	1.581	1.556	1.535	1.516	1.498
M	1.772	1.682	1.666	1.634	1.603	1.590	1.571	1.545	1.524	1.508
P	1.797	1.693	1.665	1.623	1.606	1.589	1.572	1.546	1.532	1.525
Q	1.780	1.682	1.648	1.624	1.595	1.572	1.553	1.535	1.513	1.495
R	1.778	1.690	1.642	1.619	1.595	1.567	1.558	1.533	1.510	1.491
S	1.772	1.682	1.662	1.618	1.595	1.570	1.551	1.535	1.517	1.500

Channels	11	12	13	14	15	16	17	18	19	20
A	1.470	1.451	1.434	1.425	1.410	1.397	1.387	1.390	1.387	1.430
B	1.458	1.457	1.427	1.413	1.400	1.390	1.382	1.376	1.378	1.407
C	1.473	1.455	1.429	1.416	1.410	1.400	1.384	1.381	1.380	1.428
D	1.481	1.461	1.454	1.429	1.419	1.408	1.394	1.394	1.386	1.428
E	1.496	1.481	1.467	1.450	1.439	1.429	1.421	1.415	1.420	1.463
F	1.488	1.474	1.460	1.448	1.430	1.423	1.411	1.403	1.396	1.436
G	1.478	1.455	1.445	1.422	1.413	1.390	1.381	1.373	1.369	1.411
H	1.484	1.456	1.435	1.417	1.406	1.395	1.375	1.364	1.374	1.398
J	1.468	1.449	1.430	1.429	1.410	1.388	1.381	1.375	1.365	1.398
K	1.476	1.465	1.438	1.430	1.410	1.394	1.375	1.380	1.375	1.415
L	1.478	1.467	1.451	1.437	1.426	1.406	1.407	1.413	1.406	1.445
M	1.495	1.475	1.469	1.450	1.432	1.424	1.417	1.415	1.414	1.457
P	1.506	1.483	1.456	1.456	1.440	1.434	1.417	1.424	1.432	1.459
Q	1.480	1.465	1.445	1.429	1.406	1.394	1.379	1.376	1.374	1.412
R	1.473	1.464	1.436	1.414	1.400	1.393	1.387	1.369	1.364	1.404
S	1.491	1.456	1.440	1.433	1.414	1.406	1.393	1.384	1.382	1.414

Table 7.30. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 3 for charge-pan III.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.738	1.673	1.632	1.600	1.574	1.551	1.531	1.513	1.495	1.478
B	1.737	1.673	1.633	1.601	1.575	1.553	1.533	1.515	1.498	1.482
C	1.741	1.676	1.636	1.604	1.578	1.556	1.537	1.519	1.502	1.486
D	1.739	1.674	1.633	1.601	1.575	1.553	1.533	1.515	1.498	1.482
E	1.755	1.689	1.647	1.614	1.587	1.564	1.544	1.525	1.507	1.489
F	1.753	1.687	1.645	1.612	1.585	1.562	1.542	1.523	1.505	1.487
G	1.755	1.689	1.646	1.613	1.586	1.563	1.543	1.524	1.506	1.488
H	1.755	1.689	1.647	1.614	1.587	1.564	1.543	1.525	1.507	1.489
J	1.759	1.693	1.651	1.618	1.592	1.570	1.550	1.532	1.515	1.498
K	1.761	1.695	1.653	1.621	1.595	1.573	1.554	1.536	1.520	1.504
L	1.761	1.695	1.653	1.621	1.595	1.573	1.554	1.536	1.520	1.504
M	1.758	1.692	1.651	1.618	1.592	1.570	1.550	1.532	1.515	1.498
P	1.758	1.692	1.649	1.617	1.590	1.567	1.547	1.528	1.510	1.492
Q	1.758	1.691	1.649	1.616	1.588	1.565	1.545	1.526	1.507	1.489
R	1.758	1.692	1.650	1.617	1.590	1.567	1.547	1.528	1.510	1.493
S	1.764	1.698	1.657	1.625	1.599	1.578	1.559	1.541	1.525	1.510
Channels	11	12	13	14	15	16	17	18	19	20
A	1.462	1.445	1.429	1.414	1.400	1.389	1.380	1.376	1.380	1.403
B	1.465	1.449	1.434	1.419	1.406	1.395	1.387	1.384	1.389	1.413
C	1.471	1.455	1.441	1.427	1.414	1.404	1.397	1.395	1.401	1.427
D	1.465	1.449	1.434	1.419	1.406	1.395	1.387	1.384	1.389	1.413
E	1.472	1.454	1.437	1.421	1.406	1.392	1.382	1.377	1.379	1.401
F	1.470	1.452	1.435	1.418	1.403	1.390	1.379	1.374	1.376	1.397
G	1.470	1.453	1.436	1.419	1.403	1.390	1.380	1.374	1.376	1.397
H	1.472	1.454	1.437	1.421	1.406	1.392	1.382	1.377	1.379	1.401
J	1.482	1.466	1.450	1.436	1.422	1.411	1.404	1.401	1.406	1.431
K	1.488	1.473	1.458	1.444	1.432	1.422	1.415	1.414	1.421	1.447
L	1.488	1.473	1.458	1.444	1.432	1.422	1.416	1.414	1.421	1.447
M	1.482	1.466	1.450	1.436	1.422	1.411	1.404	1.401	1.406	1.431
P	1.475	1.458	1.441	1.425	1.410	1.397	1.387	1.382	1.385	1.406
Q	1.472	1.454	1.436	1.419	1.404	1.390	1.379	1.373	1.375	1.396
R	1.475	1.458	1.441	1.425	1.410	1.397	1.387	1.382	1.385	1.406
S	1.494	1.479	1.465	1.451	1.439	1.430	1.424	1.423	1.430	1.456

Table 7.31. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 4 for charge-pan III.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.362	1.283	1.224	1.179	1.145	1.119	1.081	1.052	1.023	1.006
B	1.351	1.262	1.217	1.174	1.140	1.107	1.069	1.042	1.016	0.992
C	1.364	1.272	1.226	1.187	1.154	1.115	1.089	1.055	1.027	1.006
D	1.376	1.291	1.236	1.204	1.161	1.139	1.099	1.069	1.053	1.023
E	1.395	1.314	1.263	1.221	1.186	1.160	1.120	1.091	1.063	1.038
F	1.385	1.288	1.245	1.189	1.163	1.125	1.106	1.079	1.050	1.020
G	1.340	1.260	1.214	1.161	1.125	1.098	1.060	1.027	1.004	0.975
H	1.333	1.244	1.199	1.159	1.132	1.085	1.055	1.025	0.999	0.968
J	1.342	1.242	1.202	1.166	1.126	1.087	1.058	1.024	0.997	0.973
K	1.338	1.253	1.215	1.165	1.126	1.100	1.051	1.029	1.008	0.974
L	1.376	1.295	1.248	1.211	1.173	1.133	1.101	1.071	1.047	1.019
M	1.405	1.320	1.258	1.218	1.190	1.153	1.121	1.099	1.066	1.036
P	1.413	1.318	1.276	1.238	1.200	1.165	1.133	1.103	1.079	1.060
Q	1.352	1.260	1.214	1.173	1.132	1.098	1.066	1.029	1.009	0.992
R	1.342	1.244	1.207	1.156	1.126	1.092	1.056	1.026	0.993	0.973
S	1.343	1.266	1.216	1.168	1.141	1.090	1.073	1.041	1.011	0.985

Channels	11	12	13	14	15	16	17	18	19	20
A	0.982	0.957	0.937	0.916	0.893	0.880	0.860	0.855	0.841	0.854
B	0.962	0.949	0.924	0.899	0.887	0.866	0.857	0.839	0.832	0.844
C	0.978	0.946	0.933	0.914	0.889	0.885	0.871	0.859	0.845	0.863
D	1.002	0.976	0.954	0.930	0.909	0.892	0.877	0.874	0.860	0.879
E	1.015	0.994	0.972	0.952	0.931	0.916	0.908	0.888	0.884	0.896
F	0.992	0.972	0.952	0.930	0.908	0.894	0.876	0.869	0.859	0.879
G	0.952	0.926	0.908	0.882	0.865	0.844	0.839	0.824	0.812	0.836
H	0.946	0.926	0.900	0.874	0.862	0.850	0.834	0.819	0.811	0.824
J	0.948	0.930	0.904	0.884	0.858	0.845	0.828	0.821	0.803	0.824
K	0.951	0.931	0.913	0.896	0.873	0.855	0.830	0.830	0.818	0.839
L	1.001	0.972	0.951	0.933	0.913	0.894	0.878	0.866	0.861	0.874
M	1.016	0.996	0.971	0.956	0.929	0.920	0.909	0.891	0.880	0.899
P	1.027	1.009	0.985	0.962	0.943	0.927	0.914	0.902	0.901	0.917
Q	0.962	0.937	0.913	0.892	0.869	0.862	0.840	0.836	0.825	0.838
R	0.940	0.919	0.898	0.872	0.856	0.843	0.823	0.812	0.801	0.816
S	0.963	0.946	0.915	0.899	0.875	0.855	0.850	0.826	0.826	0.841

Table 7.32. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 4 for charge-pan III.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.345	1.273	1.221	1.177	1.139	1.105	1.074	1.045	1.019	0.993
B	1.356	1.285	1.233	1.189	1.151	1.117	1.087	1.058	1.032	1.007
C	1.372	1.301	1.249	1.206	1.169	1.135	1.105	1.077	1.050	1.026
D	1.356	1.284	1.233	1.189	1.151	1.117	1.086	1.058	1.032	1.007
E	1.339	1.265	1.212	1.167	1.128	1.093	1.061	1.032	1.005	0.980
F	1.334	1.261	1.207	1.162	1.123	1.088	1.056	1.027	1.000	0.975
G	1.335	1.261	1.207	1.162	1.123	1.088	1.056	1.027	1.000	0.975
H	1.339	1.265	1.212	1.167	1.128	1.093	1.061	1.032	1.005	0.980
J	1.375	1.302	1.250	1.206	1.168	1.134	1.103	1.075	1.048	1.023
K	1.393	1.321	1.269	1.225	1.188	1.154	1.124	1.096	1.070	1.045
L	1.393	1.321	1.269	1.226	1.188	1.155	1.124	1.096	1.070	1.045
M	1.375	1.302	1.250	1.206	1.168	1.134	1.103	1.075	1.048	1.023
P	1.345	1.272	1.219	1.175	1.136	1.101	1.069	1.040	1.013	0.988
Q	1.333	1.259	1.205	1.159	1.120	1.084	1.053	1.023	0.996	0.970
R	1.345	1.272	1.219	1.175	1.136	1.101	1.069	1.040	1.013	0.988
S	1.403	1.331	1.280	1.237	1.199	1.166	1.136	1.108	1.082	1.057
Channels	11	12	13	14	15	16	17	18	19	20
A	0.970	0.947	0.926	0.906	0.888	0.871	0.858	0.848	0.844	0.851
B	0.983	0.960	0.939	0.919	0.901	0.885	0.872	0.862	0.858	0.865
C	1.002	0.980	0.958	0.938	0.920	0.904	0.891	0.881	0.877	0.885
D	0.983	0.960	0.939	0.919	0.901	0.885	0.871	0.862	0.857	0.865
E	0.956	0.933	0.912	0.892	0.873	0.857	0.844	0.834	0.829	0.836
F	0.951	0.928	0.906	0.886	0.868	0.852	0.839	0.829	0.824	0.832
G	0.951	0.928	0.906	0.886	0.868	0.852	0.838	0.829	0.824	0.832
H	0.956	0.933	0.912	0.892	0.873	0.857	0.844	0.834	0.830	0.837
J	0.999	0.976	0.955	0.935	0.916	0.900	0.886	0.877	0.873	0.881
K	1.021	0.998	0.977	0.957	0.938	0.922	0.908	0.899	0.895	0.903
L	1.021	0.999	0.977	0.957	0.939	0.922	0.909	0.900	0.896	0.905
M	0.999	0.976	0.955	0.935	0.916	0.900	0.887	0.877	0.873	0.881
P	0.964	0.941	0.919	0.899	0.881	0.865	0.851	0.841	0.837	0.844
Q	0.946	0.923	0.902	0.882	0.863	0.847	0.833	0.823	0.819	0.826
R	0.964	0.941	0.919	0.899	0.881	0.864	0.851	0.841	0.836	0.843
S	1.033	1.011	0.989	0.969	0.951	0.934	0.921	0.911	0.907	0.916

Table 7.33. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 5 for charge-pan III.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.814	0.754	0.715	0.695	0.667	0.644	0.623	0.601	0.575	0.564
B	0.796	0.744	0.708	0.677	0.656	0.633	0.606	0.587	0.567	0.547
C	0.819	0.748	0.720	0.693	0.664	0.641	0.620	0.599	0.582	0.565
D	0.833	0.767	0.739	0.712	0.685	0.653	0.635	0.607	0.590	0.568
E	0.848	0.782	0.754	0.724	0.700	0.673	0.647	0.628	0.609	0.590
F	0.835	0.768	0.733	0.704	0.681	0.652	0.629	0.611	0.593	0.571
G	0.784	0.726	0.696	0.664	0.642	0.622	0.594	0.573	0.555	0.536
H	0.784	0.726	0.690	0.669	0.641	0.618	0.591	0.569	0.552	0.532
J	0.786	0.723	0.692	0.662	0.636	0.619	0.592	0.568	0.555	0.537
K	0.783	0.724	0.696	0.667	0.639	0.616	0.599	0.577	0.560	0.539
L	0.822	0.758	0.734	0.705	0.671	0.655	0.627	0.609	0.591	0.568
M	0.844	0.784	0.755	0.723	0.696	0.673	0.650	0.620	0.606	0.585
P	0.859	0.800	0.774	0.733	0.705	0.677	0.658	0.637	0.616	0.596
Q	0.789	0.741	0.702	0.671	0.644	0.629	0.603	0.589	0.561	0.546
R	0.777	0.718	0.684	0.657	0.631	0.608	0.592	0.567	0.552	0.527
S	0.790	0.734	0.704	0.670	0.647	0.621	0.602	0.580	0.559	0.540
Channels	11	12	13	14	15	16	17	18	19	20
A	0.542	0.524	0.511	0.500	0.481	0.470	0.452	0.447	0.438	0.444
B	0.532	0.516	0.500	0.488	0.478	0.462	0.448	0.436	0.430	0.432
C	0.543	0.527	0.509	0.494	0.480	0.471	0.456	0.450	0.436	0.441
D	0.554	0.542	0.526	0.511	0.495	0.476	0.466	0.456	0.452	0.457
E	0.577	0.551	0.535	0.522	0.510	0.493	0.482	0.467	0.452	0.465
F	0.548	0.533	0.514	0.509	0.490	0.481	0.470	0.451	0.449	0.450
G	0.528	0.511	0.493	0.478	0.460	0.451	0.435	0.430	0.424	0.426
H	0.511	0.499	0.482	0.470	0.452	0.440	0.438	0.423	0.412	0.421
J	0.521	0.499	0.480	0.468	0.453	0.446	0.434	0.426	0.415	0.424
K	0.526	0.501	0.498	0.479	0.460	0.451	0.438	0.430	0.424	0.423
L	0.555	0.534	0.517	0.508	0.487	0.479	0.467	0.460	0.449	0.449
M	0.571	0.555	0.538	0.516	0.506	0.492	0.484	0.469	0.458	0.461
P	0.582	0.560	0.540	0.529	0.509	0.499	0.483	0.473	0.468	0.470
Q	0.530	0.514	0.495	0.482	0.471	0.455	0.442	0.433	0.422	0.429
R	0.512	0.494	0.479	0.467	0.453	0.439	0.428	0.420	0.411	0.421
S	0.520	0.509	0.491	0.485	0.468	0.457	0.445	0.436	0.430	0.427

Table 7.34. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 5 for charge-pan III.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.804	0.757	0.721	0.691	0.665	0.641	0.619	0.599	0.580	0.562
B	0.818	0.770	0.734	0.703	0.676	0.652	0.630	0.610	0.591	0.572
C	0.837	0.788	0.751	0.720	0.693	0.668	0.646	0.625	0.605	0.587
D	0.818	0.769	0.734	0.703	0.676	0.652	0.630	0.610	0.590	0.572
E	0.789	0.743	0.708	0.678	0.652	0.629	0.608	0.588	0.569	0.552
F	0.785	0.738	0.703	0.674	0.648	0.624	0.603	0.583	0.565	0.547
G	0.785	0.738	0.703	0.674	0.648	0.624	0.603	0.583	0.565	0.547
H	0.791	0.744	0.709	0.679	0.653	0.629	0.608	0.588	0.569	0.552
J	0.833	0.783	0.747	0.716	0.689	0.664	0.642	0.621	0.602	0.583
K	0.854	0.804	0.767	0.735	0.707	0.683	0.660	0.639	0.619	0.600
L	0.856	0.805	0.768	0.736	0.708	0.683	0.660	0.639	0.619	0.600
M	0.833	0.784	0.747	0.716	0.689	0.664	0.642	0.621	0.602	0.583
P	0.797	0.750	0.715	0.685	0.659	0.635	0.614	0.594	0.575	0.557
Q	0.779	0.733	0.698	0.668	0.642	0.619	0.598	0.578	0.559	0.542
R	0.796	0.749	0.714	0.685	0.658	0.635	0.613	0.594	0.575	0.557
S	0.866	0.816	0.778	0.746	0.718	0.693	0.670	0.648	0.628	0.609
Channels	11	12	13	14	15	16	17	18	19	20
A	0.545	0.528	0.512	0.498	0.484	0.471	0.459	0.450	0.443	0.443
B	0.555	0.538	0.522	0.507	0.493	0.480	0.469	0.459	0.452	0.452
C	0.569	0.552	0.536	0.520	0.506	0.493	0.481	0.472	0.465	0.464
D	0.555	0.538	0.522	0.507	0.493	0.480	0.469	0.459	0.453	0.452
E	0.535	0.519	0.503	0.488	0.475	0.462	0.451	0.442	0.435	0.435
F	0.530	0.514	0.499	0.484	0.470	0.458	0.446	0.437	0.431	0.430
G	0.530	0.514	0.498	0.484	0.470	0.457	0.446	0.437	0.430	0.430
H	0.535	0.519	0.503	0.489	0.475	0.462	0.451	0.442	0.435	0.435
J	0.566	0.549	0.533	0.517	0.503	0.490	0.478	0.469	0.462	0.462
K	0.582	0.565	0.548	0.532	0.518	0.504	0.492	0.483	0.476	0.475
L	0.582	0.565	0.548	0.533	0.518	0.505	0.493	0.483	0.476	0.476
M	0.566	0.549	0.533	0.517	0.503	0.490	0.478	0.468	0.462	0.461
P	0.540	0.524	0.508	0.494	0.480	0.467	0.456	0.446	0.440	0.439
Q	0.525	0.509	0.493	0.479	0.465	0.452	0.442	0.433	0.427	0.427
R	0.540	0.524	0.508	0.494	0.480	0.467	0.456	0.446	0.440	0.439
S	0.591	0.573	0.557	0.541	0.526	0.512	0.500	0.490	0.484	0.483

Table 7.35. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 6 for charge-pan III.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.406	0.375	0.353	0.336	0.316	0.304	0.287	0.273	0.264	0.249
B	0.402	0.363	0.346	0.329	0.313	0.300	0.286	0.272	0.256	0.241
C	0.406	0.368	0.356	0.332	0.316	0.299	0.286	0.273	0.257	0.247
D	0.420	0.387	0.364	0.343	0.326	0.309	0.294	0.281	0.270	0.255
E	0.429	0.395	0.372	0.350	0.336	0.319	0.303	0.284	0.275	0.259
F	0.416	0.381	0.361	0.343	0.323	0.304	0.297	0.275	0.265	0.251
G	0.388	0.360	0.341	0.324	0.306	0.291	0.273	0.262	0.250	0.238
H	0.387	0.354	0.338	0.313	0.302	0.289	0.272	0.260	0.248	0.236
J	0.390	0.357	0.337	0.320	0.301	0.288	0.270	0.259	0.251	0.237
K	0.393	0.356	0.338	0.322	0.305	0.290	0.275	0.258	0.251	0.237
L	0.416	0.381	0.360	0.341	0.329	0.309	0.295	0.275	0.262	0.248
M	0.423	0.395	0.373	0.352	0.337	0.319	0.298	0.289	0.274	0.260
P	0.435	0.397	0.377	0.363	0.341	0.323	0.306	0.292	0.281	0.265
Q	0.395	0.364	0.345	0.322	0.307	0.291	0.277	0.264	0.253	0.242
R	0.387	0.356	0.336	0.318	0.303	0.293	0.280	0.261	0.247	0.238
S	0.396	0.362	0.345	0.328	0.306	0.291	0.276	0.263	0.250	0.239

Channels	11	12	13	14	15	16	17	18	19	20
A	0.233	0.222	0.212	0.201	0.187	0.179	0.173	0.166	0.163	0.163
B	0.226	0.220	0.207	0.194	0.184	0.177	0.168	0.159	0.161	0.157
C	0.235	0.224	0.211	0.202	0.189	0.183	0.173	0.167	0.162	0.163
D	0.240	0.230	0.215	0.206	0.194	0.185	0.177	0.173	0.166	0.169
E	0.246	0.234	0.222	0.212	0.204	0.190	0.183	0.176	0.171	0.170
F	0.239	0.228	0.213	0.205	0.191	0.183	0.174	0.168	0.163	0.164
G	0.224	0.214	0.204	0.194	0.182	0.172	0.166	0.161	0.154	0.157
H	0.224	0.207	0.201	0.189	0.177	0.170	0.161	0.157	0.150	0.151
J	0.224	0.210	0.199	0.194	0.183	0.169	0.162	0.161	0.150	0.153
K	0.225	0.215	0.202	0.192	0.180	0.175	0.165	0.159	0.151	0.153
L	0.238	0.228	0.219	0.203	0.193	0.187	0.174	0.170	0.164	0.166
M	0.244	0.236	0.226	0.213	0.201	0.195	0.183	0.178	0.169	0.172
P	0.252	0.237	0.224	0.217	0.205	0.195	0.185	0.176	0.175	0.179
Q	0.225	0.215	0.204	0.195	0.183	0.175	0.170	0.157	0.154	0.158
R	0.223	0.213	0.202	0.193	0.182	0.171	0.163	0.157	0.151	0.152
S	0.228	0.216	0.204	0.195	0.182	0.173	0.168	0.164	0.156	0.155

Table 7.36. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 6 for charge-pan III.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.408	0.380	0.358	0.338	0.320	0.304	0.289	0.275	0.261	0.248
B	0.417	0.388	0.365	0.345	0.327	0.311	0.295	0.281	0.267	0.254
C	0.429	0.399	0.376	0.355	0.337	0.320	0.304	0.289	0.275	0.261
D	0.417	0.388	0.365	0.346	0.328	0.311	0.296	0.281	0.267	0.254
E	0.401	0.373	0.351	0.331	0.314	0.298	0.283	0.269	0.256	0.243
F	0.397	0.369	0.347	0.328	0.311	0.295	0.281	0.267	0.254	0.241
G	0.397	0.369	0.347	0.328	0.311	0.295	0.281	0.267	0.253	0.241
H	0.401	0.373	0.351	0.332	0.314	0.298	0.283	0.269	0.256	0.243
J	0.426	0.396	0.373	0.353	0.334	0.318	0.302	0.287	0.273	0.259
K	0.439	0.408	0.385	0.364	0.345	0.328	0.312	0.296	0.282	0.268
L	0.440	0.409	0.385	0.364	0.345	0.328	0.312	0.296	0.282	0.268
M	0.426	0.396	0.373	0.353	0.334	0.317	0.302	0.287	0.273	0.259
P	0.405	0.377	0.355	0.335	0.318	0.302	0.287	0.273	0.259	0.246
Q	0.396	0.369	0.348	0.330	0.313	0.298	0.283	0.269	0.256	0.244
R	0.405	0.377	0.355	0.335	0.318	0.302	0.287	0.273	0.259	0.246
S	0.447	0.415	0.391	0.370	0.351	0.333	0.317	0.301	0.287	0.272
Channels	11	12	13	14	15	16	17	18	19	20
A	0.235	0.223	0.212	0.201	0.190	0.181	0.173	0.166	0.161	0.160
B	0.241	0.228	0.217	0.205	0.195	0.185	0.177	0.170	0.165	0.164
C	0.248	0.235	0.223	0.212	0.201	0.191	0.182	0.175	0.170	0.169
D	0.241	0.229	0.217	0.206	0.195	0.185	0.177	0.170	0.165	0.164
E	0.231	0.219	0.207	0.197	0.186	0.177	0.169	0.162	0.157	0.156
F	0.229	0.217	0.205	0.195	0.185	0.175	0.167	0.160	0.156	0.154
G	0.229	0.217	0.205	0.195	0.184	0.175	0.167	0.160	0.156	0.154
H	0.231	0.219	0.207	0.197	0.186	0.177	0.169	0.162	0.157	0.156
J	0.246	0.234	0.221	0.210	0.199	0.189	0.180	0.173	0.168	0.167
K	0.254	0.241	0.229	0.217	0.206	0.196	0.187	0.179	0.174	0.173
L	0.254	0.241	0.229	0.217	0.206	0.196	0.187	0.179	0.174	0.173
M	0.246	0.234	0.221	0.210	0.199	0.189	0.180	0.173	0.168	0.167
P	0.234	0.222	0.210	0.199	0.189	0.179	0.171	0.164	0.159	0.158
Q	0.231	0.219	0.208	0.197	0.187	0.177	0.169	0.162	0.157	0.155
R	0.234	0.222	0.210	0.199	0.189	0.179	0.171	0.164	0.159	0.158
S	0.259	0.246	0.233	0.221	0.209	0.199	0.190	0.182	0.177	0.176

Charge-Pan IV

Table 7.37. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 1 for charge-pan IV.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.802	0.782	0.788	0.817	0.829	0.856	0.885	0.926	0.960	1.000
B	0.804	0.776	0.786	0.811	0.835	0.861	0.887	0.925	0.960	0.991
C	0.812	0.785	0.792	0.813	0.840	0.857	0.889	0.919	0.957	0.989
D	0.803	0.782	0.790	0.816	0.833	0.858	0.893	0.924	0.964	0.991
E	0.808	0.789	0.796	0.814	0.832	0.869	0.902	0.931	0.969	1.003
F	0.805	0.786	0.799	0.812	0.844	0.867	0.906	0.928	0.966	0.996
G	0.803	0.792	0.801	0.813	0.834	0.869	0.895	0.931	0.966	1.000
H	0.811	0.784	0.790	0.813	0.835	0.867	0.898	0.931	0.967	1.004
J	0.800	0.788	0.799	0.814	0.841	0.864	0.897	0.925	0.970	1.000
K	0.809	0.787	0.801	0.810	0.832	0.865	0.899	0.926	0.961	1.001
L	0.806	0.786	0.797	0.811	0.840	0.866	0.895	0.929	0.966	1.004
M	0.803	0.784	0.790	0.813	0.838	0.865	0.897	0.939	0.971	1.004
P	0.806	0.784	0.791	0.812	0.837	0.869	0.900	0.928	0.965	1.002
Q	0.804	0.785	0.794	0.816	0.841	0.869	0.909	0.932	0.961	1.005
R	0.810	0.790	0.792	0.815	0.839	0.865	0.899	0.933	0.973	1.010
S	0.804	0.785	0.797	0.816	0.838	0.864	0.894	0.927	0.969	1.001
Channels	11	12	13	14	15	16	17	18	19	20
A	1.025	1.067	1.098	1.133	1.176	1.220	1.267	1.308	1.365	1.467
B	1.025	1.072	1.103	1.140	1.180	1.228	1.267	1.302	1.365	1.454
C	1.025	1.064	1.103	1.138	1.193	1.222	1.272	1.310	1.356	1.462
D	1.021	1.067	1.100	1.143	1.182	1.221	1.262	1.310	1.357	1.455
E	1.042	1.073	1.124	1.156	1.197	1.241	1.275	1.330	1.372	1.468
F	1.044	1.081	1.114	1.153	1.197	1.242	1.284	1.327	1.376	1.469
G	1.042	1.069	1.112	1.145	1.194	1.237	1.275	1.323	1.381	1.464
H	1.038	1.076	1.109	1.154	1.193	1.243	1.290	1.328	1.385	1.485
J	1.044	1.072	1.108	1.153	1.196	1.233	1.283	1.322	1.370	1.477
K	1.041	1.078	1.118	1.150	1.198	1.236	1.275	1.323	1.378	1.470
L	1.041	1.078	1.117	1.151	1.185	1.230	1.279	1.329	1.382	1.481
M	1.030	1.080	1.116	1.153	1.189	1.235	1.277	1.322	1.382	1.467
P	1.041	1.075	1.115	1.160	1.196	1.235	1.278	1.326	1.366	1.471
Q	1.042	1.076	1.119	1.164	1.185	1.228	1.271	1.326	1.386	1.473
R	1.044	1.080	1.116	1.159	1.203	1.242	1.290	1.328	1.380	1.483
S	1.039	1.069	1.109	1.155	1.191	1.231	1.275	1.329	1.376	1.472

Table 7.38. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 1 for charge-pan IV.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.781	0.770	0.778	0.795	0.818	0.847	0.879	0.912	0.948	0.984
B	0.781	0.770	0.778	0.795	0.818	0.847	0.879	0.912	0.948	0.984
C	0.780	0.770	0.777	0.795	0.818	0.847	0.879	0.912	0.948	0.983
D	0.780	0.770	0.777	0.795	0.818	0.847	0.879	0.912	0.947	0.983
E	0.786	0.776	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
F	0.786	0.775	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
G	0.786	0.775	0.783	0.801	0.825	0.854	0.886	0.921	0.957	0.993
H	0.786	0.775	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
J	0.786	0.775	0.783	0.801	0.825	0.854	0.886	0.921	0.957	0.993
K	0.785	0.775	0.783	0.800	0.825	0.854	0.886	0.921	0.957	0.993
L	0.786	0.775	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.994
M	0.786	0.775	0.783	0.801	0.825	0.854	0.887	0.921	0.957	0.993
P	0.786	0.776	0.784	0.802	0.826	0.856	0.888	0.923	0.958	0.995
Q	0.787	0.777	0.784	0.802	0.826	0.856	0.888	0.923	0.958	0.995
R	0.787	0.776	0.784	0.802	0.826	0.855	0.888	0.922	0.958	0.995
S	0.787	0.776	0.784	0.802	0.826	0.855	0.888	0.923	0.958	0.995
Channels	11	12	13	14	15	16	17	18	19	20
A	1.020	1.057	1.094	1.133	1.172	1.214	1.259	1.309	1.366	1.444
B	1.020	1.057	1.094	1.133	1.172	1.214	1.259	1.309	1.367	1.444
C	1.020	1.057	1.094	1.133	1.172	1.214	1.259	1.309	1.367	1.444
D	1.020	1.057	1.094	1.133	1.172	1.214	1.259	1.309	1.367	1.444
E	1.030	1.068	1.105	1.144	1.184	1.226	1.272	1.322	1.381	1.460
F	1.030	1.068	1.105	1.144	1.184	1.226	1.272	1.322	1.381	1.460
G	1.030	1.067	1.105	1.144	1.184	1.226	1.271	1.322	1.380	1.459
H	1.030	1.067	1.105	1.144	1.184	1.226	1.271	1.322	1.380	1.459
J	1.030	1.067	1.105	1.143	1.183	1.225	1.271	1.321	1.379	1.457
K	1.030	1.067	1.105	1.143	1.183	1.226	1.271	1.322	1.380	1.459
L	1.030	1.068	1.106	1.144	1.184	1.227	1.272	1.323	1.381	1.460
M	1.030	1.068	1.105	1.144	1.184	1.226	1.272	1.322	1.381	1.460
P	1.032	1.069	1.107	1.146	1.186	1.228	1.273	1.324	1.382	1.461
Q	1.032	1.069	1.107	1.146	1.186	1.228	1.273	1.324	1.382	1.460
R	1.032	1.069	1.107	1.145	1.185	1.228	1.273	1.324	1.382	1.460
S	1.032	1.069	1.107	1.146	1.186	1.228	1.273	1.324	1.382	1.461

Table 7.39. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 2 for charge-pan IV.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.517	1.469	1.471	1.476	1.478	1.480	1.497	1.505	1.515	1.535
B	1.515	1.479	1.476	1.465	1.487	1.493	1.498	1.502	1.515	1.538
C	1.517	1.473	1.473	1.474	1.486	1.490	1.500	1.499	1.509	1.531
D	1.527	1.479	1.474	1.467	1.470	1.487	1.496	1.500	1.523	1.540
E	1.536	1.484	1.491	1.485	1.502	1.499	1.512	1.524	1.537	1.545
F	1.541	1.491	1.493	1.491	1.502	1.497	1.503	1.523	1.538	1.540
G	1.538	1.488	1.484	1.489	1.492	1.504	1.503	1.522	1.536	1.549
H	1.534	1.492	1.489	1.489	1.491	1.506	1.513	1.515	1.528	1.547
J	1.535	1.498	1.487	1.494	1.494	1.510	1.507	1.532	1.550	1.551
K	1.531	1.493	1.491	1.489	1.497	1.510	1.513	1.526	1.536	1.546
L	1.537	1.490	1.487	1.486	1.485	1.501	1.516	1.523	1.541	1.550
M	1.538	1.476	1.493	1.486	1.486	1.507	1.512	1.532	1.536	1.549
P	1.537	1.498	1.488	1.492	1.494	1.501	1.524	1.529	1.539	1.556
Q	1.530	1.495	1.488	1.493	1.495	1.501	1.525	1.531	1.544	1.554
R	1.543	1.496	1.494	1.492	1.500	1.503	1.513	1.521	1.532	1.541
S	1.541	1.490	1.480	1.482	1.494	1.505	1.520	1.526	1.547	1.558
Channels	11	12	13	14	15	16	17	18	19	20
A	1.540	1.553	1.561	1.582	1.594	1.609	1.630	1.653	1.673	1.758
B	1.543	1.558	1.558	1.577	1.591	1.607	1.630	1.648	1.666	1.744
C	1.547	1.559	1.567	1.578	1.597	1.611	1.623	1.648	1.664	1.754
D	1.548	1.553	1.566	1.587	1.600	1.606	1.627	1.643	1.670	1.752
E	1.563	1.568	1.583	1.589	1.613	1.616	1.636	1.671	1.696	1.772
F	1.563	1.564	1.579	1.589	1.602	1.618	1.638	1.658	1.692	1.779
G	1.558	1.558	1.577	1.590	1.598	1.621	1.644	1.668	1.691	1.769
H	1.555	1.568	1.577	1.604	1.613	1.627	1.645	1.665	1.693	1.787
J	1.563	1.575	1.581	1.598	1.613	1.625	1.642	1.663	1.697	1.777
K	1.561	1.570	1.590	1.608	1.608	1.629	1.655	1.664	1.703	1.776
L	1.560	1.572	1.575	1.594	1.607	1.630	1.642	1.670	1.693	1.780
M	1.566	1.573	1.580	1.608	1.607	1.620	1.645	1.665	1.692	1.780
P	1.559	1.572	1.579	1.600	1.603	1.624	1.645	1.665	1.696	1.778
Q	1.567	1.582	1.588	1.592	1.611	1.628	1.639	1.662	1.691	1.780
R	1.553	1.571	1.585	1.602	1.622	1.626	1.646	1.666	1.698	1.771
S	1.568	1.577	1.588	1.603	1.606	1.628	1.651	1.669	1.697	1.779

Table 7.40. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 2 for charge-pan IV.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.504	1.476	1.469	1.469	1.473	1.481	1.490	1.501	1.512	1.524
B	1.504	1.476	1.469	1.469	1.473	1.481	1.490	1.501	1.512	1.523
C	1.504	1.476	1.469	1.469	1.473	1.481	1.490	1.501	1.512	1.524
D	1.504	1.476	1.469	1.469	1.473	1.481	1.491	1.501	1.512	1.524
E	1.520	1.492	1.484	1.484	1.488	1.496	1.506	1.517	1.528	1.540
F	1.520	1.492	1.484	1.484	1.488	1.496	1.506	1.517	1.528	1.540
G	1.519	1.491	1.483	1.483	1.488	1.495	1.505	1.516	1.527	1.539
H	1.518	1.491	1.483	1.483	1.488	1.495	1.505	1.516	1.527	1.539
J	1.517	1.490	1.483	1.482	1.487	1.495	1.505	1.515	1.527	1.538
K	1.519	1.491	1.483	1.483	1.488	1.496	1.505	1.516	1.528	1.539
L	1.520	1.492	1.484	1.484	1.489	1.496	1.506	1.517	1.528	1.540
M	1.520	1.492	1.484	1.484	1.488	1.496	1.506	1.517	1.528	1.540
P	1.521	1.493	1.486	1.486	1.491	1.498	1.508	1.519	1.531	1.542
Q	1.521	1.493	1.486	1.486	1.491	1.499	1.508	1.519	1.531	1.542
R	1.520	1.493	1.485	1.485	1.490	1.498	1.507	1.518	1.530	1.541
S	1.521	1.493	1.486	1.486	1.491	1.499	1.508	1.519	1.531	1.542
Channels	11	12	13	14	15	16	17	18	19	20
A	1.535	1.546	1.558	1.571	1.585	1.601	1.621	1.647	1.682	1.740
B	1.535	1.546	1.558	1.570	1.584	1.600	1.620	1.645	1.679	1.736
C	1.535	1.546	1.558	1.571	1.585	1.601	1.621	1.647	1.681	1.739
D	1.535	1.547	1.558	1.571	1.585	1.602	1.622	1.647	1.682	1.740
E	1.551	1.563	1.575	1.588	1.602	1.618	1.639	1.665	1.701	1.760
F	1.552	1.563	1.575	1.588	1.602	1.618	1.639	1.665	1.701	1.760
G	1.550	1.562	1.573	1.586	1.600	1.616	1.636	1.662	1.697	1.756
H	1.550	1.562	1.573	1.586	1.600	1.616	1.636	1.662	1.697	1.756
J	1.550	1.561	1.573	1.585	1.599	1.615	1.635	1.661	1.696	1.755
K	1.551	1.562	1.574	1.587	1.601	1.617	1.637	1.664	1.699	1.758
L	1.551	1.563	1.575	1.587	1.601	1.618	1.638	1.665	1.700	1.760
M	1.552	1.563	1.575	1.588	1.602	1.619	1.639	1.665	1.701	1.761
P	1.554	1.566	1.578	1.590	1.604	1.621	1.642	1.668	1.704	1.764
Q	1.554	1.565	1.577	1.590	1.604	1.620	1.641	1.667	1.702	1.761
R	1.552	1.564	1.575	1.588	1.602	1.618	1.638	1.663	1.698	1.756
S	1.554	1.566	1.578	1.590	1.604	1.621	1.641	1.668	1.703	1.763

Table 7.41. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 3 for charge-pan IV.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.742	1.650	1.618	1.586	1.563	1.546	1.516	1.491	1.466	1.447
B	1.746	1.652	1.619	1.588	1.567	1.548	1.520	1.492	1.477	1.458
C	1.739	1.663	1.626	1.583	1.565	1.549	1.517	1.498	1.476	1.458
D	1.744	1.653	1.633	1.589	1.563	1.538	1.513	1.510	1.476	1.459
E	1.754	1.677	1.645	1.620	1.585	1.554	1.536	1.517	1.496	1.467
F	1.761	1.669	1.633	1.602	1.570	1.550	1.523	1.510	1.495	1.467
G	1.760	1.680	1.648	1.606	1.574	1.544	1.534	1.511	1.485	1.472
H	1.769	1.675	1.634	1.607	1.584	1.550	1.535	1.512	1.489	1.465
J	1.772	1.675	1.639	1.611	1.582	1.557	1.543	1.518	1.494	1.479
K	1.767	1.676	1.635	1.612	1.588	1.562	1.548	1.527	1.499	1.482
L	1.772	1.670	1.654	1.608	1.579	1.562	1.545	1.516	1.504	1.476
M	1.781	1.675	1.647	1.611	1.582	1.566	1.546	1.519	1.501	1.480
P	1.756	1.691	1.642	1.616	1.585	1.570	1.543	1.517	1.502	1.482
Q	1.764	1.679	1.644	1.600	1.574	1.547	1.531	1.509	1.481	1.463
R	1.770	1.684	1.646	1.609	1.584	1.563	1.547	1.519	1.500	1.481
S	1.780	1.682	1.650	1.616	1.597	1.580	1.554	1.529	1.511	1.489

Channels	11	12	13	14	15	16	17	18	19	20
A	1.425	1.402	1.382	1.366	1.346	1.316	1.299	1.272	1.238	1.245
B	1.432	1.410	1.404	1.376	1.352	1.327	1.302	1.279	1.255	1.258
C	1.447	1.411	1.392	1.373	1.356	1.331	1.315	1.284	1.258	1.266
D	1.430	1.417	1.393	1.370	1.348	1.323	1.308	1.278	1.256	1.257
E	1.454	1.433	1.403	1.387	1.367	1.352	1.330	1.314	1.301	1.327
F	1.442	1.418	1.398	1.385	1.365	1.340	1.326	1.297	1.286	1.305
G	1.439	1.426	1.395	1.380	1.357	1.337	1.322	1.296	1.288	1.314
H	1.441	1.425	1.406	1.398	1.371	1.353	1.333	1.327	1.306	1.322
J	1.467	1.444	1.419	1.409	1.387	1.370	1.349	1.348	1.337	1.363
K	1.460	1.440	1.428	1.394	1.395	1.373	1.353	1.352	1.329	1.364
L	1.459	1.452	1.426	1.396	1.390	1.368	1.355	1.342	1.333	1.365
M	1.466	1.451	1.417	1.406	1.386	1.372	1.348	1.337	1.328	1.355
P	1.469	1.448	1.429	1.403	1.385	1.374	1.361	1.355	1.347	1.374
Q	1.443	1.424	1.407	1.374	1.368	1.341	1.330	1.313	1.304	1.331
R	1.456	1.451	1.426	1.403	1.386	1.377	1.363	1.348	1.345	1.376
S	1.477	1.463	1.427	1.420	1.408	1.389	1.366	1.359	1.355	1.393

Table 7.42. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 3 for charge-pan IV.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.731	1.665	1.623	1.590	1.563	1.539	1.517	1.496	1.477	1.457
B	1.727	1.662	1.621	1.587	1.560	1.536	1.514	1.493	1.472	1.452
C	1.731	1.665	1.623	1.590	1.563	1.539	1.517	1.496	1.477	1.457
D	1.732	1.666	1.625	1.592	1.564	1.540	1.519	1.499	1.479	1.460
E	1.752	1.686	1.643	1.610	1.583	1.559	1.538	1.519	1.500	1.481
F	1.752	1.685	1.643	1.610	1.582	1.559	1.538	1.518	1.499	1.480
G	1.747	1.681	1.638	1.604	1.576	1.552	1.531	1.510	1.490	1.471
H	1.747	1.680	1.637	1.602	1.574	1.550	1.527	1.506	1.486	1.466
J	1.745	1.678	1.635	1.602	1.573	1.549	1.527	1.506	1.486	1.465
K	1.749	1.682	1.639	1.606	1.578	1.554	1.532	1.511	1.491	1.471
L	1.751	1.685	1.642	1.609	1.582	1.558	1.537	1.518	1.499	1.480
M	1.753	1.686	1.644	1.610	1.583	1.560	1.539	1.519	1.500	1.482
P	1.756	1.689	1.647	1.613	1.586	1.563	1.542	1.523	1.504	1.486
Q	1.752	1.687	1.644	1.611	1.584	1.561	1.540	1.520	1.501	1.483
R	1.746	1.680	1.637	1.603	1.575	1.550	1.528	1.507	1.486	1.466
S	1.755	1.688	1.646	1.612	1.585	1.561	1.540	1.521	1.502	1.483

Channels	11	12	13	14	15	16	17	18	19	20
A	1.437	1.416	1.394	1.373	1.350	1.328	1.306	1.284	1.264	1.254
B	1.431	1.410	1.388	1.366	1.343	1.319	1.296	1.273	1.253	1.242
C	1.437	1.416	1.395	1.373	1.350	1.328	1.306	1.284	1.264	1.254
D	1.440	1.420	1.399	1.378	1.356	1.334	1.313	1.292	1.273	1.265
E	1.463	1.444	1.425	1.407	1.389	1.372	1.358	1.348	1.345	1.359
F	1.462	1.443	1.423	1.405	1.386	1.370	1.355	1.345	1.341	1.356
G	1.451	1.430	1.410	1.389	1.369	1.350	1.334	1.321	1.314	1.325
H	1.445	1.424	1.402	1.381	1.360	1.340	1.322	1.308	1.300	1.309
J	1.445	1.424	1.402	1.381	1.360	1.340	1.322	1.308	1.300	1.309
K	1.451	1.431	1.410	1.390	1.370	1.351	1.334	1.321	1.314	1.325
L	1.461	1.442	1.423	1.404	1.386	1.370	1.355	1.345	1.342	1.356
M	1.463	1.444	1.425	1.407	1.389	1.372	1.358	1.348	1.345	1.359
P	1.468	1.450	1.431	1.414	1.397	1.382	1.370	1.363	1.362	1.380
Q	1.464	1.445	1.426	1.408	1.390	1.375	1.362	1.353	1.351	1.368
R	1.445	1.424	1.403	1.382	1.361	1.342	1.325	1.313	1.307	1.318
S	1.464	1.445	1.427	1.408	1.391	1.375	1.362	1.353	1.352	1.368

Table 7.43. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 4 for charge-pan IV.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.122	1.019	0.958	0.912	0.874	0.837	0.811	0.784	0.749	0.733
B	1.121	1.023	0.978	0.927	0.889	0.858	0.820	0.795	0.768	0.755
C	1.139	1.043	0.985	0.939	0.902	0.867	0.837	0.811	0.792	0.768
D	1.128	1.026	0.967	0.928	0.892	0.852	0.829	0.794	0.768	0.750
E	1.245	1.155	1.103	1.058	1.019	0.985	0.940	0.910	0.885	0.861
F	1.241	1.143	1.086	1.040	0.998	0.961	0.927	0.891	0.864	0.844
G	1.231	1.140	1.081	1.034	0.998	0.959	0.925	0.906	0.869	0.844
H	1.250	1.158	1.105	1.060	1.016	0.980	0.958	0.923	0.887	0.859
J	1.291	1.187	1.146	1.100	1.059	1.021	0.985	0.954	0.932	0.904
K	1.294	1.198	1.156	1.102	1.062	1.022	1.001	0.963	0.940	0.908
L	1.297	1.196	1.154	1.107	1.067	1.024	1.000	0.966	0.943	0.916
M	1.282	1.194	1.142	1.098	1.059	1.023	0.991	0.958	0.933	0.907
P	1.307	1.206	1.164	1.122	1.076	1.044	1.008	0.982	0.954	0.932
Q	1.238	1.166	1.103	1.061	1.018	0.979	0.948	0.913	0.890	0.864
R	1.314	1.214	1.163	1.122	1.092	1.052	1.012	0.980	0.952	0.927
S	1.318	1.230	1.181	1.139	1.102	1.066	1.036	1.007	0.970	0.947

Channels	11	12	13	14	15	16	17	18	19	20
A	0.707	0.688	0.669	0.656	0.636	0.619	0.606	0.598	0.594	0.605
B	0.727	0.710	0.687	0.675	0.651	0.642	0.625	0.618	0.620	0.625
C	0.745	0.720	0.702	0.687	0.674	0.662	0.643	0.631	0.628	0.642
D	0.729	0.707	0.689	0.673	0.657	0.638	0.635	0.619	0.621	0.628
E	0.843	0.816	0.794	0.779	0.761	0.743	0.727	0.713	0.706	0.718
F	0.821	0.790	0.777	0.755	0.739	0.723	0.704	0.691	0.688	0.695
G	0.818	0.797	0.773	0.756	0.738	0.723	0.708	0.695	0.679	0.701
H	0.840	0.820	0.798	0.773	0.758	0.742	0.734	0.716	0.706	0.724
J	0.879	0.870	0.835	0.817	0.801	0.784	0.771	0.760	0.757	0.765
K	0.892	0.863	0.837	0.825	0.806	0.788	0.768	0.761	0.760	0.769
L	0.887	0.866	0.849	0.829	0.812	0.786	0.773	0.771	0.758	0.772
M	0.883	0.861	0.840	0.825	0.804	0.792	0.773	0.756	0.754	0.767
P	0.903	0.881	0.859	0.837	0.820	0.805	0.787	0.780	0.768	0.790
Q	0.831	0.809	0.795	0.768	0.747	0.730	0.720	0.712	0.694	0.710
R	0.899	0.880	0.859	0.841	0.817	0.802	0.793	0.778	0.771	0.779
S	0.923	0.900	0.876	0.852	0.840	0.819	0.802	0.790	0.784	0.803

Table 7.44. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 4 for charge-pan IV.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	1.126	1.040	0.979	0.930	0.890	0.856	0.826	0.799	0.775	0.753
B	1.112	1.025	0.963	0.914	0.873	0.838	0.808	0.781	0.756	0.734
C	1.126	1.041	0.980	0.931	0.890	0.856	0.826	0.799	0.775	0.753
D	1.139	1.053	0.992	0.943	0.903	0.869	0.839	0.813	0.789	0.767
E	1.285	1.209	1.153	1.106	1.065	1.030	0.998	0.968	0.941	0.916
F	1.281	1.204	1.148	1.101	1.060	1.024	0.992	0.963	0.936	0.911
G	1.245	1.167	1.110	1.062	1.020	0.983	0.950	0.920	0.893	0.868
H	1.227	1.149	1.091	1.042	1.000	0.963	0.929	0.899	0.872	0.846
J	1.227	1.149	1.092	1.043	1.000	0.963	0.930	0.900	0.872	0.847
K	1.245	1.168	1.110	1.062	1.020	0.983	0.951	0.921	0.894	0.868
L	1.281	1.205	1.149	1.102	1.061	1.025	0.993	0.964	0.937	0.912
M	1.285	1.209	1.153	1.106	1.066	1.030	0.998	0.969	0.942	0.917
P	1.313	1.239	1.185	1.139	1.099	1.064	1.032	1.003	0.976	0.950
Q	1.299	1.224	1.170	1.123	1.083	1.047	1.014	0.985	0.957	0.932
R	1.241	1.166	1.110	1.061	1.020	0.982	0.949	0.918	0.890	0.864
S	1.299	1.225	1.170	1.124	1.083	1.048	1.015	0.986	0.959	0.933
Channels	11	12	13	14	15	16	17	18	19	20
A	0.732	0.713	0.695	0.678	0.663	0.649	0.638	0.630	0.625	0.630
B	0.713	0.694	0.676	0.659	0.644	0.630	0.619	0.611	0.606	0.610
C	0.733	0.713	0.695	0.679	0.663	0.650	0.639	0.630	0.626	0.631
D	0.746	0.727	0.709	0.692	0.677	0.663	0.652	0.644	0.639	0.644
E	0.893	0.870	0.849	0.830	0.812	0.796	0.783	0.774	0.769	0.775
F	0.887	0.865	0.844	0.824	0.806	0.791	0.777	0.768	0.763	0.769
G	0.844	0.822	0.801	0.782	0.764	0.748	0.735	0.726	0.721	0.726
H	0.822	0.800	0.779	0.760	0.742	0.726	0.713	0.704	0.698	0.703
J	0.823	0.800	0.779	0.760	0.742	0.727	0.714	0.704	0.699	0.704
K	0.845	0.822	0.802	0.782	0.765	0.749	0.736	0.727	0.722	0.727
L	0.888	0.866	0.845	0.826	0.808	0.793	0.780	0.770	0.766	0.772
M	0.893	0.871	0.850	0.830	0.813	0.797	0.784	0.774	0.770	0.776
P	0.926	0.903	0.882	0.862	0.844	0.828	0.814	0.804	0.800	0.806
Q	0.908	0.885	0.863	0.843	0.825	0.809	0.795	0.785	0.780	0.786
R	0.839	0.816	0.795	0.775	0.757	0.741	0.727	0.717	0.712	0.716
S	0.909	0.886	0.865	0.845	0.827	0.811	0.797	0.787	0.783	0.789

Table 7.45. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 5 for charge-pan IV.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.567	0.528	0.507	0.483	0.463	0.450	0.431	0.411	0.403	0.389
B	0.584	0.540	0.521	0.504	0.476	0.457	0.441	0.426	0.415	0.403
C	0.595	0.555	0.535	0.511	0.492	0.475	0.458	0.444	0.427	0.413
D	0.591	0.545	0.519	0.495	0.481	0.459	0.448	0.431	0.416	0.405
E	0.677	0.631	0.600	0.574	0.554	0.533	0.516	0.503	0.481	0.467
F	0.658	0.606	0.584	0.562	0.533	0.519	0.500	0.484	0.462	0.447
G	0.648	0.608	0.583	0.553	0.531	0.518	0.494	0.473	0.467	0.450
H	0.679	0.625	0.598	0.579	0.550	0.532	0.518	0.496	0.477	0.460
J	0.717	0.661	0.640	0.614	0.588	0.566	0.541	0.524	0.511	0.491
K	0.725	0.676	0.645	0.616	0.591	0.570	0.549	0.540	0.513	0.497
L	0.727	0.675	0.645	0.619	0.595	0.578	0.554	0.535	0.515	0.494
M	0.717	0.667	0.640	0.616	0.593	0.567	0.551	0.528	0.512	0.493
P	0.737	0.683	0.654	0.630	0.607	0.583	0.563	0.538	0.529	0.505
Q	0.673	0.624	0.595	0.563	0.545	0.522	0.509	0.487	0.466	0.456
R	0.745	0.683	0.655	0.620	0.604	0.578	0.553	0.542	0.521	0.504
S	0.757	0.694	0.665	0.635	0.620	0.595	0.571	0.554	0.541	0.520
Channels	11	12	13	14	15	16	17	18	19	20
A	0.380	0.363	0.354	0.342	0.334	0.322	0.311	0.305	0.299	0.303
B	0.392	0.373	0.367	0.355	0.340	0.333	0.320	0.311	0.310	0.312
C	0.398	0.383	0.374	0.360	0.349	0.343	0.334	0.325	0.319	0.317
D	0.391	0.379	0.368	0.356	0.347	0.331	0.326	0.317	0.309	0.312
E	0.446	0.434	0.427	0.411	0.399	0.384	0.375	0.369	0.361	0.363
F	0.433	0.419	0.409	0.395	0.381	0.372	0.360	0.351	0.355	0.348
G	0.430	0.422	0.405	0.387	0.382	0.374	0.359	0.352	0.347	0.352
H	0.442	0.433	0.415	0.409	0.386	0.381	0.372	0.367	0.356	0.362
J	0.472	0.464	0.449	0.431	0.420	0.405	0.401	0.397	0.385	0.393
K	0.482	0.466	0.448	0.434	0.426	0.417	0.408	0.399	0.390	0.399
L	0.481	0.466	0.448	0.445	0.426	0.414	0.408	0.393	0.382	0.387
M	0.479	0.461	0.453	0.437	0.427	0.413	0.404	0.389	0.389	0.391
P	0.489	0.475	0.464	0.446	0.440	0.426	0.413	0.402	0.396	0.398
Q	0.442	0.427	0.412	0.399	0.387	0.375	0.366	0.357	0.354	0.355
R	0.484	0.468	0.453	0.443	0.426	0.416	0.406	0.402	0.396	0.401
S	0.501	0.483	0.470	0.454	0.442	0.433	0.422	0.409	0.402	0.411

Table 7.46. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 5 for charge-pan IV.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.593	0.557	0.531	0.508	0.488	0.470	0.454	0.439	0.424	0.411
B	0.575	0.540	0.514	0.492	0.473	0.456	0.440	0.425	0.411	0.398
C	0.594	0.559	0.532	0.510	0.490	0.472	0.456	0.441	0.427	0.413
D	0.607	0.571	0.544	0.521	0.500	0.482	0.466	0.450	0.435	0.422
E	0.731	0.687	0.654	0.626	0.602	0.579	0.559	0.540	0.523	0.506
F	0.725	0.681	0.648	0.621	0.596	0.574	0.554	0.535	0.518	0.501
G	0.684	0.642	0.612	0.585	0.562	0.541	0.522	0.505	0.488	0.472
H	0.662	0.622	0.592	0.567	0.544	0.524	0.506	0.489	0.473	0.458
J	0.663	0.623	0.593	0.568	0.545	0.525	0.507	0.490	0.474	0.459
K	0.685	0.644	0.614	0.587	0.565	0.544	0.525	0.508	0.492	0.476
L	0.728	0.685	0.652	0.625	0.601	0.579	0.559	0.541	0.523	0.507
M	0.732	0.688	0.656	0.628	0.604	0.582	0.562	0.543	0.526	0.509
P	0.761	0.715	0.681	0.652	0.627	0.604	0.583	0.563	0.545	0.528
Q	0.740	0.696	0.663	0.634	0.609	0.587	0.566	0.547	0.529	0.512
R	0.674	0.633	0.603	0.577	0.554	0.534	0.515	0.498	0.482	0.467
S	0.744	0.700	0.667	0.639	0.614	0.592	0.572	0.553	0.536	0.519
Channels	11	12	13	14	15	16	17	18	19	20
A	0.398	0.385	0.373	0.362	0.351	0.341	0.332	0.325	0.320	0.320
B	0.386	0.374	0.362	0.351	0.341	0.331	0.323	0.316	0.311	0.310
C	0.400	0.388	0.376	0.365	0.354	0.345	0.336	0.329	0.323	0.323
D	0.408	0.396	0.383	0.372	0.361	0.351	0.342	0.335	0.330	0.330
E	0.490	0.474	0.460	0.446	0.434	0.422	0.413	0.406	0.402	0.405
F	0.485	0.470	0.455	0.441	0.429	0.418	0.408	0.401	0.398	0.401
G	0.457	0.443	0.429	0.416	0.403	0.392	0.382	0.374	0.368	0.367
H	0.443	0.429	0.416	0.403	0.392	0.381	0.371	0.363	0.357	0.355
J	0.445	0.431	0.418	0.405	0.394	0.383	0.373	0.365	0.359	0.358
K	0.462	0.447	0.434	0.421	0.409	0.398	0.388	0.380	0.374	0.373
L	0.491	0.476	0.462	0.448	0.435	0.424	0.413	0.405	0.398	0.398
M	0.493	0.478	0.463	0.450	0.437	0.425	0.414	0.406	0.400	0.399
P	0.511	0.495	0.480	0.466	0.453	0.441	0.431	0.423	0.419	0.421
Q	0.495	0.479	0.465	0.450	0.438	0.426	0.416	0.409	0.406	0.408
R	0.452	0.438	0.424	0.412	0.400	0.388	0.379	0.370	0.365	0.364
S	0.503	0.488	0.473	0.459	0.446	0.434	0.424	0.415	0.409	0.408

Table 7.47. Problem 6.1.1 reference solution Shift power peaking factors for axial segments in element 6 for charge-pan IV.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.274	0.258	0.239	0.227	0.217	0.203	0.196	0.182	0.174	0.166
B	0.289	0.265	0.250	0.235	0.226	0.213	0.203	0.193	0.182	0.174
C	0.295	0.271	0.255	0.241	0.231	0.220	0.207	0.201	0.189	0.179
D	0.289	0.265	0.253	0.236	0.228	0.215	0.199	0.193	0.180	0.170
E	0.340	0.308	0.289	0.274	0.263	0.250	0.234	0.223	0.214	0.199
F	0.322	0.296	0.277	0.265	0.253	0.238	0.223	0.211	0.205	0.190
G	0.319	0.290	0.281	0.264	0.248	0.233	0.219	0.209	0.198	0.189
H	0.333	0.303	0.285	0.268	0.255	0.246	0.233	0.221	0.210	0.197
J	0.376	0.342	0.330	0.313	0.298	0.290	0.280	0.261	0.252	0.240
K	0.376	0.349	0.336	0.318	0.303	0.287	0.275	0.265	0.254	0.239
L	0.361	0.329	0.311	0.294	0.279	0.267	0.255	0.243	0.225	0.217
M	0.361	0.328	0.310	0.290	0.281	0.260	0.253	0.235	0.224	0.213
P	0.365	0.337	0.318	0.301	0.284	0.268	0.257	0.246	0.236	0.219
Q	0.328	0.299	0.281	0.265	0.251	0.239	0.226	0.215	0.204	0.196
R	0.387	0.354	0.335	0.322	0.309	0.291	0.280	0.266	0.254	0.241
S	0.386	0.359	0.339	0.325	0.315	0.296	0.280	0.271	0.257	0.243

Channels	11	12	13	14	15	16	17	18	19	20
A	0.158	0.148	0.146	0.133	0.128	0.122	0.114	0.112	0.106	0.106
B	0.165	0.156	0.151	0.143	0.134	0.128	0.118	0.115	0.112	0.111
C	0.169	0.161	0.152	0.146	0.137	0.131	0.125	0.118	0.115	0.114
D	0.163	0.159	0.149	0.140	0.133	0.129	0.121	0.114	0.110	0.110
E	0.190	0.180	0.169	0.162	0.149	0.146	0.139	0.131	0.130	0.128
F	0.179	0.174	0.165	0.155	0.149	0.141	0.132	0.130	0.124	0.123
G	0.183	0.171	0.158	0.155	0.144	0.138	0.134	0.127	0.123	0.122
H	0.192	0.180	0.167	0.161	0.149	0.144	0.137	0.131	0.129	0.129
J	0.227	0.213	0.204	0.190	0.182	0.173	0.162	0.154	0.152	0.150
K	0.225	0.218	0.206	0.194	0.185	0.175	0.164	0.155	0.151	0.148
L	0.206	0.197	0.186	0.175	0.163	0.159	0.149	0.144	0.141	0.142
M	0.203	0.191	0.182	0.175	0.165	0.156	0.149	0.142	0.138	0.141
P	0.210	0.201	0.189	0.181	0.167	0.159	0.153	0.147	0.140	0.143
Q	0.186	0.175	0.166	0.154	0.148	0.140	0.134	0.129	0.122	0.126
R	0.228	0.219	0.207	0.196	0.183	0.176	0.167	0.156	0.151	0.150
S	0.230	0.219	0.209	0.198	0.187	0.176	0.166	0.160	0.150	0.152

Table 7.48. Problem 6.1.1 reference solution MPACT power peaking factors for axial segments in element 6 for charge-pan IV.

Channels	Power Peaking Factors									
	1	2	3	4	5	6	7	8	9	10
A	0.295	0.275	0.259	0.245	0.232	0.221	0.210	0.199	0.189	0.180
B	0.285	0.265	0.249	0.235	0.223	0.211	0.201	0.190	0.181	0.172
C	0.297	0.276	0.260	0.245	0.232	0.221	0.210	0.199	0.189	0.180
D	0.305	0.284	0.267	0.253	0.240	0.228	0.217	0.206	0.196	0.186
E	0.383	0.361	0.343	0.328	0.313	0.299	0.286	0.273	0.260	0.248
F	0.380	0.357	0.340	0.325	0.311	0.297	0.284	0.271	0.258	0.246
G	0.339	0.315	0.297	0.280	0.266	0.252	0.240	0.228	0.216	0.205
H	0.327	0.304	0.285	0.270	0.255	0.242	0.230	0.218	0.207	0.197
J	0.330	0.306	0.288	0.272	0.258	0.245	0.232	0.221	0.209	0.199
K	0.343	0.319	0.300	0.284	0.269	0.255	0.242	0.230	0.219	0.208
L	0.367	0.341	0.321	0.303	0.287	0.272	0.259	0.246	0.234	0.222
M	0.369	0.343	0.323	0.305	0.290	0.275	0.261	0.249	0.236	0.224
P	0.396	0.371	0.352	0.335	0.320	0.305	0.291	0.277	0.264	0.251
Q	0.387	0.364	0.346	0.331	0.316	0.302	0.288	0.275	0.262	0.250
R	0.335	0.311	0.292	0.276	0.261	0.248	0.235	0.223	0.212	0.201
S	0.376	0.350	0.329	0.311	0.295	0.280	0.266	0.253	0.240	0.228
Channels	11	12	13	14	15	16	17	18	19	20
A	0.171	0.162	0.153	0.145	0.137	0.130	0.124	0.119	0.115	0.114
B	0.163	0.154	0.146	0.138	0.131	0.124	0.118	0.113	0.110	0.109
C	0.170	0.161	0.153	0.145	0.137	0.130	0.124	0.119	0.115	0.114
D	0.176	0.167	0.158	0.150	0.142	0.135	0.128	0.123	0.119	0.118
E	0.235	0.223	0.212	0.201	0.190	0.180	0.171	0.163	0.157	0.154
F	0.234	0.222	0.210	0.199	0.188	0.178	0.169	0.161	0.155	0.152
G	0.195	0.185	0.175	0.166	0.157	0.149	0.141	0.136	0.131	0.130
H	0.186	0.177	0.167	0.158	0.150	0.142	0.135	0.130	0.126	0.124
J	0.189	0.179	0.169	0.160	0.152	0.144	0.137	0.131	0.127	0.126
K	0.197	0.187	0.177	0.167	0.158	0.150	0.143	0.137	0.133	0.132
L	0.211	0.200	0.189	0.179	0.170	0.161	0.153	0.147	0.143	0.142
M	0.213	0.202	0.191	0.181	0.172	0.163	0.155	0.149	0.144	0.143
P	0.239	0.227	0.215	0.204	0.193	0.183	0.174	0.166	0.160	0.157
Q	0.237	0.225	0.213	0.202	0.191	0.181	0.172	0.164	0.157	0.154
R	0.191	0.181	0.171	0.162	0.153	0.145	0.138	0.133	0.129	0.127
S	0.216	0.205	0.194	0.184	0.174	0.165	0.158	0.151	0.147	0.146

7.2 DEPLETION

7.2.1 Problem 6.2.1

7.2.1.1 Description

Problem 6.2.1 uses the same geometry as Problem 6.1.1, but the fuel material is depleted throughout the simulation. The control rod material is not depleted and the control rods do not move with depletion.

7.2.1.2 Reference Solution

The neutron multiplication factor for Problem 6.2.1 is shown in Table 7.49. The timing variables for both problems are shown in Table 7.50. Note that the number of particles per generation in Shift was increased and number of generations compared to Problem 6.1.1. This sped up the Shift calculation significantly.

In the reference solution for Problem 6.2.1, power peaking factors are reported by element rather than by axial segment. his is done to reduce the volume of data reported. The geometry model includes the 20 axial subdivisions of each fuel elements, as with the previous problems.

Table 7.49. Neutron multiplication factor for the reference solution of Problem 6.2.1.

Step	Burnup	Shift	MPACT	Difference
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	k_{eff} (1σ)	k_{eff} (1σ)	[pcm]
0	0.0	1.02749(11)	1.02528(1)	-221(11)
1	25.0	1.01553(10)	1.00876(1)	-676(10)
2	50.0	1.01539(10)	1.00911(1)	-629(11)
3	100.0	1.01642(11)	1.01143(1)	-500(11)
4	200.0	1.01912(10)	1.01662(1)	-250(10)
5	300.0	1.02168(11)	1.02077(1)	-91(11)
6	400.0	1.02367(10)	1.02387(1)	20(11)
7	500.0	1.02512(10)	1.02628(1)	115(10)
8	600.0	1.02642(10)	1.02795(1)	153(10)
9	700.0	1.02763(11)	1.02912(1)	149(11)
10	800.0	1.02832(11)	1.0299(1)	158(11)
11	900.0	1.02893(10)	1.03038(1)	145(10)
12	1000.0	1.02937(11)	1.03053(1)	116(11)
13	1100.0	1.02973(12)	1.03047(1)	74(12)
14	1200.0	1.02973(10)	1.0302(1)	47(10)
15	1300.0	1.02989(11)	1.02978(1)	-11(11)

Table 7.50. Timing variables for the reference solution of Problem 6.2.1

Shift						
Depletion Solves	Total Cycles per Transport Solve	Active Cycles per Transport Solve	Histories per Cycle	Compute Nodes	Cores per Node	Wall Total Time [hours]
15	1500	1200	500000	8	48	6.04
MPACT						
Depletion Solves	k_{eff} Convergence Criteria	Source Convergence Criteria	Ray Spacing [cm]	Compute Nodes	Cores per Node	Wall Total Time [hours]
15	1.0×10^{-04}	3.0×10^{-04}	0.01	12	128	24.94

Table 7.51. Problem 6.2.1 reference solution power peaking factors in element 1 for charge-pan I (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.034	1.034	1.032	1.033	1.044	1.046	1.047	1.048
1	25.0	1.064	1.063	1.062	1.068	1.081	1.076	1.071	1.079
2	50.0	1.066	1.062	1.065	1.068	1.082	1.078	1.074	1.079
3	100.0	1.057	1.057	1.062	1.057	1.073	1.074	1.070	1.070
4	200.0	1.041	1.046	1.052	1.035	1.056	1.066	1.063	1.053
5	300.0	1.028	1.037	1.047	1.022	1.043	1.057	1.056	1.038
6	400.0	1.019	1.031	1.041	1.011	1.034	1.054	1.052	1.036
7	500.0	1.014	1.028	1.039	1.005	1.031	1.051	1.047	1.026
8	600.0	1.013	1.028	1.041	1.002	1.031	1.050	1.046	1.025
9	700.0	1.012	1.030	1.040	0.998	1.027	1.052	1.049	1.023
10	800.0	1.014	1.029	1.039	0.997	1.031	1.052	1.045	1.025
11	900.0	1.015	1.033	1.043	0.997	1.034	1.057	1.051	1.030
12	1000.0	1.023	1.036	1.047	1.000	1.038	1.059	1.051	1.033
13	1100.0	1.026	1.041	1.052	1.003	1.043	1.063	1.058	1.039
14	1200.0	1.029	1.044	1.053	1.005	1.047	1.062	1.058	1.041
15	1300.0	1.035	1.047	1.054	1.009	1.054	1.068	1.057	1.048
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.046	1.046	1.046	1.046	1.058	1.058	1.058	1.058
1	25.0	1.030	1.029	1.029	1.029	1.040	1.041	1.040	1.040
2	50.0	1.030	1.031	1.030	1.031	1.041	1.042	1.041	1.041
3	100.0	1.033	1.033	1.033	1.033	1.044	1.044	1.044	1.044
4	200.0	1.036	1.036	1.036	1.035	1.047	1.047	1.047	1.047
5	300.0	1.039	1.039	1.039	1.039	1.050	1.051	1.051	1.050
6	400.0	1.040	1.040	1.040	1.040	1.052	1.052	1.052	1.052
7	500.0	1.040	1.040	1.040	1.040	1.052	1.052	1.052	1.051
8	600.0	1.040	1.040	1.040	1.040	1.052	1.052	1.051	1.051
9	700.0	1.039	1.039	1.039	1.039	1.050	1.051	1.050	1.050
10	800.0	1.038	1.038	1.038	1.038	1.050	1.050	1.049	1.049
11	900.0	1.036	1.036	1.036	1.036	1.048	1.048	1.047	1.047
12	1000.0	1.035	1.034	1.034	1.034	1.046	1.047	1.046	1.046
13	1100.0	1.033	1.032	1.032	1.032	1.044	1.045	1.044	1.044
14	1200.0	1.031	1.030	1.030	1.030	1.042	1.043	1.041	1.042
15	1300.0	1.028	1.028	1.028	1.027	1.039	1.040	1.039	1.039

Table 7.52. Problem 6.2.1 reference solution power peaking factors in element 1 for charge-pan I (2/2).

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Shift Power Peaking Factors E	F	G	H	J	K	L	M
0	0.0	1.042	1.044	1.043	1.044	1.043	1.044	1.044	1.044
1	25.0	1.073	1.073	1.073	1.072	1.069	1.074	1.075	1.075
2	50.0	1.077	1.076	1.076	1.075	1.072	1.074	1.076	1.075
3	100.0	1.070	1.073	1.069	1.066	1.064	1.066	1.070	1.070
4	200.0	1.057	1.062	1.056	1.047	1.056	1.051	1.061	1.058
5	300.0	1.050	1.056	1.045	1.033	1.051	1.043	1.051	1.049
6	400.0	1.042	1.050	1.039	1.023	1.046	1.039	1.052	1.045
7	500.0	1.040	1.049	1.035	1.013	1.044	1.036	1.050	1.040
8	600.0	1.040	1.049	1.033	1.010	1.043	1.034	1.052	1.040
9	700.0	1.040	1.049	1.036	1.009	1.046	1.035	1.052	1.039
10	800.0	1.046	1.054	1.039	1.009	1.044	1.035	1.054	1.043
11	900.0	1.046	1.058	1.044	1.009	1.053	1.041	1.057	1.046
12	1000.0	1.055	1.061	1.050	1.009	1.054	1.045	1.063	1.052
13	1100.0	1.059	1.068	1.056	1.017	1.059	1.051	1.069	1.060
14	1200.0	1.063	1.066	1.054	1.017	1.061	1.054	1.069	1.061
15	1300.0	1.069	1.074	1.063	1.017	1.060	1.056	1.072	1.064

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	MPACT Power Peaking Factors E	F	G	H	J	K	L	M
0	0.0	1.056	1.056	1.056	1.056	1.055	1.055	1.055	1.055
1	25.0	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039
2	50.0	1.040	1.040	1.040	1.039	1.039	1.039	1.039	1.040
3	100.0	1.043	1.043	1.043	1.043	1.043	1.042	1.042	1.042
4	200.0	1.046	1.046	1.046	1.045	1.045	1.045	1.046	1.045
5	300.0	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.049
6	400.0	1.050	1.050	1.050	1.050	1.050	1.050	1.050	1.049
7	500.0	1.050	1.051	1.050	1.050	1.050	1.050	1.050	1.050
8	600.0	1.050	1.050	1.050	1.050	1.049	1.049	1.050	1.050
9	700.0	1.049	1.049	1.049	1.049	1.049	1.048	1.048	1.048
10	800.0	1.048	1.048	1.048	1.048	1.047	1.047	1.048	1.047
11	900.0	1.046	1.046	1.046	1.046	1.046	1.045	1.045	1.045
12	1000.0	1.045	1.045	1.045	1.045	1.044	1.044	1.044	1.044
13	1100.0	1.043	1.043	1.043	1.043	1.042	1.042	1.042	1.042
14	1200.0	1.041	1.041	1.040	1.041	1.040	1.040	1.040	1.040
15	1300.0	1.038	1.038	1.038	1.038	1.037	1.037	1.037	1.037

Table 7.53. Problem 6.2.1 reference solution power peaking factors in element 2 for charge-pan (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.558	1.555	1.556	1.554	1.574	1.570	1.576	1.575
1	25.0	1.592	1.580	1.585	1.586	1.615	1.608	1.597	1.614
2	50.0	1.589	1.585	1.587	1.589	1.616	1.610	1.602	1.613
3	100.0	1.578	1.582	1.581	1.580	1.602	1.606	1.596	1.603
4	200.0	1.557	1.581	1.577	1.572	1.581	1.601	1.596	1.579
5	300.0	1.536	1.571	1.571	1.557	1.560	1.589	1.584	1.561
6	400.0	1.526	1.571	1.570	1.555	1.546	1.591	1.581	1.552
7	500.0	1.516	1.568	1.563	1.548	1.539	1.588	1.579	1.538
8	600.0	1.510	1.568	1.567	1.551	1.536	1.592	1.581	1.535
9	700.0	1.502	1.566	1.568	1.552	1.531	1.588	1.583	1.532
10	800.0	1.501	1.564	1.570	1.553	1.529	1.595	1.583	1.531
11	900.0	1.503	1.570	1.573	1.555	1.528	1.599	1.583	1.533
12	1000.0	1.502	1.569	1.575	1.554	1.530	1.599	1.583	1.531
13	1100.0	1.505	1.571	1.579	1.562	1.536	1.608	1.587	1.538
14	1200.0	1.507	1.574	1.584	1.566	1.539	1.611	1.592	1.539
15	1300.0	1.510	1.573	1.588	1.570	1.541	1.613	1.591	1.545
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.592	1.591	1.591	1.591	1.609	1.611	1.609	1.609
1	25.0	1.552	1.551	1.551	1.551	1.568	1.571	1.569	1.568
2	50.0	1.557	1.558	1.557	1.557	1.574	1.577	1.575	1.574
3	100.0	1.570	1.569	1.569	1.570	1.586	1.589	1.588	1.586
4	200.0	1.586	1.585	1.585	1.585	1.604	1.606	1.604	1.604
5	300.0	1.596	1.595	1.595	1.595	1.613	1.616	1.614	1.613
6	400.0	1.599	1.598	1.598	1.598	1.618	1.620	1.617	1.617
7	500.0	1.600	1.599	1.599	1.599	1.618	1.620	1.618	1.617
8	600.0	1.598	1.598	1.597	1.598	1.617	1.619	1.616	1.616
9	700.0	1.595	1.594	1.593	1.594	1.613	1.615	1.612	1.612
10	800.0	1.591	1.589	1.589	1.589	1.608	1.611	1.608	1.608
11	900.0	1.585	1.583	1.583	1.583	1.602	1.605	1.602	1.601
12	1000.0	1.579	1.577	1.577	1.577	1.596	1.598	1.595	1.595
13	1100.0	1.572	1.570	1.569	1.570	1.588	1.591	1.588	1.588
14	1200.0	1.564	1.562	1.562	1.562	1.581	1.584	1.580	1.580
15	1300.0	1.556	1.554	1.554	1.554	1.572	1.575	1.572	1.572

Table 7.54. Problem 6.2.1 reference solution power peaking factors in element 2 for charge-pan I (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.570	1.570	1.573	1.571	1.575	1.571	1.572	1.570
1	25.0	1.610	1.607	1.605	1.598	1.600	1.608	1.607	1.604
2	50.0	1.611	1.607	1.608	1.596	1.604	1.606	1.606	1.608
3	100.0	1.597	1.600	1.593	1.593	1.590	1.594	1.596	1.602
4	200.0	1.582	1.588	1.575	1.585	1.585	1.575	1.585	1.599
5	300.0	1.566	1.576	1.557	1.570	1.568	1.561	1.571	1.590
6	400.0	1.554	1.574	1.551	1.567	1.568	1.554	1.566	1.592
7	500.0	1.554	1.569	1.544	1.562	1.559	1.547	1.564	1.588
8	600.0	1.553	1.572	1.543	1.567	1.562	1.546	1.566	1.590
9	700.0	1.550	1.568	1.543	1.566	1.564	1.545	1.567	1.589
10	800.0	1.549	1.574	1.539	1.563	1.561	1.545	1.571	1.591
11	900.0	1.554	1.577	1.544	1.566	1.565	1.544	1.574	1.590
12	1000.0	1.560	1.582	1.543	1.567	1.568	1.548	1.578	1.594
13	1100.0	1.563	1.584	1.551	1.573	1.573	1.553	1.588	1.600
14	1200.0	1.568	1.593	1.555	1.576	1.578	1.559	1.589	1.601
15	1300.0	1.574	1.597	1.558	1.581	1.583	1.563	1.598	1.603
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.607	1.607	1.608	1.607	1.606	1.606	1.606	1.606
1	25.0	1.568	1.569	1.569	1.568	1.567	1.567	1.567	1.567
2	50.0	1.573	1.574	1.573	1.573	1.572	1.572	1.572	1.572
3	100.0	1.586	1.587	1.586	1.586	1.585	1.584	1.584	1.584
4	200.0	1.603	1.603	1.602	1.602	1.601	1.600	1.602	1.601
5	300.0	1.613	1.613	1.613	1.612	1.611	1.610	1.610	1.611
6	400.0	1.615	1.616	1.616	1.616	1.614	1.615	1.615	1.614
7	500.0	1.616	1.617	1.617	1.616	1.615	1.615	1.615	1.615
8	600.0	1.615	1.616	1.616	1.615	1.614	1.613	1.614	1.614
9	700.0	1.611	1.612	1.612	1.611	1.610	1.609	1.610	1.610
10	800.0	1.606	1.607	1.607	1.606	1.605	1.605	1.605	1.605
11	900.0	1.600	1.601	1.601	1.600	1.599	1.599	1.599	1.599
12	1000.0	1.594	1.595	1.595	1.594	1.592	1.592	1.592	1.593
13	1100.0	1.587	1.588	1.588	1.587	1.585	1.585	1.585	1.586
14	1200.0	1.579	1.580	1.580	1.579	1.577	1.577	1.577	1.578
15	1300.0	1.571	1.572	1.572	1.571	1.569	1.569	1.569	1.570

Table 7.55. Problem 6.2.1 reference solution power peaking factors in element 3 for charge-pan (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.502	1.507	1.501	1.499	1.507	1.511	1.533	1.511
1	25.0	1.499	1.506	1.502	1.493	1.504	1.511	1.532	1.507
2	50.0	1.499	1.504	1.501	1.495	1.497	1.511	1.533	1.506
3	100.0	1.497	1.508	1.498	1.498	1.501	1.510	1.531	1.510
4	200.0	1.503	1.517	1.500	1.506	1.506	1.514	1.534	1.514
5	300.0	1.505	1.524	1.503	1.514	1.504	1.512	1.535	1.516
6	400.0	1.501	1.524	1.499	1.514	1.507	1.513	1.531	1.514
7	500.0	1.507	1.525	1.500	1.517	1.509	1.512	1.532	1.518
8	600.0	1.507	1.529	1.502	1.518	1.507	1.511	1.536	1.521
9	700.0	1.506	1.525	1.503	1.517	1.507	1.517	1.534	1.519
10	800.0	1.506	1.530	1.505	1.519	1.512	1.517	1.536	1.523
11	900.0	1.506	1.528	1.507	1.516	1.508	1.518	1.538	1.522
12	1000.0	1.505	1.529	1.505	1.512	1.509	1.519	1.536	1.523
13	1100.0	1.509	1.532	1.511	1.515	1.511	1.525	1.540	1.523
14	1200.0	1.511	1.529	1.511	1.511	1.506	1.524	1.540	1.524
15	1300.0	1.507	1.527	1.512	1.509	1.509	1.526	1.542	1.522
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.526	1.519	1.515	1.519	1.529	1.550	1.529	1.524
1	25.0	1.503	1.497	1.493	1.496	1.505	1.527	1.506	1.500
2	50.0	1.506	1.501	1.496	1.500	1.508	1.530	1.509	1.504
3	100.0	1.514	1.508	1.504	1.508	1.516	1.539	1.517	1.512
4	200.0	1.525	1.520	1.516	1.520	1.529	1.551	1.530	1.525
5	300.0	1.532	1.526	1.522	1.526	1.535	1.557	1.535	1.530
6	400.0	1.535	1.528	1.525	1.529	1.539	1.561	1.538	1.533
7	500.0	1.536	1.530	1.526	1.530	1.540	1.562	1.539	1.534
8	600.0	1.535	1.529	1.525	1.529	1.540	1.562	1.539	1.534
9	700.0	1.535	1.528	1.524	1.529	1.538	1.560	1.538	1.533
10	800.0	1.532	1.526	1.521	1.526	1.536	1.558	1.536	1.531
11	900.0	1.529	1.523	1.518	1.523	1.533	1.554	1.533	1.528
12	1000.0	1.526	1.519	1.515	1.520	1.529	1.551	1.529	1.524
13	1100.0	1.522	1.515	1.511	1.516	1.525	1.547	1.526	1.520
14	1200.0	1.518	1.511	1.507	1.512	1.521	1.542	1.521	1.516
15	1300.0	1.514	1.507	1.502	1.508	1.516	1.537	1.517	1.511

Table 7.56. Problem 6.2.1 reference solution power peaking factors in element 3 for charge-pan I (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.504	1.507	1.519	1.525	1.528	1.518	1.507	1.504
1	25.0	1.505	1.509	1.524	1.523	1.530	1.523	1.508	1.499
2	50.0	1.502	1.503	1.521	1.524	1.526	1.523	1.504	1.501
3	100.0	1.500	1.503	1.517	1.527	1.523	1.518	1.501	1.502
4	200.0	1.490	1.497	1.510	1.536	1.522	1.511	1.497	1.508
5	300.0	1.483	1.496	1.501	1.538	1.517	1.504	1.493	1.516
6	400.0	1.475	1.490	1.491	1.545	1.512	1.496	1.487	1.519
7	500.0	1.472	1.490	1.488	1.546	1.512	1.492	1.488	1.524
8	600.0	1.467	1.486	1.481	1.546	1.509	1.486	1.484	1.522
9	700.0	1.464	1.487	1.479	1.543	1.508	1.484	1.480	1.524
10	800.0	1.463	1.490	1.478	1.545	1.508	1.480	1.484	1.525
11	900.0	1.457	1.487	1.474	1.545	1.507	1.477	1.482	1.525
12	1000.0	1.457	1.487	1.474	1.544	1.509	1.480	1.482	1.527
13	1100.0	1.455	1.491	1.472	1.542	1.509	1.475	1.486	1.530
14	1200.0	1.453	1.490	1.468	1.539	1.510	1.477	1.482	1.527
15	1300.0	1.449	1.489	1.469	1.537	1.511	1.476	1.483	1.525
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.536	1.543	1.544	1.536	1.524	1.523	1.523	1.524
1	25.0	1.514	1.521	1.521	1.514	1.502	1.500	1.500	1.502
2	50.0	1.517	1.525	1.524	1.518	1.505	1.504	1.504	1.505
3	100.0	1.525	1.533	1.533	1.526	1.514	1.512	1.512	1.513
4	200.0	1.538	1.545	1.545	1.537	1.525	1.524	1.524	1.525
5	300.0	1.544	1.551	1.551	1.543	1.531	1.530	1.530	1.531
6	400.0	1.546	1.554	1.553	1.547	1.534	1.533	1.533	1.534
7	500.0	1.548	1.555	1.555	1.549	1.536	1.534	1.535	1.536
8	600.0	1.547	1.555	1.554	1.548	1.536	1.534	1.534	1.535
9	700.0	1.546	1.554	1.554	1.546	1.534	1.533	1.533	1.534
10	800.0	1.543	1.551	1.551	1.543	1.532	1.530	1.530	1.532
11	900.0	1.540	1.548	1.548	1.540	1.528	1.527	1.527	1.529
12	1000.0	1.537	1.545	1.545	1.537	1.525	1.524	1.524	1.526
13	1100.0	1.532	1.541	1.541	1.533	1.521	1.520	1.520	1.522
14	1200.0	1.528	1.537	1.537	1.528	1.517	1.516	1.516	1.518
15	1300.0	1.524	1.532	1.532	1.524	1.512	1.511	1.511	1.513

Table 7.57. Problem 6.2.1 reference solution power peaking factors in element 4 for charge-pan (1/2).

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Shift Power Peaking Factors A	B	C	D	P	Q	R	S
0	0.0	1.026	1.043	1.025	1.012	0.993	1.008	1.074	1.009
1	25.0	0.997	1.017	1.002	0.984	0.959	0.986	1.051	0.981
2	50.0	0.999	1.018	1.002	0.987	0.959	0.983	1.050	0.979
3	100.0	1.008	1.025	1.004	0.995	0.972	0.989	1.056	0.989
4	200.0	1.024	1.035	1.011	1.009	0.987	0.994	1.065	1.003
5	300.0	1.036	1.045	1.017	1.022	0.998	1.000	1.067	1.019
6	400.0	1.039	1.048	1.018	1.027	1.005	0.998	1.075	1.022
7	500.0	1.047	1.050	1.021	1.032	1.012	1.005	1.074	1.030
8	600.0	1.046	1.052	1.018	1.034	1.011	1.001	1.073	1.030
9	700.0	1.050	1.057	1.020	1.035	1.013	1.004	1.074	1.032
10	800.0	1.047	1.055	1.019	1.036	1.010	1.001	1.074	1.030
11	900.0	1.047	1.056	1.017	1.032	1.007	1.001	1.074	1.026
12	1000.0	1.041	1.053	1.016	1.028	1.001	0.999	1.073	1.023
13	1100.0	1.034	1.046	1.010	1.026	0.995	0.992	1.065	1.015
14	1200.0	1.032	1.046	1.008	1.022	0.993	0.994	1.068	1.014
15	1300.0	1.030	1.047	1.006	1.019	0.987	0.989	1.068	1.010

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	MPACT Power Peaking Factors A	B	C	D	P	Q	R	S
0	0.0	1.022	1.005	0.992	1.005	0.988	1.053	0.988	0.972
1	25.0	1.043	1.025	1.013	1.025	1.008	1.073	1.008	0.992
2	50.0	1.040	1.022	1.009	1.022	1.004	1.070	1.005	0.988
3	100.0	1.034	1.016	1.003	1.016	0.999	1.064	0.999	0.983
4	200.0	1.026	1.009	0.996	1.008	0.992	1.057	0.992	0.976
5	300.0	1.022	1.004	0.992	1.004	0.988	1.052	0.988	0.971
6	400.0	1.021	1.003	0.991	1.003	0.987	1.052	0.987	0.971
7	500.0	1.021	1.004	0.992	1.004	0.988	1.053	0.988	0.972
8	600.0	1.023	1.006	0.993	1.006	0.989	1.054	0.989	0.973
9	700.0	1.027	1.009	0.997	1.009	0.993	1.058	0.993	0.977
10	800.0	1.030	1.012	1.000	1.013	0.996	1.062	0.997	0.980
11	900.0	1.034	1.017	1.004	1.017	1.001	1.066	1.001	0.985
12	1000.0	1.038	1.021	1.008	1.021	1.005	1.069	1.005	0.989
13	1100.0	1.043	1.025	1.013	1.026	1.009	1.074	1.009	0.993
14	1200.0	1.048	1.030	1.017	1.031	1.014	1.079	1.014	0.998
15	1300.0	1.053	1.035	1.022	1.036	1.019	1.084	1.019	1.003

Table 7.58. Problem 6.2.1 reference solution power peaking factors in element 4 for charge-pan I (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.995	1.000	1.041	1.063	1.063	1.040	1.002	0.996
1	25.0	0.967	0.979	1.016	1.034	1.041	1.015	0.976	0.971
2	50.0	0.968	0.976	1.017	1.036	1.040	1.016	0.977	0.969
3	100.0	0.974	0.979	1.021	1.045	1.044	1.024	0.979	0.976
4	200.0	0.986	0.982	1.032	1.061	1.049	1.035	0.984	0.984
5	300.0	0.995	0.987	1.044	1.071	1.049	1.044	0.986	0.991
6	400.0	1.000	0.986	1.047	1.078	1.051	1.049	0.983	1.000
7	500.0	1.002	0.984	1.052	1.084	1.051	1.054	0.985	1.001
8	600.0	1.006	0.982	1.051	1.084	1.049	1.054	0.983	1.002
9	700.0	1.008	0.982	1.056	1.086	1.049	1.057	0.981	1.004
10	800.0	1.006	0.977	1.052	1.089	1.044	1.057	0.979	1.005
11	900.0	1.003	0.976	1.053	1.086	1.041	1.056	0.973	1.005
12	1000.0	0.998	0.971	1.048	1.085	1.041	1.054	0.970	1.002
13	1100.0	0.996	0.965	1.043	1.077	1.032	1.046	0.962	0.998
14	1200.0	0.994	0.964	1.044	1.073	1.030	1.048	0.963	0.996
15	1300.0	0.987	0.958	1.038	1.072	1.027	1.044	0.958	0.993
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.021	1.041	1.042	1.021	0.980	0.976	0.976	0.980
1	25.0	1.041	1.062	1.062	1.041	1.001	0.996	0.996	1.001
2	50.0	1.038	1.059	1.059	1.038	0.998	0.993	0.993	0.997
3	100.0	1.032	1.052	1.053	1.032	0.991	0.987	0.987	0.991
4	200.0	1.024	1.045	1.045	1.024	0.984	0.980	0.980	0.984
5	300.0	1.021	1.041	1.041	1.020	0.980	0.976	0.976	0.980
6	400.0	1.020	1.040	1.040	1.020	0.979	0.975	0.975	0.979
7	500.0	1.020	1.041	1.040	1.021	0.980	0.975	0.975	0.980
8	600.0	1.022	1.043	1.043	1.022	0.982	0.977	0.977	0.982
9	700.0	1.025	1.046	1.047	1.025	0.985	0.981	0.981	0.985
10	800.0	1.029	1.050	1.050	1.029	0.989	0.984	0.984	0.989
11	900.0	1.033	1.055	1.054	1.033	0.993	0.989	0.988	0.993
12	1000.0	1.037	1.058	1.058	1.037	0.997	0.992	0.992	0.997
13	1100.0	1.042	1.063	1.063	1.042	1.002	0.997	0.997	1.002
14	1200.0	1.047	1.068	1.068	1.047	1.006	1.002	1.002	1.007
15	1300.0	1.052	1.073	1.073	1.052	1.011	1.007	1.007	1.011

Table 7.59. Problem 6.2.1 reference solution power peaking factors in element 5 for charge-pan (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	0.571	0.584	0.571	0.563	0.545	0.557	0.605	0.556
1	25.0	0.545	0.558	0.548	0.536	0.519	0.532	0.578	0.528
2	50.0	0.548	0.561	0.549	0.540	0.518	0.532	0.582	0.530
3	100.0	0.553	0.564	0.552	0.543	0.525	0.534	0.585	0.537
4	200.0	0.566	0.572	0.560	0.554	0.539	0.544	0.594	0.548
5	300.0	0.575	0.579	0.564	0.563	0.548	0.548	0.598	0.559
6	400.0	0.584	0.585	0.568	0.568	0.555	0.552	0.602	0.565
7	500.0	0.587	0.587	0.569	0.574	0.558	0.552	0.602	0.570
8	600.0	0.589	0.589	0.568	0.575	0.562	0.552	0.603	0.574
9	700.0	0.593	0.591	0.569	0.579	0.564	0.553	0.605	0.575
10	800.0	0.590	0.586	0.563	0.573	0.559	0.548	0.599	0.570
11	900.0	0.590	0.588	0.563	0.576	0.559	0.548	0.600	0.571
12	1000.0	0.588	0.585	0.560	0.572	0.556	0.543	0.599	0.568
13	1100.0	0.580	0.579	0.555	0.567	0.552	0.537	0.592	0.563
14	1200.0	0.579	0.578	0.551	0.566	0.550	0.537	0.589	0.561
15	1300.0	0.576	0.576	0.549	0.565	0.546	0.533	0.587	0.557
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	0.550	0.538	0.529	0.538	0.523	0.568	0.523	0.513
1	25.0	0.591	0.579	0.570	0.578	0.563	0.610	0.563	0.553
2	50.0	0.586	0.573	0.565	0.573	0.557	0.604	0.558	0.548
3	100.0	0.573	0.561	0.553	0.561	0.545	0.592	0.546	0.536
4	200.0	0.556	0.544	0.536	0.544	0.529	0.574	0.528	0.520
5	300.0	0.545	0.533	0.525	0.533	0.519	0.563	0.519	0.509
6	400.0	0.541	0.529	0.521	0.529	0.514	0.559	0.514	0.505
7	500.0	0.539	0.527	0.519	0.528	0.513	0.558	0.513	0.503
8	600.0	0.540	0.529	0.520	0.528	0.513	0.558	0.514	0.504
9	700.0	0.543	0.531	0.523	0.531	0.516	0.561	0.517	0.507
10	800.0	0.547	0.535	0.527	0.535	0.520	0.565	0.520	0.510
11	900.0	0.552	0.540	0.532	0.540	0.525	0.571	0.525	0.516
12	1000.0	0.558	0.546	0.537	0.545	0.530	0.576	0.530	0.521
13	1100.0	0.564	0.552	0.544	0.552	0.537	0.583	0.537	0.527
14	1200.0	0.571	0.559	0.551	0.559	0.544	0.591	0.543	0.534
15	1300.0	0.579	0.567	0.558	0.567	0.551	0.598	0.552	0.542

Table 7.60. Problem 6.2.1 reference solution power peaking factors in element 5 for charge-pan I (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.549	0.553	0.581	0.596	0.595	0.580	0.551	0.548
1	25.0	0.522	0.524	0.553	0.570	0.568	0.554	0.525	0.523
2	50.0	0.523	0.526	0.556	0.575	0.572	0.555	0.525	0.522
3	100.0	0.530	0.532	0.562	0.575	0.576	0.562	0.532	0.528
4	200.0	0.543	0.543	0.577	0.587	0.587	0.576	0.544	0.536
5	300.0	0.551	0.551	0.586	0.597	0.598	0.585	0.550	0.543
6	400.0	0.559	0.558	0.594	0.603	0.603	0.594	0.558	0.549
7	500.0	0.562	0.559	0.597	0.604	0.607	0.597	0.561	0.551
8	600.0	0.566	0.564	0.601	0.606	0.609	0.600	0.562	0.551
9	700.0	0.567	0.566	0.602	0.609	0.611	0.602	0.566	0.553
10	800.0	0.565	0.561	0.597	0.606	0.608	0.596	0.562	0.548
11	900.0	0.563	0.562	0.600	0.609	0.611	0.598	0.562	0.548
12	1000.0	0.560	0.561	0.595	0.606	0.608	0.594	0.560	0.547
13	1100.0	0.553	0.554	0.590	0.602	0.602	0.590	0.555	0.543
14	1200.0	0.550	0.553	0.587	0.600	0.601	0.587	0.552	0.537
15	1300.0	0.548	0.550	0.585	0.599	0.599	0.583	0.551	0.537
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.547	0.561	0.561	0.547	0.519	0.516	0.516	0.519
1	25.0	0.588	0.602	0.603	0.588	0.559	0.556	0.556	0.558
2	50.0	0.582	0.597	0.597	0.582	0.553	0.551	0.551	0.553
3	100.0	0.570	0.584	0.584	0.570	0.541	0.539	0.539	0.541
4	200.0	0.553	0.567	0.566	0.552	0.525	0.522	0.522	0.525
5	300.0	0.542	0.556	0.556	0.542	0.515	0.512	0.512	0.515
6	400.0	0.538	0.551	0.552	0.538	0.510	0.508	0.508	0.510
7	500.0	0.536	0.550	0.550	0.536	0.509	0.506	0.506	0.509
8	600.0	0.537	0.551	0.551	0.537	0.510	0.507	0.507	0.510
9	700.0	0.540	0.554	0.554	0.540	0.512	0.510	0.510	0.512
10	800.0	0.544	0.558	0.558	0.543	0.516	0.514	0.513	0.516
11	900.0	0.549	0.564	0.563	0.549	0.521	0.519	0.519	0.521
12	1000.0	0.554	0.569	0.569	0.555	0.527	0.524	0.524	0.526
13	1100.0	0.561	0.576	0.575	0.561	0.533	0.530	0.531	0.533
14	1200.0	0.568	0.583	0.583	0.568	0.540	0.537	0.537	0.540
15	1300.0	0.576	0.591	0.591	0.576	0.547	0.545	0.545	0.547

Charge-Pan II

Table 7.61. Problem 6.2.1 reference solution power peaking factors in element 1 for charge-pan II (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.033	1.033	1.035	1.033	1.045	1.044	1.043	1.048
1	25.0	1.070	1.070	1.072	1.070	1.078	1.080	1.082	1.083
2	50.0	1.069	1.072	1.070	1.071	1.079	1.081	1.081	1.082
3	100.0	1.060	1.061	1.061	1.061	1.070	1.071	1.075	1.073
4	200.0	1.045	1.045	1.045	1.044	1.055	1.056	1.053	1.056
5	300.0	1.032	1.033	1.031	1.032	1.041	1.044	1.041	1.047
6	400.0	1.028	1.026	1.027	1.026	1.034	1.039	1.037	1.037
7	500.0	1.020	1.021	1.020	1.022	1.029	1.032	1.029	1.033
8	600.0	1.020	1.018	1.019	1.020	1.026	1.035	1.028	1.033
9	700.0	1.018	1.019	1.021	1.018	1.027	1.031	1.028	1.031
10	800.0	1.023	1.024	1.024	1.026	1.032	1.034	1.029	1.040
11	900.0	1.027	1.025	1.026	1.028	1.034	1.037	1.037	1.041
12	1000.0	1.034	1.032	1.033	1.034	1.041	1.044	1.038	1.048
13	1100.0	1.038	1.036	1.040	1.040	1.046	1.047	1.048	1.052
14	1200.0	1.044	1.045	1.047	1.044	1.050	1.053	1.050	1.058
15	1300.0	1.045	1.048	1.049	1.049	1.053	1.060	1.052	1.061
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.046	1.046	1.046	1.045	1.057	1.057	1.057	1.057
1	25.0	1.029	1.029	1.029	1.029	1.040	1.040	1.040	1.040
2	50.0	1.030	1.030	1.030	1.030	1.040	1.042	1.041	1.041
3	100.0	1.033	1.033	1.033	1.033	1.043	1.044	1.044	1.044
4	200.0	1.036	1.035	1.036	1.036	1.047	1.047	1.047	1.047
5	300.0	1.039	1.039	1.039	1.039	1.050	1.050	1.050	1.050
6	400.0	1.040	1.040	1.040	1.040	1.052	1.051	1.051	1.051
7	500.0	1.040	1.040	1.040	1.040	1.051	1.052	1.052	1.052
8	600.0	1.039	1.039	1.040	1.039	1.051	1.051	1.051	1.052
9	700.0	1.038	1.038	1.038	1.038	1.050	1.050	1.050	1.050
10	800.0	1.037	1.038	1.037	1.037	1.049	1.049	1.049	1.049
11	900.0	1.036	1.036	1.035	1.035	1.047	1.047	1.047	1.047
12	1000.0	1.034	1.034	1.034	1.034	1.046	1.046	1.046	1.046
13	1100.0	1.032	1.032	1.032	1.032	1.044	1.044	1.044	1.044
14	1200.0	1.030	1.030	1.030	1.030	1.041	1.041	1.042	1.042
15	1300.0	1.027	1.028	1.027	1.027	1.039	1.039	1.039	1.039

Table 7.62. Problem 6.2.1 reference solution power peaking factors in element 1 for charge-pan II (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.044	1.044	1.042	1.045	1.044	1.045	1.043	1.041
1	25.0	1.078	1.078	1.080	1.079	1.082	1.081	1.082	1.081
2	50.0	1.078	1.080	1.079	1.078	1.082	1.082	1.083	1.082
3	100.0	1.069	1.068	1.068	1.070	1.072	1.070	1.073	1.071
4	200.0	1.053	1.054	1.054	1.052	1.053	1.055	1.054	1.055
5	300.0	1.042	1.042	1.040	1.043	1.041	1.044	1.044	1.040
6	400.0	1.032	1.034	1.035	1.035	1.038	1.037	1.036	1.036
7	500.0	1.030	1.030	1.029	1.029	1.029	1.032	1.030	1.030
8	600.0	1.028	1.030	1.030	1.027	1.026	1.031	1.031	1.031
9	700.0	1.027	1.029	1.028	1.030	1.027	1.031	1.030	1.028
10	800.0	1.030	1.032	1.034	1.031	1.031	1.038	1.033	1.033
11	900.0	1.035	1.033	1.034	1.036	1.034	1.040	1.037	1.038
12	1000.0	1.040	1.040	1.041	1.041	1.040	1.044	1.045	1.043
13	1100.0	1.043	1.043	1.046	1.045	1.042	1.052	1.050	1.049
14	1200.0	1.050	1.053	1.051	1.051	1.050	1.056	1.056	1.056
15	1300.0	1.053	1.054	1.053	1.053	1.054	1.060	1.059	1.060
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.056	1.055	1.055	1.055	1.055	1.055	1.055	1.055
1	25.0	1.038	1.039	1.039	1.039	1.039	1.038	1.038	1.038
2	50.0	1.039	1.040	1.039	1.039	1.040	1.039	1.039	1.039
3	100.0	1.042	1.042	1.042	1.042	1.043	1.042	1.042	1.042
4	200.0	1.045	1.045	1.046	1.045	1.045	1.045	1.045	1.045
5	300.0	1.048	1.049	1.049	1.048	1.049	1.048	1.049	1.048
6	400.0	1.049	1.050	1.050	1.049	1.049	1.050	1.049	1.050
7	500.0	1.049	1.050	1.049	1.050	1.050	1.050	1.049	1.050
8	600.0	1.049	1.049	1.049	1.049	1.049	1.049	1.049	1.050
9	700.0	1.048	1.048	1.048	1.049	1.048	1.048	1.048	1.049
10	800.0	1.047	1.048	1.047	1.047	1.047	1.047	1.047	1.048
11	900.0	1.045	1.045	1.045	1.046	1.045	1.045	1.045	1.045
12	1000.0	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044
13	1100.0	1.042	1.042	1.042	1.042	1.042	1.042	1.042	1.042
14	1200.0	1.039	1.040	1.039	1.040	1.039	1.039	1.039	1.040
15	1300.0	1.037	1.037	1.037	1.038	1.037	1.037	1.037	1.037

Table 7.63. Problem 6.2.1 reference solution power peaking factors in element 2 for charge-pan II (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.553	1.551	1.550	1.553	1.570	1.574	1.571	1.569
1	25.0	1.596	1.597	1.598	1.599	1.613	1.616	1.619	1.618
2	50.0	1.600	1.601	1.598	1.599	1.611	1.614	1.615	1.620
3	100.0	1.587	1.588	1.584	1.586	1.602	1.603	1.603	1.606
4	200.0	1.565	1.565	1.566	1.566	1.580	1.585	1.583	1.584
5	300.0	1.547	1.543	1.548	1.546	1.562	1.565	1.565	1.565
6	400.0	1.537	1.536	1.539	1.537	1.550	1.553	1.554	1.552
7	500.0	1.526	1.526	1.525	1.525	1.543	1.545	1.543	1.546
8	600.0	1.521	1.523	1.523	1.521	1.538	1.541	1.539	1.542
9	700.0	1.521	1.523	1.518	1.521	1.533	1.537	1.534	1.538
10	800.0	1.519	1.520	1.522	1.521	1.540	1.538	1.534	1.542
11	900.0	1.521	1.523	1.524	1.523	1.537	1.539	1.534	1.543
12	1000.0	1.523	1.524	1.525	1.524	1.540	1.544	1.540	1.544
13	1100.0	1.533	1.531	1.535	1.535	1.543	1.547	1.543	1.555
14	1200.0	1.536	1.533	1.538	1.537	1.546	1.550	1.545	1.557
15	1300.0	1.538	1.540	1.542	1.540	1.553	1.556	1.547	1.563
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.588	1.589	1.589	1.588	1.607	1.608	1.608	1.608
1	25.0	1.549	1.549	1.549	1.549	1.566	1.568	1.568	1.568
2	50.0	1.555	1.555	1.555	1.554	1.571	1.574	1.575	1.574
3	100.0	1.568	1.568	1.568	1.567	1.584	1.587	1.587	1.587
4	200.0	1.583	1.583	1.583	1.582	1.602	1.603	1.603	1.603
5	300.0	1.593	1.593	1.593	1.592	1.611	1.613	1.613	1.613
6	400.0	1.596	1.596	1.596	1.595	1.614	1.615	1.617	1.617
7	500.0	1.597	1.597	1.597	1.596	1.615	1.618	1.618	1.618
8	600.0	1.595	1.595	1.595	1.594	1.613	1.615	1.616	1.616
9	700.0	1.591	1.592	1.591	1.591	1.610	1.612	1.613	1.612
10	800.0	1.587	1.588	1.587	1.587	1.605	1.607	1.608	1.607
11	900.0	1.581	1.582	1.581	1.581	1.599	1.601	1.602	1.601
12	1000.0	1.575	1.576	1.575	1.575	1.593	1.595	1.596	1.595
13	1100.0	1.567	1.569	1.568	1.568	1.585	1.587	1.588	1.587
14	1200.0	1.560	1.561	1.560	1.561	1.578	1.579	1.581	1.579
15	1300.0	1.552	1.553	1.552	1.552	1.569	1.571	1.572	1.571

Table 7.64. Problem 6.2.1 reference solution power peaking factors in element 2 for charge-pan II (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.568	1.571	1.568	1.568	1.567	1.566	1.565	1.567
1	25.0	1.612	1.614	1.611	1.612	1.617	1.616	1.616	1.613
2	50.0	1.611	1.614	1.611	1.614	1.617	1.616	1.619	1.613
3	100.0	1.600	1.601	1.598	1.599	1.600	1.604	1.603	1.605
4	200.0	1.578	1.582	1.578	1.582	1.580	1.580	1.583	1.579
5	300.0	1.559	1.562	1.560	1.560	1.560	1.564	1.561	1.563
6	400.0	1.550	1.549	1.548	1.551	1.552	1.552	1.550	1.551
7	500.0	1.541	1.539	1.540	1.540	1.542	1.541	1.541	1.543
8	600.0	1.538	1.541	1.537	1.538	1.534	1.538	1.537	1.536
9	700.0	1.534	1.536	1.532	1.534	1.529	1.539	1.536	1.535
10	800.0	1.537	1.535	1.531	1.533	1.530	1.537	1.537	1.537
11	900.0	1.534	1.538	1.534	1.536	1.534	1.542	1.538	1.537
12	1000.0	1.540	1.538	1.536	1.540	1.532	1.540	1.541	1.543
13	1100.0	1.546	1.544	1.542	1.548	1.543	1.550	1.553	1.548
14	1200.0	1.547	1.547	1.544	1.550	1.542	1.554	1.555	1.551
15	1300.0	1.552	1.550	1.548	1.550	1.546	1.558	1.560	1.556
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.604	1.604	1.605	1.605	1.605	1.605	1.604	1.603
1	25.0	1.564	1.565	1.566	1.566	1.566	1.566	1.565	1.564
2	50.0	1.569	1.570	1.571	1.571	1.571	1.571	1.570	1.570
3	100.0	1.582	1.583	1.584	1.584	1.584	1.584	1.583	1.581
4	200.0	1.598	1.599	1.600	1.600	1.601	1.600	1.600	1.598
5	300.0	1.608	1.609	1.610	1.610	1.610	1.610	1.609	1.608
6	400.0	1.611	1.613	1.614	1.613	1.613	1.614	1.613	1.612
7	500.0	1.612	1.614	1.614	1.615	1.614	1.614	1.614	1.613
8	600.0	1.611	1.612	1.613	1.613	1.613	1.613	1.612	1.611
9	700.0	1.607	1.608	1.609	1.610	1.609	1.609	1.608	1.607
10	800.0	1.603	1.603	1.605	1.605	1.605	1.605	1.603	1.603
11	900.0	1.597	1.597	1.598	1.599	1.599	1.599	1.597	1.597
12	1000.0	1.590	1.591	1.592	1.593	1.592	1.592	1.591	1.590
13	1100.0	1.583	1.584	1.585	1.586	1.585	1.585	1.583	1.583
14	1200.0	1.576	1.576	1.577	1.578	1.578	1.578	1.576	1.575
15	1300.0	1.567	1.567	1.569	1.570	1.569	1.569	1.567	1.567

Table 7.65. Problem 6.2.1 reference solution power peaking factors in element 3 for charge-pan II (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.459	1.457	1.448	1.455	1.493	1.501	1.498	1.471
1	25.0	1.454	1.450	1.443	1.449	1.488	1.495	1.491	1.467
2	50.0	1.454	1.451	1.443	1.450	1.486	1.495	1.492	1.468
3	100.0	1.453	1.452	1.446	1.450	1.490	1.494	1.494	1.467
4	200.0	1.455	1.451	1.446	1.452	1.493	1.498	1.495	1.472
5	300.0	1.458	1.454	1.448	1.456	1.498	1.500	1.496	1.474
6	400.0	1.461	1.459	1.451	1.457	1.494	1.501	1.499	1.475
7	500.0	1.463	1.459	1.451	1.459	1.500	1.504	1.500	1.478
8	600.0	1.463	1.457	1.451	1.457	1.501	1.502	1.498	1.473
9	700.0	1.461	1.457	1.451	1.458	1.502	1.505	1.498	1.472
10	800.0	1.465	1.461	1.452	1.458	1.506	1.506	1.503	1.479
11	900.0	1.463	1.459	1.450	1.460	1.504	1.503	1.499	1.477
12	1000.0	1.465	1.458	1.450	1.460	1.500	1.504	1.499	1.477
13	1100.0	1.469	1.464	1.455	1.461	1.506	1.508	1.498	1.479
14	1200.0	1.466	1.463	1.453	1.462	1.504	1.504	1.500	1.481
15	1300.0	1.468	1.465	1.454	1.464	1.507	1.505	1.501	1.478
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.476	1.480	1.476	1.470	1.493	1.514	1.519	1.515
1	25.0	1.453	1.457	1.453	1.447	1.470	1.492	1.496	1.492
2	50.0	1.457	1.461	1.457	1.451	1.474	1.495	1.500	1.496
3	100.0	1.464	1.469	1.465	1.459	1.481	1.504	1.509	1.504
4	200.0	1.476	1.480	1.477	1.470	1.494	1.516	1.521	1.515
5	300.0	1.482	1.486	1.483	1.476	1.500	1.522	1.527	1.522
6	400.0	1.484	1.489	1.485	1.479	1.502	1.524	1.530	1.525
7	500.0	1.487	1.491	1.486	1.480	1.504	1.527	1.531	1.527
8	600.0	1.486	1.489	1.486	1.479	1.503	1.525	1.531	1.526
9	700.0	1.484	1.489	1.485	1.479	1.502	1.524	1.530	1.525
10	800.0	1.482	1.487	1.483	1.478	1.500	1.522	1.527	1.522
11	900.0	1.479	1.484	1.480	1.475	1.497	1.519	1.525	1.519
12	1000.0	1.476	1.481	1.476	1.472	1.494	1.516	1.521	1.516
13	1100.0	1.472	1.478	1.473	1.468	1.490	1.511	1.517	1.512
14	1200.0	1.469	1.474	1.469	1.464	1.486	1.507	1.513	1.508
15	1300.0	1.464	1.469	1.464	1.460	1.482	1.503	1.509	1.503

Table 7.66. Problem 6.2.1 reference solution power peaking factors in element 3 for charge-pan II (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.491	1.492	1.491	1.492	1.482	1.469	1.470	1.479
1	25.0	1.484	1.487	1.488	1.486	1.474	1.465	1.466	1.469
2	50.0	1.483	1.484	1.489	1.489	1.472	1.466	1.465	1.474
3	100.0	1.484	1.487	1.489	1.486	1.473	1.464	1.465	1.473
4	200.0	1.487	1.487	1.492	1.490	1.476	1.469	1.468	1.475
5	300.0	1.490	1.493	1.494	1.494	1.479	1.468	1.471	1.479
6	400.0	1.490	1.492	1.493	1.490	1.482	1.474	1.472	1.480
7	500.0	1.492	1.498	1.496	1.497	1.478	1.473	1.474	1.478
8	600.0	1.493	1.493	1.494	1.494	1.483	1.472	1.472	1.483
9	700.0	1.494	1.495	1.493	1.494	1.480	1.474	1.471	1.480
10	800.0	1.498	1.497	1.498	1.499	1.483	1.475	1.474	1.483
11	900.0	1.494	1.498	1.499	1.499	1.482	1.476	1.473	1.482
12	1000.0	1.494	1.496	1.495	1.498	1.480	1.473	1.474	1.483
13	1100.0	1.496	1.500	1.501	1.503	1.486	1.477	1.479	1.489
14	1200.0	1.499	1.498	1.499	1.500	1.485	1.476	1.476	1.486
15	1300.0	1.499	1.500	1.499	1.503	1.481	1.474	1.479	1.487
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.490	1.498	1.510	1.511	1.511	1.510	1.497	1.490
1	25.0	1.468	1.475	1.488	1.489	1.489	1.488	1.476	1.468
2	50.0	1.472	1.479	1.491	1.492	1.492	1.491	1.479	1.471
3	100.0	1.480	1.487	1.499	1.501	1.501	1.499	1.487	1.479
4	200.0	1.491	1.498	1.511	1.512	1.513	1.511	1.499	1.491
5	300.0	1.498	1.504	1.517	1.518	1.518	1.518	1.505	1.497
6	400.0	1.500	1.508	1.520	1.522	1.522	1.521	1.508	1.501
7	500.0	1.502	1.509	1.521	1.523	1.523	1.522	1.509	1.502
8	600.0	1.501	1.509	1.521	1.522	1.522	1.521	1.509	1.501
9	700.0	1.500	1.507	1.520	1.522	1.522	1.520	1.508	1.500
10	800.0	1.499	1.505	1.518	1.520	1.520	1.518	1.506	1.498
11	900.0	1.496	1.502	1.515	1.517	1.517	1.515	1.503	1.496
12	1000.0	1.492	1.499	1.512	1.514	1.514	1.512	1.500	1.492
13	1100.0	1.488	1.495	1.508	1.510	1.510	1.508	1.496	1.488
14	1200.0	1.485	1.491	1.504	1.506	1.506	1.504	1.492	1.484
15	1300.0	1.480	1.486	1.500	1.501	1.502	1.500	1.487	1.480

Table 7.67. Problem 6.2.1 reference solution power peaking factors in element 4 for charge-pan II (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	0.794	0.780	0.763	0.782	0.959	0.974	0.958	0.889
1	25.0	0.768	0.754	0.735	0.756	0.925	0.943	0.926	0.857
2	50.0	0.769	0.755	0.738	0.754	0.921	0.942	0.928	0.860
3	100.0	0.774	0.765	0.744	0.762	0.932	0.952	0.937	0.870
4	200.0	0.788	0.775	0.755	0.773	0.949	0.966	0.951	0.882
5	300.0	0.799	0.785	0.767	0.785	0.962	0.978	0.962	0.895
6	400.0	0.804	0.790	0.772	0.790	0.968	0.984	0.967	0.898
7	500.0	0.811	0.795	0.774	0.795	0.973	0.990	0.974	0.904
8	600.0	0.810	0.795	0.776	0.798	0.975	0.991	0.971	0.906
9	700.0	0.811	0.796	0.778	0.795	0.975	0.991	0.974	0.909
10	800.0	0.809	0.796	0.777	0.798	0.976	0.994	0.974	0.911
11	900.0	0.809	0.794	0.774	0.794	0.971	0.990	0.969	0.905
12	1000.0	0.807	0.794	0.772	0.791	0.967	0.986	0.965	0.902
13	1100.0	0.801	0.786	0.766	0.787	0.961	0.980	0.957	0.895
14	1200.0	0.801	0.786	0.764	0.783	0.958	0.977	0.957	0.894
15	1300.0	0.797	0.782	0.760	0.782	0.954	0.973	0.952	0.890
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	0.765	0.778	0.765	0.746	0.871	0.936	0.954	0.938
1	25.0	0.781	0.795	0.782	0.763	0.890	0.956	0.974	0.957
2	50.0	0.779	0.793	0.780	0.761	0.887	0.952	0.970	0.954
3	100.0	0.774	0.787	0.775	0.756	0.882	0.947	0.965	0.948
4	200.0	0.768	0.781	0.769	0.750	0.875	0.941	0.958	0.942
5	300.0	0.765	0.778	0.766	0.747	0.872	0.936	0.954	0.938
6	400.0	0.764	0.777	0.765	0.746	0.871	0.936	0.953	0.937
7	500.0	0.765	0.778	0.765	0.747	0.872	0.936	0.954	0.938
8	600.0	0.766	0.779	0.767	0.749	0.874	0.938	0.955	0.939
9	700.0	0.769	0.783	0.770	0.752	0.876	0.942	0.959	0.943
10	800.0	0.773	0.786	0.773	0.755	0.880	0.945	0.962	0.946
11	900.0	0.776	0.789	0.777	0.758	0.884	0.949	0.966	0.951
12	1000.0	0.780	0.793	0.780	0.762	0.888	0.953	0.971	0.955
13	1100.0	0.784	0.797	0.784	0.766	0.892	0.957	0.975	0.959
14	1200.0	0.788	0.801	0.789	0.771	0.897	0.962	0.980	0.964
15	1300.0	0.793	0.806	0.793	0.775	0.902	0.967	0.985	0.969

Table 7.68. Problem 6.2.1 reference solution power peaking factors in element 4 for charge-pan II (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.936	0.941	0.942	0.937	0.895	0.874	0.871	0.895
1	25.0	0.905	0.910	0.913	0.908	0.864	0.842	0.843	0.863
2	50.0	0.905	0.910	0.911	0.910	0.866	0.845	0.846	0.864
3	100.0	0.912	0.918	0.922	0.918	0.876	0.853	0.851	0.872
4	200.0	0.929	0.934	0.935	0.931	0.889	0.867	0.863	0.884
5	300.0	0.941	0.945	0.947	0.943	0.898	0.877	0.879	0.897
6	400.0	0.946	0.951	0.954	0.948	0.903	0.883	0.884	0.905
7	500.0	0.953	0.960	0.959	0.957	0.909	0.888	0.889	0.909
8	600.0	0.956	0.958	0.961	0.956	0.911	0.886	0.889	0.911
9	700.0	0.954	0.962	0.961	0.957	0.911	0.890	0.889	0.912
10	800.0	0.953	0.959	0.959	0.956	0.909	0.888	0.893	0.912
11	900.0	0.952	0.957	0.960	0.953	0.908	0.884	0.887	0.909
12	1000.0	0.948	0.954	0.956	0.952	0.904	0.882	0.886	0.905
13	1100.0	0.943	0.950	0.953	0.945	0.896	0.874	0.877	0.900
14	1200.0	0.938	0.944	0.948	0.945	0.894	0.871	0.877	0.896
15	1300.0	0.936	0.943	0.945	0.942	0.891	0.869	0.872	0.894
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.854	0.875	0.916	0.921	0.922	0.917	0.876	0.854
1	25.0	0.873	0.894	0.936	0.941	0.941	0.937	0.895	0.874
2	50.0	0.871	0.892	0.932	0.938	0.939	0.934	0.892	0.871
3	100.0	0.865	0.886	0.927	0.932	0.933	0.928	0.887	0.865
4	200.0	0.859	0.880	0.921	0.926	0.926	0.921	0.880	0.859
5	300.0	0.855	0.876	0.916	0.921	0.922	0.918	0.877	0.855
6	400.0	0.855	0.875	0.916	0.921	0.922	0.917	0.876	0.855
7	500.0	0.855	0.876	0.917	0.922	0.922	0.918	0.877	0.856
8	600.0	0.857	0.878	0.919	0.923	0.924	0.920	0.879	0.858
9	700.0	0.861	0.881	0.922	0.927	0.928	0.923	0.882	0.861
10	800.0	0.864	0.884	0.925	0.930	0.931	0.926	0.886	0.864
11	900.0	0.868	0.888	0.929	0.935	0.935	0.930	0.890	0.869
12	1000.0	0.872	0.892	0.933	0.939	0.939	0.934	0.894	0.872
13	1100.0	0.876	0.896	0.938	0.943	0.944	0.939	0.898	0.876
14	1200.0	0.881	0.901	0.943	0.948	0.949	0.944	0.903	0.881
15	1300.0	0.886	0.906	0.948	0.953	0.954	0.948	0.908	0.886

Table 7.69. Problem 6.2.1 reference solution power peaking factors in element 5 for charge-pan II (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	0.423	0.411	0.400	0.414	0.521	0.532	0.518	0.469
1	25.0	0.401	0.391	0.378	0.391	0.493	0.504	0.489	0.442
2	50.0	0.401	0.390	0.378	0.393	0.492	0.503	0.490	0.443
3	100.0	0.408	0.397	0.384	0.397	0.500	0.512	0.498	0.450
4	200.0	0.417	0.406	0.394	0.408	0.514	0.525	0.509	0.462
5	300.0	0.426	0.414	0.404	0.418	0.523	0.534	0.518	0.470
6	400.0	0.430	0.419	0.405	0.423	0.531	0.540	0.524	0.476
7	500.0	0.435	0.423	0.409	0.425	0.533	0.544	0.528	0.478
8	600.0	0.437	0.425	0.413	0.427	0.536	0.548	0.531	0.483
9	700.0	0.438	0.426	0.413	0.428	0.537	0.550	0.532	0.484
10	800.0	0.437	0.424	0.413	0.427	0.534	0.546	0.529	0.483
11	900.0	0.434	0.423	0.410	0.426	0.532	0.545	0.529	0.482
12	1000.0	0.434	0.420	0.408	0.423	0.529	0.544	0.524	0.479
13	1100.0	0.428	0.416	0.403	0.419	0.524	0.538	0.522	0.474
14	1200.0	0.426	0.415	0.400	0.415	0.521	0.536	0.518	0.471
15	1300.0	0.424	0.414	0.399	0.415	0.520	0.532	0.517	0.469
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	0.388	0.398	0.390	0.376	0.441	0.486	0.500	0.491
1	25.0	0.419	0.430	0.422	0.406	0.477	0.524	0.540	0.530
2	50.0	0.415	0.427	0.418	0.403	0.472	0.519	0.535	0.525
3	100.0	0.406	0.417	0.408	0.394	0.462	0.508	0.523	0.513
4	200.0	0.393	0.404	0.396	0.381	0.447	0.492	0.507	0.497
5	300.0	0.385	0.396	0.388	0.373	0.438	0.483	0.497	0.488
6	400.0	0.382	0.392	0.384	0.370	0.434	0.478	0.492	0.483
7	500.0	0.381	0.391	0.382	0.369	0.433	0.477	0.491	0.481
8	600.0	0.381	0.391	0.383	0.369	0.434	0.478	0.492	0.482
9	700.0	0.383	0.393	0.385	0.371	0.436	0.480	0.495	0.485
10	800.0	0.386	0.396	0.388	0.374	0.439	0.484	0.498	0.489
11	900.0	0.390	0.400	0.392	0.378	0.443	0.489	0.503	0.494
12	1000.0	0.394	0.404	0.396	0.382	0.448	0.494	0.509	0.499
13	1100.0	0.399	0.410	0.401	0.387	0.454	0.500	0.515	0.505
14	1200.0	0.404	0.415	0.407	0.392	0.460	0.506	0.521	0.511
15	1300.0	0.410	0.421	0.413	0.398	0.467	0.513	0.529	0.519

Table 7.70. Problem 6.2.1 reference solution power peaking factors in element 5 for charge-pan II (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.508	0.511	0.509	0.506	0.473	0.458	0.461	0.478
1	25.0	0.481	0.483	0.483	0.479	0.449	0.434	0.434	0.453
2	50.0	0.481	0.484	0.484	0.480	0.450	0.435	0.435	0.452
3	100.0	0.488	0.490	0.491	0.489	0.458	0.442	0.443	0.460
4	200.0	0.503	0.505	0.504	0.500	0.468	0.453	0.455	0.470
5	300.0	0.512	0.515	0.514	0.509	0.477	0.463	0.465	0.481
6	400.0	0.518	0.521	0.520	0.515	0.483	0.467	0.469	0.485
7	500.0	0.520	0.524	0.525	0.520	0.486	0.472	0.473	0.491
8	600.0	0.524	0.527	0.526	0.521	0.491	0.475	0.477	0.494
9	700.0	0.525	0.528	0.530	0.522	0.490	0.474	0.476	0.494
10	800.0	0.522	0.525	0.525	0.519	0.487	0.474	0.477	0.493
11	900.0	0.522	0.526	0.526	0.519	0.486	0.472	0.475	0.490
12	1000.0	0.519	0.523	0.524	0.518	0.484	0.470	0.470	0.486
13	1100.0	0.513	0.516	0.519	0.514	0.481	0.465	0.467	0.482
14	1200.0	0.511	0.515	0.515	0.511	0.478	0.462	0.463	0.479
15	1300.0	0.509	0.514	0.514	0.508	0.475	0.460	0.462	0.478
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.432	0.446	0.475	0.480	0.481	0.479	0.449	0.433
1	25.0	0.467	0.482	0.513	0.518	0.520	0.517	0.486	0.469
2	50.0	0.463	0.478	0.508	0.513	0.515	0.513	0.482	0.465
3	100.0	0.453	0.467	0.497	0.502	0.504	0.501	0.471	0.455
4	200.0	0.439	0.453	0.482	0.486	0.488	0.486	0.456	0.440
5	300.0	0.430	0.444	0.472	0.477	0.478	0.476	0.447	0.431
6	400.0	0.426	0.440	0.468	0.473	0.474	0.472	0.443	0.427
7	500.0	0.424	0.438	0.467	0.471	0.472	0.470	0.441	0.426
8	600.0	0.425	0.439	0.468	0.472	0.473	0.471	0.442	0.427
9	700.0	0.428	0.441	0.470	0.475	0.476	0.473	0.445	0.429
10	800.0	0.431	0.445	0.473	0.478	0.479	0.477	0.448	0.432
11	900.0	0.435	0.449	0.478	0.483	0.484	0.482	0.453	0.436
12	1000.0	0.440	0.454	0.483	0.488	0.489	0.487	0.457	0.441
13	1100.0	0.445	0.460	0.489	0.494	0.495	0.493	0.463	0.447
14	1200.0	0.451	0.466	0.496	0.500	0.502	0.499	0.470	0.452
15	1300.0	0.458	0.473	0.503	0.508	0.509	0.507	0.476	0.459

Table 7.71. Problem 6.2.1 reference solution power peaking factors in element 6 for charge-pan II (1/2).

Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	Shift Power Peaking Factors A	B	C	D	P	Q	R	S
0	0.0	0.185	0.179	0.171	0.179	0.228	0.249	0.244	0.201
1	25.0	0.174	0.168	0.160	0.168	0.213	0.233	0.232	0.189
2	50.0	0.174	0.168	0.161	0.168	0.213	0.234	0.231	0.188
3	100.0	0.176	0.171	0.163	0.170	0.216	0.237	0.234	0.192
4	200.0	0.182	0.175	0.167	0.176	0.222	0.243	0.241	0.195
5	300.0	0.185	0.180	0.172	0.179	0.228	0.249	0.245	0.203
6	400.0	0.188	0.182	0.174	0.182	0.230	0.251	0.250	0.204
7	500.0	0.190	0.184	0.177	0.184	0.233	0.255	0.251	0.207
8	600.0	0.190	0.186	0.177	0.184	0.234	0.255	0.252	0.208
9	700.0	0.193	0.187	0.178	0.186	0.235	0.258	0.254	0.209
10	800.0	0.191	0.185	0.177	0.186	0.235	0.256	0.252	0.208
11	900.0	0.192	0.186	0.179	0.186	0.235	0.258	0.254	0.209
12	1000.0	0.191	0.184	0.178	0.185	0.233	0.256	0.253	0.208
13	1100.0	0.189	0.183	0.176	0.184	0.231	0.254	0.251	0.206
14	1200.0	0.189	0.183	0.174	0.182	0.232	0.254	0.250	0.205
15	1300.0	0.188	0.182	0.175	0.182	0.230	0.252	0.249	0.205
Step	Burnup $\left[\frac{\text{MWd}}{\text{MtU}}\right]$	MPACT Power Peaking Factors A	B	C	D	P	Q	R	S
0	0.0	0.162	0.168	0.162	0.155	0.182	0.223	0.225	0.205
1	25.0	0.184	0.190	0.184	0.176	0.206	0.251	0.254	0.233
2	50.0	0.182	0.188	0.182	0.174	0.204	0.248	0.251	0.230
3	100.0	0.175	0.181	0.175	0.168	0.197	0.240	0.242	0.222
4	200.0	0.167	0.172	0.166	0.159	0.187	0.228	0.230	0.211
5	300.0	0.161	0.166	0.160	0.153	0.180	0.220	0.222	0.203
6	400.0	0.158	0.163	0.157	0.150	0.177	0.216	0.218	0.199
7	500.0	0.156	0.161	0.156	0.149	0.175	0.215	0.216	0.198
8	600.0	0.156	0.161	0.155	0.149	0.175	0.214	0.216	0.197
9	700.0	0.157	0.162	0.156	0.149	0.175	0.215	0.217	0.198
10	800.0	0.158	0.163	0.157	0.150	0.176	0.217	0.218	0.199
11	900.0	0.159	0.165	0.159	0.152	0.178	0.219	0.221	0.202
12	1000.0	0.162	0.167	0.161	0.154	0.181	0.222	0.224	0.204
13	1100.0	0.164	0.169	0.163	0.157	0.184	0.225	0.227	0.208
14	1200.0	0.167	0.172	0.166	0.159	0.187	0.229	0.231	0.211
15	1300.0	0.170	0.175	0.170	0.162	0.191	0.233	0.235	0.215

Table 7.72. Problem 6.2.1 reference solution power peaking factors in element 6 for charge-pan II (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.222	0.225	0.244	0.240	0.205	0.197	0.198	0.206
1	25.0	0.206	0.210	0.229	0.227	0.193	0.185	0.186	0.194
2	50.0	0.208	0.211	0.229	0.227	0.193	0.185	0.186	0.195
3	100.0	0.210	0.213	0.232	0.232	0.196	0.187	0.189	0.197
4	200.0	0.216	0.220	0.239	0.236	0.201	0.192	0.195	0.202
5	300.0	0.222	0.225	0.243	0.242	0.205	0.197	0.200	0.208
6	400.0	0.225	0.228	0.248	0.246	0.209	0.200	0.202	0.211
7	500.0	0.227	0.229	0.251	0.247	0.210	0.202	0.204	0.213
8	600.0	0.228	0.231	0.251	0.250	0.211	0.202	0.205	0.213
9	700.0	0.229	0.232	0.253	0.251	0.212	0.204	0.206	0.216
10	800.0	0.228	0.230	0.251	0.250	0.212	0.202	0.206	0.214
11	900.0	0.228	0.231	0.253	0.251	0.213	0.204	0.207	0.216
12	1000.0	0.228	0.231	0.253	0.250	0.211	0.202	0.205	0.214
13	1100.0	0.226	0.227	0.250	0.248	0.209	0.200	0.203	0.212
14	1200.0	0.225	0.229	0.249	0.246	0.208	0.200	0.202	0.210
15	1300.0	0.224	0.227	0.248	0.246	0.209	0.199	0.203	0.210
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.178	0.186	0.219	0.221	0.203	0.200	0.187	0.179
1	25.0	0.202	0.210	0.247	0.249	0.230	0.227	0.212	0.204
2	50.0	0.199	0.208	0.244	0.246	0.227	0.224	0.210	0.201
3	100.0	0.192	0.201	0.236	0.238	0.219	0.217	0.203	0.194
4	200.0	0.183	0.191	0.224	0.226	0.208	0.206	0.192	0.184
5	300.0	0.176	0.184	0.217	0.218	0.201	0.198	0.185	0.178
6	400.0	0.173	0.181	0.213	0.214	0.197	0.194	0.182	0.174
7	500.0	0.171	0.179	0.211	0.213	0.195	0.193	0.180	0.173
8	600.0	0.171	0.179	0.211	0.212	0.195	0.192	0.180	0.172
9	700.0	0.171	0.179	0.211	0.213	0.195	0.193	0.180	0.173
10	800.0	0.173	0.180	0.213	0.215	0.197	0.194	0.182	0.174
11	900.0	0.175	0.183	0.215	0.217	0.199	0.197	0.184	0.176
12	1000.0	0.177	0.185	0.218	0.220	0.201	0.199	0.186	0.178
13	1100.0	0.180	0.188	0.222	0.223	0.205	0.202	0.189	0.181
14	1200.0	0.183	0.191	0.225	0.227	0.208	0.206	0.192	0.184
15	1300.0	0.186	0.195	0.229	0.231	0.212	0.210	0.196	0.188

Charge-Pan III

Table 7.73. Problem 6.2.1 reference solution power peaking factors in element 1 for charge-pan III (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.034	1.033	1.033	1.032	1.044	1.043	1.045	1.044
1	25.0	1.060	1.063	1.064	1.058	1.071	1.076	1.082	1.075
2	50.0	1.058	1.063	1.061	1.059	1.068	1.071	1.081	1.076
3	100.0	1.056	1.056	1.053	1.054	1.063	1.069	1.071	1.070
4	200.0	1.048	1.044	1.038	1.041	1.053	1.057	1.054	1.063
5	300.0	1.043	1.035	1.025	1.033	1.043	1.046	1.041	1.054
6	400.0	1.038	1.032	1.018	1.030	1.040	1.042	1.032	1.051
7	500.0	1.035	1.026	1.013	1.025	1.037	1.039	1.030	1.052
8	600.0	1.037	1.028	1.014	1.025	1.037	1.039	1.027	1.049
9	700.0	1.034	1.025	1.011	1.025	1.036	1.038	1.027	1.048
10	800.0	1.039	1.028	1.014	1.028	1.040	1.043	1.031	1.055
11	900.0	1.039	1.031	1.015	1.033	1.042	1.045	1.028	1.055
12	1000.0	1.045	1.039	1.024	1.036	1.050	1.051	1.039	1.061
13	1100.0	1.043	1.042	1.022	1.038	1.048	1.051	1.042	1.061
14	1200.0	1.049	1.046	1.026	1.043	1.052	1.058	1.047	1.066
15	1300.0	1.050	1.050	1.032	1.047	1.056	1.064	1.048	1.070
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.046	1.046	1.046	1.046	1.058	1.057	1.058	1.058
1	25.0	1.029	1.029	1.029	1.029	1.040	1.040	1.040	1.041
2	50.0	1.030	1.030	1.030	1.031	1.041	1.041	1.041	1.042
3	100.0	1.033	1.033	1.033	1.033	1.044	1.044	1.045	1.044
4	200.0	1.036	1.036	1.036	1.036	1.047	1.047	1.047	1.048
5	300.0	1.039	1.039	1.039	1.039	1.050	1.050	1.051	1.051
6	400.0	1.040	1.040	1.040	1.040	1.051	1.052	1.052	1.052
7	500.0	1.040	1.040	1.040	1.040	1.052	1.051	1.052	1.052
8	600.0	1.040	1.040	1.040	1.040	1.051	1.052	1.052	1.052
9	700.0	1.038	1.039	1.039	1.039	1.050	1.050	1.050	1.051
10	800.0	1.037	1.038	1.038	1.038	1.049	1.049	1.049	1.050
11	900.0	1.036	1.036	1.036	1.036	1.047	1.047	1.047	1.048
12	1000.0	1.034	1.034	1.035	1.034	1.046	1.046	1.046	1.046
13	1100.0	1.032	1.032	1.033	1.032	1.044	1.043	1.044	1.045
14	1200.0	1.030	1.030	1.031	1.030	1.041	1.041	1.041	1.042
15	1300.0	1.027	1.028	1.028	1.028	1.039	1.039	1.039	1.040

Table 7.74. Problem 6.2.1 reference solution power peaking factors in element 1 for charge-pan III (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.044	1.041	1.041	1.043	1.040	1.043	1.040	1.042
1	25.0	1.067	1.070	1.075	1.072	1.076	1.075	1.072	1.073
2	50.0	1.066	1.068	1.070	1.075	1.077	1.072	1.068	1.067
3	100.0	1.064	1.065	1.069	1.070	1.066	1.067	1.064	1.059
4	200.0	1.058	1.057	1.060	1.062	1.051	1.054	1.054	1.046
5	300.0	1.052	1.049	1.052	1.055	1.039	1.047	1.045	1.037
6	400.0	1.047	1.046	1.049	1.054	1.033	1.041	1.040	1.031
7	500.0	1.046	1.040	1.045	1.048	1.025	1.039	1.039	1.025
8	600.0	1.045	1.040	1.048	1.053	1.025	1.037	1.038	1.025
9	700.0	1.044	1.040	1.046	1.051	1.024	1.038	1.039	1.021
10	800.0	1.048	1.045	1.049	1.054	1.027	1.044	1.041	1.026
11	900.0	1.049	1.046	1.048	1.054	1.029	1.046	1.046	1.026
12	1000.0	1.054	1.052	1.055	1.062	1.036	1.054	1.052	1.033
13	1100.0	1.053	1.046	1.056	1.064	1.037	1.055	1.054	1.033
14	1200.0	1.057	1.052	1.060	1.068	1.046	1.063	1.061	1.037
15	1300.0	1.058	1.052	1.062	1.070	1.046	1.066	1.061	1.040
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.055	1.055	1.055	1.055	1.055	1.056	1.056	1.056
1	25.0	1.039	1.039	1.039	1.039	1.039	1.039	1.039	1.039
2	50.0	1.039	1.040	1.040	1.040	1.040	1.040	1.040	1.040
3	100.0	1.043	1.043	1.042	1.042	1.042	1.042	1.043	1.042
4	200.0	1.045	1.045	1.045	1.045	1.046	1.046	1.046	1.046
5	300.0	1.049	1.049	1.048	1.048	1.049	1.049	1.049	1.049
6	400.0	1.050	1.049	1.050	1.050	1.050	1.050	1.050	1.050
7	500.0	1.050	1.050	1.050	1.050	1.050	1.050	1.050	1.050
8	600.0	1.050	1.050	1.049	1.050	1.050	1.050	1.050	1.050
9	700.0	1.049	1.048	1.048	1.048	1.049	1.049	1.048	1.048
10	800.0	1.048	1.047	1.047	1.047	1.048	1.048	1.047	1.048
11	900.0	1.046	1.046	1.045	1.045	1.046	1.046	1.045	1.046
12	1000.0	1.044	1.044	1.044	1.044	1.044	1.045	1.044	1.044
13	1100.0	1.042	1.042	1.042	1.042	1.042	1.042	1.042	1.042
14	1200.0	1.040	1.040	1.040	1.040	1.040	1.040	1.040	1.040
15	1300.0	1.037	1.037	1.037	1.037	1.037	1.038	1.037	1.037

Table 7.75. Problem 6.2.1 reference solution power peaking factors in element 2 for charge-pan III (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.553	1.553	1.554	1.556	1.576	1.575	1.572	1.574
1	25.0	1.577	1.581	1.580	1.575	1.592	1.608	1.614	1.605
2	50.0	1.580	1.581	1.580	1.577	1.592	1.607	1.611	1.604
3	100.0	1.577	1.581	1.576	1.572	1.590	1.596	1.600	1.600
4	200.0	1.569	1.577	1.565	1.572	1.583	1.578	1.582	1.590
5	300.0	1.567	1.572	1.557	1.565	1.581	1.567	1.562	1.579
6	400.0	1.562	1.567	1.550	1.569	1.580	1.556	1.548	1.576
7	500.0	1.561	1.566	1.551	1.561	1.580	1.550	1.543	1.577
8	600.0	1.561	1.566	1.550	1.562	1.582	1.551	1.536	1.574
9	700.0	1.556	1.564	1.547	1.559	1.574	1.548	1.531	1.572
10	800.0	1.560	1.568	1.549	1.565	1.583	1.551	1.532	1.580
11	900.0	1.560	1.571	1.547	1.563	1.576	1.546	1.527	1.582
12	1000.0	1.561	1.571	1.555	1.565	1.582	1.555	1.529	1.586
13	1100.0	1.565	1.576	1.559	1.569	1.581	1.558	1.538	1.596
14	1200.0	1.564	1.579	1.561	1.571	1.586	1.564	1.537	1.596
15	1300.0	1.565	1.580	1.565	1.572	1.583	1.566	1.543	1.601
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.590	1.591	1.591	1.591	1.609	1.608	1.609	1.611
1	25.0	1.551	1.551	1.552	1.552	1.569	1.569	1.569	1.571
2	50.0	1.557	1.557	1.558	1.558	1.575	1.575	1.575	1.577
3	100.0	1.569	1.569	1.570	1.569	1.588	1.587	1.588	1.589
4	200.0	1.585	1.586	1.586	1.585	1.604	1.603	1.604	1.606
5	300.0	1.596	1.595	1.595	1.595	1.613	1.613	1.614	1.615
6	400.0	1.599	1.599	1.599	1.599	1.618	1.617	1.618	1.620
7	500.0	1.599	1.600	1.600	1.600	1.619	1.618	1.618	1.620
8	600.0	1.598	1.598	1.598	1.598	1.617	1.616	1.617	1.620
9	700.0	1.593	1.594	1.595	1.594	1.613	1.612	1.612	1.615
10	800.0	1.589	1.589	1.591	1.589	1.609	1.607	1.608	1.610
11	900.0	1.583	1.583	1.585	1.583	1.602	1.601	1.601	1.604
12	1000.0	1.576	1.577	1.579	1.577	1.596	1.595	1.595	1.598
13	1100.0	1.569	1.570	1.572	1.570	1.589	1.587	1.588	1.591
14	1200.0	1.562	1.563	1.564	1.562	1.581	1.580	1.580	1.583
15	1300.0	1.553	1.554	1.556	1.554	1.573	1.571	1.571	1.575

Table 7.76. Problem 6.2.1 reference solution power peaking factors in element 2 for charge-pan III (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.572	1.570	1.571	1.568	1.569	1.568	1.569	1.574
1	25.0	1.589	1.594	1.598	1.601	1.609	1.608	1.599	1.592
2	50.0	1.591	1.592	1.599	1.604	1.609	1.604	1.597	1.590
3	100.0	1.592	1.588	1.596	1.602	1.595	1.596	1.590	1.585
4	200.0	1.583	1.577	1.585	1.596	1.576	1.578	1.573	1.579
5	300.0	1.579	1.573	1.578	1.588	1.553	1.564	1.560	1.568
6	400.0	1.577	1.564	1.570	1.586	1.541	1.556	1.553	1.566
7	500.0	1.571	1.566	1.571	1.587	1.535	1.552	1.546	1.562
8	600.0	1.572	1.565	1.569	1.588	1.528	1.552	1.547	1.561
9	700.0	1.571	1.559	1.570	1.588	1.523	1.548	1.540	1.558
10	800.0	1.575	1.562	1.572	1.587	1.522	1.551	1.543	1.560
11	900.0	1.572	1.559	1.570	1.591	1.522	1.549	1.545	1.559
12	1000.0	1.575	1.567	1.578	1.591	1.525	1.554	1.547	1.567
13	1100.0	1.577	1.571	1.585	1.598	1.528	1.564	1.553	1.566
14	1200.0	1.576	1.574	1.587	1.597	1.528	1.565	1.554	1.572
15	1300.0	1.575	1.577	1.591	1.603	1.535	1.569	1.560	1.573
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.605	1.606	1.605	1.606	1.606	1.607	1.607	1.606
1	25.0	1.567	1.566	1.567	1.567	1.568	1.568	1.568	1.568
2	50.0	1.572	1.572	1.572	1.573	1.574	1.574	1.574	1.573
3	100.0	1.585	1.585	1.584	1.584	1.585	1.586	1.586	1.586
4	200.0	1.601	1.600	1.600	1.601	1.602	1.602	1.603	1.602
5	300.0	1.611	1.610	1.610	1.610	1.612	1.612	1.613	1.611
6	400.0	1.614	1.614	1.614	1.615	1.616	1.616	1.616	1.616
7	500.0	1.616	1.615	1.615	1.616	1.616	1.617	1.617	1.616
8	600.0	1.614	1.614	1.614	1.614	1.615	1.615	1.615	1.615
9	700.0	1.610	1.610	1.609	1.609	1.610	1.611	1.611	1.611
10	800.0	1.605	1.605	1.605	1.605	1.606	1.607	1.606	1.606
11	900.0	1.599	1.599	1.598	1.598	1.600	1.601	1.600	1.600
12	1000.0	1.593	1.593	1.592	1.592	1.593	1.594	1.594	1.593
13	1100.0	1.585	1.586	1.585	1.585	1.586	1.587	1.586	1.586
14	1200.0	1.578	1.578	1.577	1.577	1.578	1.580	1.579	1.578
15	1300.0	1.569	1.570	1.569	1.569	1.570	1.571	1.570	1.570

Table 7.77. Problem 6.2.1 reference solution power peaking factors in element 3 for charge-pan III (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.501	1.500	1.501	1.511	1.534	1.515	1.506	1.510
1	25.0	1.491	1.485	1.487	1.497	1.516	1.500	1.499	1.506
2	50.0	1.490	1.485	1.487	1.493	1.513	1.502	1.497	1.499
3	100.0	1.492	1.489	1.493	1.498	1.519	1.502	1.494	1.496
4	200.0	1.493	1.495	1.502	1.507	1.528	1.507	1.500	1.496
5	300.0	1.498	1.505	1.511	1.512	1.535	1.512	1.506	1.496
6	400.0	1.499	1.505	1.512	1.515	1.540	1.513	1.503	1.493
7	500.0	1.502	1.510	1.519	1.521	1.546	1.518	1.509	1.495
8	600.0	1.502	1.511	1.516	1.521	1.543	1.515	1.506	1.491
9	700.0	1.504	1.513	1.519	1.522	1.542	1.516	1.509	1.493
10	800.0	1.502	1.517	1.520	1.523	1.543	1.518	1.511	1.495
11	900.0	1.500	1.510	1.517	1.518	1.543	1.516	1.507	1.490
12	1000.0	1.499	1.512	1.515	1.519	1.537	1.513	1.504	1.488
13	1100.0	1.501	1.511	1.519	1.519	1.540	1.518	1.510	1.492
14	1200.0	1.501	1.506	1.512	1.517	1.537	1.514	1.506	1.489
15	1300.0	1.498	1.505	1.511	1.514	1.534	1.511	1.506	1.491
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.515	1.520	1.526	1.519	1.529	1.524	1.529	1.551
1	25.0	1.493	1.497	1.503	1.497	1.506	1.502	1.506	1.527
2	50.0	1.497	1.501	1.507	1.501	1.509	1.505	1.510	1.531
3	100.0	1.504	1.509	1.515	1.508	1.518	1.513	1.517	1.539
4	200.0	1.516	1.520	1.526	1.520	1.530	1.524	1.530	1.551
5	300.0	1.523	1.526	1.532	1.526	1.535	1.531	1.536	1.557
6	400.0	1.525	1.529	1.535	1.529	1.539	1.534	1.539	1.562
7	500.0	1.526	1.531	1.537	1.530	1.541	1.535	1.541	1.562
8	600.0	1.525	1.529	1.535	1.529	1.539	1.534	1.540	1.562
9	700.0	1.524	1.529	1.535	1.528	1.539	1.533	1.538	1.561
10	800.0	1.522	1.527	1.533	1.526	1.537	1.531	1.536	1.558
11	900.0	1.519	1.524	1.530	1.523	1.534	1.528	1.533	1.555
12	1000.0	1.515	1.520	1.526	1.519	1.530	1.524	1.529	1.551
13	1100.0	1.511	1.517	1.523	1.516	1.526	1.520	1.525	1.547
14	1200.0	1.507	1.513	1.518	1.511	1.522	1.516	1.521	1.543
15	1300.0	1.503	1.508	1.514	1.507	1.517	1.511	1.516	1.538

Table 7.78. Problem 6.2.1 reference solution power peaking factors in element 3 for charge-pan III (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.528	1.523	1.510	1.505	1.506	1.503	1.518	1.526
1	25.0	1.515	1.511	1.499	1.495	1.496	1.497	1.507	1.511
2	50.0	1.511	1.507	1.497	1.497	1.494	1.495	1.505	1.510
3	100.0	1.514	1.510	1.498	1.495	1.497	1.497	1.508	1.514
4	200.0	1.518	1.502	1.493	1.497	1.496	1.499	1.509	1.525
5	300.0	1.523	1.507	1.494	1.498	1.502	1.504	1.519	1.532
6	400.0	1.526	1.502	1.489	1.503	1.500	1.504	1.518	1.535
7	500.0	1.528	1.504	1.492	1.504	1.506	1.507	1.517	1.541
8	600.0	1.527	1.499	1.490	1.503	1.505	1.505	1.519	1.540
9	700.0	1.526	1.502	1.488	1.505	1.503	1.507	1.520	1.540
10	800.0	1.527	1.502	1.487	1.508	1.508	1.509	1.521	1.541
11	900.0	1.525	1.498	1.486	1.507	1.506	1.508	1.517	1.541
12	1000.0	1.523	1.497	1.483	1.504	1.502	1.507	1.514	1.536
13	1100.0	1.523	1.500	1.485	1.506	1.508	1.509	1.518	1.540
14	1200.0	1.524	1.497	1.487	1.504	1.503	1.509	1.516	1.537
15	1300.0	1.519	1.498	1.483	1.504	1.503	1.506	1.513	1.529
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.524	1.523	1.523	1.525	1.537	1.544	1.544	1.537
1	25.0	1.502	1.500	1.501	1.502	1.514	1.521	1.522	1.514
2	50.0	1.505	1.504	1.504	1.507	1.519	1.526	1.526	1.518
3	100.0	1.514	1.512	1.512	1.513	1.526	1.533	1.533	1.526
4	200.0	1.525	1.524	1.523	1.526	1.538	1.545	1.545	1.538
5	300.0	1.532	1.531	1.530	1.531	1.545	1.552	1.551	1.544
6	400.0	1.534	1.533	1.534	1.536	1.547	1.554	1.555	1.547
7	500.0	1.536	1.534	1.535	1.537	1.549	1.556	1.557	1.549
8	600.0	1.535	1.534	1.534	1.536	1.547	1.555	1.554	1.548
9	700.0	1.535	1.533	1.533	1.534	1.547	1.554	1.554	1.547
10	800.0	1.532	1.531	1.530	1.532	1.544	1.552	1.552	1.544
11	900.0	1.529	1.528	1.527	1.529	1.541	1.549	1.548	1.541
12	1000.0	1.526	1.524	1.524	1.525	1.538	1.545	1.545	1.538
13	1100.0	1.522	1.520	1.520	1.521	1.534	1.541	1.541	1.533
14	1200.0	1.518	1.516	1.516	1.517	1.530	1.537	1.537	1.529
15	1300.0	1.513	1.512	1.511	1.512	1.525	1.532	1.532	1.524

Table 7.79. Problem 6.2.1 reference solution power peaking factors in element 4 for charge-pan III (1/2).

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Shift Power Peaking Factors A	B	C	D	P	Q	R	S
0	0.0	1.026	1.015	1.026	1.046	1.077	1.011	0.992	1.008
1	25.0	0.997	0.981	0.991	1.014	1.044	0.977	0.959	0.975
2	50.0	0.993	0.978	0.991	1.008	1.038	0.975	0.958	0.974
3	100.0	1.000	0.989	1.002	1.018	1.051	0.987	0.969	0.982
4	200.0	1.008	0.998	1.019	1.030	1.064	1.003	0.984	0.993
5	300.0	1.016	1.011	1.031	1.042	1.075	1.018	0.998	1.005
6	400.0	1.021	1.017	1.037	1.047	1.080	1.024	1.005	1.011
7	500.0	1.023	1.023	1.046	1.055	1.086	1.027	1.011	1.015
8	600.0	1.023	1.024	1.047	1.058	1.091	1.031	1.011	1.018
9	700.0	1.021	1.025	1.047	1.058	1.092	1.032	1.011	1.014
10	800.0	1.021	1.021	1.044	1.053	1.087	1.032	1.010	1.016
11	900.0	1.018	1.023	1.045	1.056	1.089	1.027	1.008	1.012
12	1000.0	1.016	1.018	1.041	1.052	1.083	1.024	1.003	1.010
13	1100.0	1.010	1.015	1.035	1.046	1.079	1.018	0.996	1.002
14	1200.0	1.006	1.012	1.032	1.046	1.075	1.015	0.989	1.000
15	1300.0	1.006	1.007	1.027	1.041	1.072	1.009	0.988	0.999
Step	Burnup $\left[\frac{MWd}{MtU}\right]$	MPACT Power Peaking Factors A	B	C	D	P	Q	R	S
0	0.0	0.994	1.007	1.025	1.007	0.990	0.973	0.990	1.056
1	25.0	1.015	1.028	1.046	1.028	1.010	0.993	1.010	1.077
2	50.0	1.011	1.025	1.043	1.024	1.006	0.990	1.007	1.074
3	100.0	1.005	1.019	1.037	1.018	1.001	0.984	1.001	1.067
4	200.0	0.998	1.011	1.029	1.010	0.994	0.977	0.994	1.060
5	300.0	0.993	1.006	1.025	1.007	0.990	0.973	0.990	1.055
6	400.0	0.993	1.006	1.023	1.005	0.989	0.972	0.989	1.055
7	500.0	0.993	1.006	1.024	1.006	0.989	0.972	0.990	1.055
8	600.0	0.995	1.007	1.025	1.007	0.991	0.974	0.991	1.056
9	700.0	0.998	1.012	1.029	1.011	0.995	0.977	0.995	1.061
10	800.0	1.002	1.015	1.033	1.014	0.998	0.981	0.998	1.064
11	900.0	1.006	1.019	1.037	1.019	1.003	0.985	1.003	1.069
12	1000.0	1.010	1.023	1.041	1.023	1.006	0.989	1.007	1.073
13	1100.0	1.015	1.028	1.046	1.027	1.011	0.994	1.011	1.078
14	1200.0	1.019	1.033	1.051	1.032	1.016	0.999	1.016	1.083
15	1300.0	1.024	1.038	1.056	1.037	1.021	1.004	1.021	1.088

Table 7.80. Problem 6.2.1 reference solution power peaking factors in element 4 for charge-pan III (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.063	1.042	1.003	0.997	0.998	1.003	1.042	1.063
1	25.0	1.031	1.012	0.970	0.967	0.963	0.967	1.005	1.028
2	50.0	1.028	1.007	0.969	0.963	0.961	0.969	1.004	1.027
3	100.0	1.039	1.018	0.977	0.969	0.973	0.977	1.015	1.040
4	200.0	1.048	1.031	0.990	0.979	0.989	0.993	1.034	1.054
5	300.0	1.054	1.044	0.999	0.986	1.000	1.007	1.048	1.071
6	400.0	1.061	1.048	1.009	0.989	1.007	1.013	1.055	1.076
7	500.0	1.063	1.054	1.012	0.992	1.015	1.018	1.060	1.084
8	600.0	1.065	1.057	1.012	0.993	1.014	1.021	1.065	1.086
9	700.0	1.065	1.056	1.013	0.990	1.015	1.020	1.065	1.086
10	800.0	1.063	1.056	1.013	0.988	1.013	1.018	1.064	1.086
11	900.0	1.058	1.053	1.010	0.986	1.011	1.015	1.062	1.085
12	1000.0	1.056	1.050	1.005	0.984	1.006	1.012	1.055	1.081
13	1100.0	1.051	1.046	1.003	0.981	1.000	1.004	1.050	1.072
14	1200.0	1.049	1.042	0.999	0.976	0.995	0.998	1.047	1.072
15	1300.0	1.046	1.040	0.996	0.974	0.990	0.996	1.045	1.068
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.982	0.977	0.977	0.982	1.023	1.044	1.044	1.023
1	25.0	1.002	0.997	0.997	1.003	1.044	1.065	1.066	1.044
2	50.0	0.999	0.994	0.994	1.000	1.042	1.062	1.063	1.041
3	100.0	0.993	0.988	0.988	0.994	1.035	1.055	1.056	1.035
4	200.0	0.986	0.981	0.981	0.986	1.027	1.048	1.048	1.027
5	300.0	0.982	0.978	0.977	0.982	1.023	1.044	1.044	1.023
6	400.0	0.981	0.976	0.976	0.982	1.022	1.043	1.043	1.022
7	500.0	0.981	0.977	0.977	0.982	1.023	1.044	1.044	1.023
8	600.0	0.983	0.978	0.978	0.984	1.024	1.045	1.045	1.025
9	700.0	0.987	0.982	0.982	0.987	1.029	1.049	1.049	1.028
10	800.0	0.991	0.985	0.986	0.990	1.032	1.053	1.053	1.032
11	900.0	0.995	0.990	0.990	0.995	1.036	1.057	1.057	1.036
12	1000.0	1.000	0.994	0.994	0.999	1.041	1.061	1.061	1.040
13	1100.0	1.004	0.998	0.999	1.003	1.045	1.066	1.066	1.045
14	1200.0	1.009	1.003	1.003	1.008	1.050	1.071	1.071	1.050
15	1300.0	1.014	1.008	1.008	1.013	1.056	1.076	1.076	1.055

Table 7.81. Problem 6.2.1 reference solution power peaking factors in element 5 for charge-pan III (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	0.576	0.564	0.575	0.589	0.611	0.560	0.546	0.560
1	25.0	0.545	0.535	0.545	0.559	0.582	0.531	0.516	0.529
2	50.0	0.546	0.536	0.546	0.560	0.581	0.529	0.515	0.531
3	100.0	0.552	0.540	0.551	0.564	0.588	0.537	0.523	0.536
4	200.0	0.565	0.551	0.565	0.575	0.599	0.552	0.537	0.552
5	300.0	0.575	0.560	0.574	0.584	0.607	0.563	0.548	0.562
6	400.0	0.581	0.565	0.581	0.591	0.616	0.570	0.556	0.572
7	500.0	0.585	0.567	0.583	0.593	0.617	0.573	0.558	0.573
8	600.0	0.586	0.566	0.585	0.593	0.619	0.573	0.560	0.576
9	700.0	0.587	0.568	0.587	0.593	0.618	0.574	0.562	0.577
10	800.0	0.583	0.565	0.585	0.590	0.616	0.574	0.557	0.572
11	900.0	0.586	0.566	0.585	0.592	0.615	0.573	0.559	0.573
12	1000.0	0.581	0.560	0.582	0.586	0.614	0.571	0.555	0.566
13	1100.0	0.577	0.554	0.576	0.580	0.606	0.564	0.547	0.560
14	1200.0	0.574	0.555	0.575	0.582	0.606	0.562	0.545	0.559
15	1300.0	0.572	0.551	0.573	0.577	0.605	0.559	0.545	0.554
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	0.532	0.541	0.555	0.541	0.527	0.513	0.527	0.577
1	25.0	0.574	0.584	0.599	0.584	0.569	0.553	0.569	0.622
2	50.0	0.568	0.579	0.593	0.579	0.563	0.548	0.563	0.616
3	100.0	0.556	0.566	0.580	0.566	0.551	0.536	0.551	0.602
4	200.0	0.538	0.548	0.562	0.548	0.534	0.520	0.534	0.584
5	300.0	0.528	0.537	0.551	0.537	0.524	0.509	0.524	0.573
6	400.0	0.523	0.533	0.546	0.533	0.519	0.505	0.519	0.567
7	500.0	0.521	0.531	0.545	0.531	0.517	0.503	0.517	0.566
8	600.0	0.522	0.532	0.546	0.532	0.518	0.504	0.518	0.566
9	700.0	0.525	0.535	0.549	0.535	0.521	0.507	0.521	0.570
10	800.0	0.529	0.539	0.552	0.538	0.524	0.511	0.524	0.574
11	900.0	0.534	0.544	0.558	0.544	0.530	0.516	0.530	0.580
12	1000.0	0.540	0.550	0.564	0.550	0.535	0.521	0.535	0.586
13	1100.0	0.546	0.556	0.571	0.557	0.542	0.527	0.542	0.593
14	1200.0	0.554	0.564	0.578	0.564	0.549	0.534	0.549	0.601
15	1300.0	0.561	0.572	0.586	0.572	0.557	0.542	0.557	0.609

Table 7.82. Problem 6.2.1 reference solution power peaking factors in element 5 for charge-pan III (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.603	0.587	0.556	0.549	0.550	0.553	0.586	0.603
1	25.0	0.570	0.555	0.524	0.521	0.520	0.524	0.556	0.572
2	50.0	0.573	0.555	0.523	0.520	0.521	0.526	0.555	0.570
3	100.0	0.581	0.563	0.531	0.527	0.528	0.532	0.563	0.580
4	200.0	0.592	0.577	0.547	0.539	0.542	0.547	0.578	0.592
5	300.0	0.603	0.589	0.556	0.547	0.553	0.558	0.589	0.604
6	400.0	0.611	0.598	0.566	0.555	0.560	0.565	0.598	0.612
7	500.0	0.614	0.601	0.569	0.558	0.564	0.566	0.601	0.614
8	600.0	0.615	0.602	0.571	0.559	0.566	0.571	0.606	0.616
9	700.0	0.618	0.604	0.571	0.562	0.567	0.570	0.604	0.618
10	800.0	0.615	0.602	0.567	0.557	0.565	0.568	0.601	0.615
11	900.0	0.616	0.603	0.568	0.560	0.563	0.569	0.604	0.617
12	1000.0	0.612	0.597	0.563	0.554	0.560	0.563	0.598	0.614
13	1100.0	0.605	0.590	0.560	0.549	0.554	0.558	0.592	0.605
14	1200.0	0.604	0.589	0.557	0.548	0.553	0.558	0.591	0.607
15	1300.0	0.603	0.585	0.552	0.544	0.551	0.554	0.589	0.605
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.522	0.517	0.517	0.522	0.552	0.568	0.568	0.552
1	25.0	0.563	0.559	0.558	0.563	0.595	0.612	0.613	0.595
2	50.0	0.558	0.553	0.553	0.558	0.590	0.606	0.607	0.590
3	100.0	0.545	0.541	0.541	0.546	0.577	0.593	0.593	0.577
4	200.0	0.528	0.524	0.524	0.528	0.559	0.575	0.575	0.559
5	300.0	0.518	0.514	0.513	0.518	0.548	0.564	0.564	0.548
6	400.0	0.513	0.509	0.509	0.514	0.543	0.559	0.559	0.543
7	500.0	0.511	0.508	0.508	0.512	0.542	0.557	0.557	0.541
8	600.0	0.512	0.508	0.508	0.513	0.543	0.558	0.558	0.543
9	700.0	0.516	0.511	0.511	0.516	0.545	0.561	0.561	0.545
10	800.0	0.519	0.515	0.515	0.519	0.549	0.565	0.565	0.549
11	900.0	0.524	0.520	0.520	0.524	0.555	0.571	0.571	0.555
12	1000.0	0.530	0.526	0.525	0.530	0.561	0.577	0.577	0.561
13	1100.0	0.537	0.532	0.532	0.537	0.567	0.584	0.584	0.568
14	1200.0	0.544	0.539	0.539	0.543	0.575	0.591	0.592	0.575
15	1300.0	0.551	0.547	0.547	0.552	0.583	0.600	0.600	0.583

Table 7.83. Problem 6.2.1 reference solution power peaking factors in element 6 for charge-pan III (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	0.254	0.249	0.254	0.261	0.272	0.246	0.243	0.246
1	25.0	0.238	0.233	0.238	0.245	0.255	0.231	0.228	0.230
2	50.0	0.237	0.232	0.238	0.246	0.256	0.231	0.229	0.231
3	100.0	0.241	0.236	0.241	0.248	0.256	0.233	0.230	0.235
4	200.0	0.250	0.243	0.246	0.255	0.265	0.241	0.236	0.241
5	300.0	0.254	0.248	0.251	0.261	0.271	0.245	0.242	0.249
6	400.0	0.260	0.252	0.255	0.265	0.277	0.249	0.245	0.253
7	500.0	0.261	0.254	0.255	0.266	0.277	0.250	0.248	0.254
8	600.0	0.263	0.254	0.257	0.270	0.279	0.253	0.249	0.257
9	700.0	0.264	0.256	0.258	0.269	0.281	0.254	0.251	0.257
10	800.0	0.262	0.254	0.257	0.268	0.281	0.253	0.248	0.256
11	900.0	0.263	0.256	0.257	0.269	0.280	0.253	0.250	0.256
12	1000.0	0.262	0.253	0.254	0.267	0.279	0.252	0.249	0.254
13	1100.0	0.259	0.251	0.252	0.264	0.277	0.249	0.246	0.252
14	1200.0	0.259	0.252	0.252	0.265	0.276	0.248	0.246	0.252
15	1300.0	0.255	0.249	0.251	0.262	0.273	0.247	0.244	0.249
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	0.224	0.229	0.236	0.229	0.222	0.219	0.222	0.245
1	25.0	0.254	0.260	0.267	0.260	0.252	0.248	0.252	0.279
2	50.0	0.251	0.257	0.264	0.257	0.249	0.245	0.249	0.275
3	100.0	0.243	0.248	0.255	0.248	0.240	0.237	0.240	0.266
4	200.0	0.230	0.235	0.242	0.235	0.228	0.225	0.228	0.252
5	300.0	0.222	0.226	0.233	0.226	0.220	0.217	0.220	0.243
6	400.0	0.217	0.222	0.229	0.222	0.215	0.213	0.216	0.238
7	500.0	0.216	0.220	0.227	0.220	0.214	0.211	0.213	0.236
8	600.0	0.215	0.220	0.226	0.220	0.213	0.211	0.213	0.236
9	700.0	0.216	0.220	0.227	0.221	0.214	0.211	0.214	0.236
10	800.0	0.217	0.222	0.229	0.222	0.215	0.213	0.215	0.238
11	900.0	0.220	0.225	0.231	0.225	0.218	0.216	0.218	0.241
12	1000.0	0.223	0.228	0.234	0.228	0.221	0.218	0.221	0.244
13	1100.0	0.226	0.231	0.238	0.232	0.225	0.222	0.224	0.248
14	1200.0	0.230	0.236	0.242	0.236	0.228	0.226	0.228	0.253
15	1300.0	0.235	0.240	0.247	0.240	0.233	0.230	0.233	0.258

Table 7.84. Problem 6.2.1 reference solution power peaking factors in element 6 for charge-pan III (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.269	0.260	0.243	0.241	0.242	0.243	0.258	0.268
1	25.0	0.250	0.242	0.228	0.225	0.226	0.228	0.243	0.251
2	50.0	0.250	0.243	0.228	0.226	0.226	0.229	0.243	0.252
3	100.0	0.254	0.246	0.231	0.229	0.229	0.231	0.245	0.254
4	200.0	0.262	0.253	0.238	0.237	0.233	0.238	0.253	0.260
5	300.0	0.268	0.261	0.244	0.243	0.241	0.243	0.259	0.265
6	400.0	0.274	0.264	0.249	0.246	0.244	0.246	0.265	0.269
7	500.0	0.275	0.266	0.249	0.249	0.245	0.249	0.265	0.271
8	600.0	0.278	0.267	0.252	0.251	0.247	0.249	0.267	0.272
9	700.0	0.278	0.269	0.254	0.252	0.249	0.252	0.267	0.271
10	800.0	0.277	0.267	0.251	0.248	0.246	0.249	0.265	0.270
11	900.0	0.278	0.268	0.252	0.249	0.247	0.250	0.268	0.273
12	1000.0	0.276	0.266	0.251	0.248	0.247	0.248	0.265	0.270
13	1100.0	0.273	0.264	0.248	0.246	0.243	0.248	0.264	0.267
14	1200.0	0.272	0.264	0.247	0.245	0.244	0.246	0.264	0.266
15	1300.0	0.270	0.261	0.246	0.243	0.243	0.245	0.261	0.265
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.219	0.217	0.217	0.219	0.234	0.241	0.241	0.234
1	25.0	0.249	0.247	0.247	0.249	0.265	0.274	0.274	0.265
2	50.0	0.246	0.243	0.244	0.246	0.262	0.270	0.271	0.262
3	100.0	0.237	0.235	0.235	0.238	0.253	0.261	0.261	0.253
4	200.0	0.225	0.223	0.223	0.225	0.240	0.248	0.248	0.240
5	300.0	0.217	0.215	0.215	0.217	0.231	0.239	0.239	0.231
6	400.0	0.213	0.211	0.211	0.213	0.227	0.234	0.234	0.227
7	500.0	0.211	0.209	0.209	0.211	0.225	0.232	0.232	0.225
8	600.0	0.210	0.209	0.209	0.211	0.224	0.232	0.232	0.224
9	700.0	0.211	0.210	0.209	0.211	0.225	0.232	0.232	0.225
10	800.0	0.213	0.211	0.211	0.213	0.227	0.234	0.234	0.227
11	900.0	0.215	0.213	0.213	0.215	0.230	0.237	0.237	0.229
12	1000.0	0.218	0.216	0.216	0.218	0.233	0.240	0.240	0.233
13	1100.0	0.222	0.220	0.220	0.222	0.236	0.244	0.244	0.236
14	1200.0	0.226	0.224	0.224	0.225	0.240	0.248	0.248	0.240
15	1300.0	0.230	0.228	0.228	0.230	0.245	0.253	0.253	0.245

Charge-Pan IV

Table 7.85. Problem 6.2.1 reference solution power peaking factors in element 1 for charge-pan IV (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.032	1.033	1.033	1.036	1.045	1.047	1.047	1.046
1	25.0	1.075	1.073	1.074	1.075	1.083	1.088	1.082	1.080
2	50.0	1.075	1.074	1.071	1.074	1.080	1.089	1.082	1.082
3	100.0	1.066	1.063	1.063	1.065	1.073	1.080	1.072	1.073
4	200.0	1.045	1.047	1.047	1.048	1.054	1.061	1.055	1.055
5	300.0	1.035	1.032	1.033	1.032	1.040	1.046	1.042	1.045
6	400.0	1.023	1.025	1.024	1.025	1.035	1.035	1.035	1.037
7	500.0	1.023	1.023	1.022	1.020	1.028	1.035	1.032	1.032
8	600.0	1.022	1.021	1.020	1.018	1.027	1.030	1.027	1.031
9	700.0	1.019	1.019	1.018	1.018	1.027	1.027	1.028	1.029
10	800.0	1.022	1.026	1.022	1.023	1.031	1.031	1.030	1.035
11	900.0	1.026	1.028	1.023	1.025	1.033	1.036	1.034	1.034
12	1000.0	1.035	1.032	1.029	1.032	1.037	1.046	1.039	1.043
13	1100.0	1.035	1.037	1.036	1.036	1.040	1.047	1.043	1.045
14	1200.0	1.044	1.041	1.038	1.038	1.046	1.052	1.047	1.049
15	1300.0	1.047	1.048	1.043	1.042	1.049	1.059	1.052	1.055
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.046	1.046	1.046	1.046	1.057	1.058	1.057	1.058
1	25.0	1.029	1.029	1.029	1.029	1.040	1.040	1.040	1.040
2	50.0	1.030	1.030	1.030	1.030	1.041	1.041	1.040	1.041
3	100.0	1.033	1.033	1.032	1.032	1.044	1.044	1.043	1.044
4	200.0	1.036	1.035	1.035	1.035	1.047	1.047	1.047	1.047
5	300.0	1.039	1.038	1.039	1.039	1.050	1.050	1.050	1.051
6	400.0	1.040	1.040	1.040	1.040	1.052	1.051	1.052	1.051
7	500.0	1.040	1.040	1.039	1.040	1.052	1.052	1.051	1.051
8	600.0	1.040	1.039	1.040	1.039	1.052	1.052	1.051	1.051
9	700.0	1.038	1.038	1.038	1.039	1.050	1.050	1.050	1.050
10	800.0	1.037	1.037	1.037	1.038	1.049	1.050	1.049	1.049
11	900.0	1.035	1.035	1.035	1.036	1.048	1.047	1.047	1.047
12	1000.0	1.034	1.034	1.034	1.034	1.046	1.046	1.045	1.046
13	1100.0	1.032	1.032	1.032	1.033	1.044	1.044	1.043	1.044
14	1200.0	1.030	1.029	1.030	1.030	1.042	1.042	1.041	1.041
15	1300.0	1.027	1.027	1.027	1.028	1.039	1.039	1.038	1.039

Table 7.86. Problem 6.2.1 reference solution power peaking factors in element 1 for charge-pan IV (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.045	1.043	1.043	1.044	1.043	1.044	1.044	1.043
1	25.0	1.083	1.086	1.087	1.084	1.078	1.080	1.081	1.081
2	50.0	1.083	1.086	1.085	1.084	1.082	1.079	1.080	1.079
3	100.0	1.074	1.078	1.076	1.075	1.071	1.072	1.071	1.072
4	200.0	1.056	1.056	1.059	1.057	1.053	1.054	1.052	1.053
5	300.0	1.043	1.046	1.045	1.044	1.041	1.042	1.040	1.037
6	400.0	1.035	1.035	1.034	1.035	1.035	1.034	1.033	1.034
7	500.0	1.032	1.034	1.030	1.032	1.030	1.031	1.028	1.026
8	600.0	1.028	1.030	1.030	1.029	1.027	1.029	1.025	1.026
9	700.0	1.028	1.030	1.028	1.030	1.026	1.027	1.024	1.024
10	800.0	1.030	1.035	1.031	1.032	1.029	1.031	1.027	1.026
11	900.0	1.033	1.036	1.032	1.036	1.033	1.033	1.031	1.027
12	1000.0	1.041	1.044	1.043	1.042	1.037	1.038	1.035	1.034
13	1100.0	1.042	1.046	1.045	1.046	1.042	1.042	1.038	1.036
14	1200.0	1.050	1.053	1.050	1.051	1.044	1.047	1.043	1.041
15	1300.0	1.054	1.057	1.058	1.057	1.052	1.054	1.048	1.047
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.055	1.055	1.055	1.055	1.055	1.055	1.055	1.055
1	25.0	1.039	1.039	1.038	1.038	1.038	1.038	1.039	1.039
2	50.0	1.039	1.040	1.039	1.039	1.039	1.039	1.040	1.040
3	100.0	1.042	1.042	1.042	1.042	1.041	1.042	1.042	1.042
4	200.0	1.045	1.045	1.045	1.045	1.045	1.045	1.045	1.046
5	300.0	1.048	1.049	1.049	1.048	1.048	1.048	1.048	1.048
6	400.0	1.050	1.050	1.050	1.049	1.049	1.050	1.050	1.050
7	500.0	1.050	1.050	1.049	1.049	1.050	1.050	1.050	1.050
8	600.0	1.050	1.050	1.049	1.049	1.049	1.050	1.050	1.050
9	700.0	1.048	1.048	1.048	1.048	1.048	1.048	1.048	1.048
10	800.0	1.047	1.047	1.047	1.047	1.047	1.047	1.047	1.047
11	900.0	1.045	1.045	1.045	1.045	1.045	1.046	1.045	1.045
12	1000.0	1.044	1.044	1.044	1.044	1.044	1.044	1.044	1.044
13	1100.0	1.042	1.042	1.042	1.042	1.041	1.042	1.042	1.042
14	1200.0	1.039	1.039	1.039	1.039	1.039	1.040	1.039	1.040
15	1300.0	1.037	1.037	1.037	1.037	1.037	1.037	1.037	1.037

Table 7.87. Problem 6.2.1 reference solution power peaking factors in element 2 for charge-pan IV (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.551	1.553	1.553	1.553	1.574	1.568	1.572	1.573
1	25.0	1.602	1.602	1.599	1.602	1.615	1.623	1.616	1.618
2	50.0	1.601	1.598	1.599	1.603	1.616	1.622	1.615	1.616
3	100.0	1.589	1.589	1.587	1.589	1.607	1.614	1.602	1.603
4	200.0	1.567	1.567	1.569	1.566	1.582	1.586	1.582	1.584
5	300.0	1.547	1.545	1.547	1.548	1.566	1.569	1.562	1.565
6	400.0	1.535	1.534	1.534	1.537	1.552	1.553	1.552	1.552
7	500.0	1.526	1.527	1.528	1.526	1.542	1.545	1.542	1.544
8	600.0	1.522	1.520	1.523	1.521	1.540	1.542	1.540	1.540
9	700.0	1.518	1.518	1.518	1.516	1.532	1.536	1.533	1.536
10	800.0	1.518	1.521	1.517	1.519	1.537	1.534	1.532	1.537
11	900.0	1.511	1.520	1.518	1.518	1.532	1.534	1.532	1.537
12	1000.0	1.517	1.519	1.521	1.522	1.535	1.535	1.533	1.540
13	1100.0	1.524	1.526	1.527	1.525	1.539	1.547	1.539	1.543
14	1200.0	1.526	1.529	1.524	1.528	1.539	1.545	1.544	1.546
15	1300.0	1.530	1.531	1.531	1.531	1.544	1.549	1.546	1.553
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.589	1.588	1.588	1.589	1.608	1.608	1.607	1.608
1	25.0	1.549	1.549	1.549	1.549	1.568	1.568	1.566	1.568
2	50.0	1.555	1.554	1.555	1.555	1.575	1.573	1.571	1.574
3	100.0	1.567	1.566	1.567	1.567	1.587	1.586	1.583	1.586
4	200.0	1.584	1.582	1.583	1.583	1.603	1.603	1.601	1.603
5	300.0	1.593	1.592	1.593	1.593	1.613	1.613	1.610	1.613
6	400.0	1.597	1.596	1.597	1.596	1.618	1.616	1.616	1.617
7	500.0	1.597	1.597	1.597	1.597	1.618	1.617	1.615	1.617
8	600.0	1.596	1.595	1.596	1.596	1.616	1.617	1.614	1.616
9	700.0	1.592	1.591	1.591	1.592	1.612	1.612	1.610	1.611
10	800.0	1.587	1.586	1.587	1.588	1.607	1.608	1.605	1.607
11	900.0	1.581	1.580	1.581	1.582	1.601	1.601	1.599	1.600
12	1000.0	1.575	1.574	1.574	1.576	1.595	1.595	1.593	1.594
13	1100.0	1.568	1.567	1.567	1.569	1.588	1.588	1.585	1.587
14	1200.0	1.560	1.559	1.560	1.561	1.580	1.580	1.578	1.579
15	1300.0	1.552	1.551	1.552	1.553	1.572	1.572	1.569	1.570

Table 7.88. Problem 6.2.1 reference solution power peaking factors in element 2 for charge-pan IV (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.569	1.566	1.564	1.566	1.568	1.570	1.573	1.571
1	25.0	1.618	1.618	1.617	1.616	1.612	1.615	1.613	1.611
2	50.0	1.616	1.617	1.618	1.620	1.614	1.615	1.613	1.612
3	100.0	1.608	1.608	1.610	1.602	1.604	1.603	1.601	1.603
4	200.0	1.584	1.579	1.583	1.583	1.580	1.582	1.577	1.577
5	300.0	1.567	1.564	1.565	1.560	1.558	1.562	1.560	1.561
6	400.0	1.553	1.550	1.552	1.549	1.549	1.551	1.548	1.549
7	500.0	1.541	1.541	1.541	1.542	1.541	1.541	1.537	1.539
8	600.0	1.539	1.538	1.538	1.538	1.536	1.539	1.536	1.534
9	700.0	1.531	1.534	1.534	1.537	1.531	1.534	1.531	1.529
10	800.0	1.536	1.533	1.533	1.535	1.530	1.534	1.529	1.532
11	900.0	1.532	1.526	1.531	1.532	1.533	1.533	1.528	1.526
12	1000.0	1.540	1.533	1.536	1.539	1.532	1.537	1.531	1.527
13	1100.0	1.542	1.541	1.542	1.546	1.538	1.541	1.535	1.533
14	1200.0	1.543	1.542	1.546	1.545	1.541	1.545	1.536	1.533
15	1300.0	1.546	1.544	1.548	1.547	1.544	1.546	1.539	1.537
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.605	1.605	1.604	1.604	1.604	1.604	1.605	1.605
1	25.0	1.566	1.566	1.564	1.564	1.563	1.565	1.566	1.566
2	50.0	1.572	1.571	1.570	1.569	1.569	1.570	1.572	1.571
3	100.0	1.583	1.584	1.583	1.582	1.581	1.582	1.584	1.583
4	200.0	1.600	1.600	1.599	1.598	1.599	1.599	1.600	1.600
5	300.0	1.610	1.610	1.609	1.608	1.608	1.609	1.610	1.610
6	400.0	1.614	1.614	1.613	1.612	1.612	1.613	1.614	1.614
7	500.0	1.615	1.614	1.613	1.612	1.613	1.613	1.614	1.614
8	600.0	1.613	1.613	1.613	1.612	1.612	1.613	1.613	1.613
9	700.0	1.609	1.609	1.608	1.607	1.607	1.608	1.609	1.609
10	800.0	1.604	1.604	1.603	1.602	1.602	1.604	1.604	1.605
11	900.0	1.598	1.598	1.597	1.596	1.596	1.598	1.598	1.599
12	1000.0	1.592	1.592	1.591	1.590	1.590	1.591	1.592	1.592
13	1100.0	1.584	1.585	1.583	1.583	1.582	1.584	1.585	1.585
14	1200.0	1.577	1.577	1.576	1.575	1.575	1.577	1.577	1.577
15	1300.0	1.568	1.569	1.567	1.566	1.566	1.568	1.569	1.569

Table 7.89. Problem 6.2.1 reference solution power peaking factors in element 3 for charge-pan IV (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.449	1.457	1.460	1.459	1.498	1.471	1.496	1.500
1	25.0	1.446	1.454	1.454	1.452	1.489	1.468	1.495	1.497
2	50.0	1.444	1.450	1.455	1.451	1.485	1.470	1.493	1.495
3	100.0	1.447	1.453	1.455	1.449	1.488	1.469	1.494	1.495
4	200.0	1.446	1.455	1.457	1.450	1.491	1.471	1.495	1.498
5	300.0	1.449	1.455	1.457	1.456	1.496	1.474	1.494	1.500
6	400.0	1.447	1.456	1.460	1.455	1.497	1.473	1.496	1.502
7	500.0	1.451	1.457	1.460	1.458	1.501	1.472	1.501	1.504
8	600.0	1.450	1.457	1.462	1.457	1.497	1.474	1.502	1.504
9	700.0	1.453	1.460	1.461	1.460	1.499	1.477	1.503	1.505
10	800.0	1.454	1.457	1.461	1.457	1.498	1.475	1.499	1.505
11	900.0	1.449	1.454	1.462	1.455	1.498	1.474	1.501	1.505
12	1000.0	1.450	1.454	1.459	1.457	1.497	1.474	1.500	1.504
13	1100.0	1.452	1.460	1.463	1.459	1.499	1.476	1.506	1.503
14	1200.0	1.449	1.456	1.459	1.454	1.498	1.476	1.503	1.504
15	1300.0	1.448	1.456	1.459	1.458	1.495	1.473	1.504	1.502
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	A	B	C	D	P	Q	R	S
0	0.0	1.476	1.470	1.476	1.480	1.519	1.515	1.493	1.515
1	25.0	1.453	1.447	1.453	1.457	1.496	1.491	1.470	1.492
2	50.0	1.457	1.451	1.457	1.461	1.501	1.495	1.474	1.496
3	100.0	1.464	1.459	1.464	1.469	1.509	1.503	1.481	1.503
4	200.0	1.476	1.470	1.476	1.480	1.520	1.515	1.494	1.515
5	300.0	1.482	1.476	1.482	1.486	1.527	1.522	1.500	1.522
6	400.0	1.486	1.479	1.485	1.489	1.530	1.525	1.504	1.524
7	500.0	1.487	1.481	1.487	1.491	1.531	1.526	1.504	1.526
8	600.0	1.487	1.480	1.486	1.490	1.530	1.526	1.505	1.526
9	700.0	1.484	1.478	1.484	1.489	1.529	1.524	1.502	1.524
10	800.0	1.482	1.476	1.482	1.486	1.527	1.522	1.500	1.522
11	900.0	1.479	1.474	1.479	1.483	1.524	1.519	1.498	1.519
12	1000.0	1.476	1.470	1.476	1.480	1.520	1.516	1.494	1.516
13	1100.0	1.473	1.467	1.472	1.477	1.516	1.512	1.491	1.512
14	1200.0	1.469	1.463	1.468	1.473	1.512	1.508	1.487	1.507
15	1300.0	1.464	1.458	1.464	1.468	1.507	1.504	1.482	1.503

Table 7.90. Problem 6.2.1 reference solution power peaking factors in element 3 for charge-pan IV (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.481	1.471	1.470	1.478	1.491	1.495	1.492	1.493
1	25.0	1.472	1.465	1.469	1.479	1.489	1.490	1.487	1.482
2	50.0	1.476	1.464	1.468	1.475	1.487	1.488	1.484	1.482
3	100.0	1.475	1.468	1.466	1.474	1.487	1.493	1.486	1.485
4	200.0	1.474	1.469	1.468	1.479	1.491	1.491	1.487	1.488
5	300.0	1.475	1.470	1.467	1.479	1.491	1.495	1.493	1.491
6	400.0	1.480	1.471	1.469	1.478	1.495	1.494	1.492	1.494
7	500.0	1.478	1.469	1.473	1.482	1.494	1.497	1.495	1.496
8	600.0	1.479	1.472	1.473	1.480	1.495	1.497	1.491	1.495
9	700.0	1.479	1.474	1.472	1.482	1.496	1.498	1.496	1.497
10	800.0	1.479	1.475	1.475	1.481	1.497	1.500	1.499	1.494
11	900.0	1.477	1.470	1.472	1.479	1.499	1.500	1.493	1.493
12	1000.0	1.477	1.470	1.469	1.477	1.495	1.499	1.495	1.494
13	1100.0	1.482	1.474	1.475	1.482	1.503	1.502	1.495	1.495
14	1200.0	1.481	1.472	1.471	1.479	1.497	1.497	1.497	1.495
15	1300.0	1.478	1.473	1.469	1.481	1.497	1.498	1.496	1.493
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	1.511	1.510	1.498	1.490	1.490	1.498	1.510	1.511
1	25.0	1.489	1.488	1.475	1.468	1.468	1.476	1.487	1.489
2	50.0	1.493	1.491	1.479	1.472	1.472	1.479	1.492	1.493
3	100.0	1.500	1.499	1.487	1.479	1.480	1.487	1.500	1.500
4	200.0	1.512	1.510	1.498	1.491	1.491	1.498	1.511	1.512
5	300.0	1.518	1.517	1.505	1.498	1.498	1.505	1.518	1.518
6	400.0	1.521	1.520	1.508	1.501	1.501	1.508	1.520	1.522
7	500.0	1.523	1.521	1.509	1.501	1.502	1.509	1.521	1.523
8	600.0	1.523	1.521	1.509	1.502	1.502	1.509	1.522	1.523
9	700.0	1.521	1.520	1.508	1.500	1.500	1.508	1.520	1.522
10	800.0	1.518	1.518	1.505	1.498	1.498	1.505	1.518	1.519
11	900.0	1.515	1.515	1.503	1.495	1.495	1.503	1.515	1.516
12	1000.0	1.512	1.512	1.499	1.492	1.492	1.499	1.512	1.513
13	1100.0	1.508	1.508	1.496	1.488	1.488	1.496	1.508	1.509
14	1200.0	1.504	1.504	1.492	1.484	1.484	1.492	1.504	1.505
15	1300.0	1.499	1.499	1.487	1.479	1.479	1.487	1.500	1.501

Table 7.91. Problem 6.2.1 reference solution power peaking factors in element 4 for charge-pan IV (1/2).

Step	Burnup $\left[\frac{MWd}{MtU}\right]$	Shift Power Peaking Factors A	B	C	D	P	Q	R	S
0	0.0	0.761	0.780	0.795	0.782	0.956	0.889	0.954	0.977
1	25.0	0.737	0.755	0.769	0.754	0.925	0.858	0.928	0.943
2	50.0	0.737	0.755	0.769	0.755	0.923	0.861	0.927	0.942
3	100.0	0.744	0.763	0.775	0.763	0.934	0.867	0.935	0.952
4	200.0	0.756	0.776	0.789	0.772	0.946	0.880	0.949	0.966
5	300.0	0.765	0.784	0.800	0.785	0.961	0.892	0.962	0.978
6	400.0	0.771	0.789	0.804	0.789	0.967	0.899	0.968	0.986
7	500.0	0.773	0.793	0.807	0.795	0.973	0.903	0.974	0.988
8	600.0	0.774	0.795	0.808	0.796	0.973	0.905	0.975	0.989
9	700.0	0.777	0.798	0.811	0.794	0.974	0.905	0.977	0.991
10	800.0	0.772	0.791	0.807	0.794	0.970	0.899	0.974	0.989
11	900.0	0.772	0.793	0.805	0.790	0.966	0.899	0.973	0.985
12	1000.0	0.768	0.785	0.799	0.786	0.963	0.893	0.970	0.983
13	1100.0	0.765	0.784	0.797	0.784	0.958	0.888	0.962	0.976
14	1200.0	0.758	0.780	0.791	0.780	0.953	0.886	0.961	0.973
15	1300.0	0.759	0.775	0.791	0.777	0.949	0.882	0.956	0.965
Step	Burnup $\left[\frac{MWd}{MtU}\right]$	MPACT Power Peaking Factors A	B	C	D	P	Q	R	S
0	0.0	0.765	0.746	0.765	0.778	0.954	0.937	0.871	0.938
1	25.0	0.781	0.763	0.782	0.795	0.973	0.956	0.890	0.957
2	50.0	0.779	0.761	0.780	0.793	0.971	0.953	0.887	0.954
3	100.0	0.774	0.756	0.775	0.787	0.965	0.947	0.882	0.948
4	200.0	0.768	0.750	0.769	0.781	0.958	0.940	0.876	0.942
5	300.0	0.765	0.747	0.765	0.778	0.954	0.936	0.872	0.938
6	400.0	0.764	0.746	0.764	0.777	0.952	0.936	0.871	0.936
7	500.0	0.765	0.747	0.766	0.778	0.954	0.937	0.872	0.937
8	600.0	0.766	0.749	0.767	0.780	0.956	0.938	0.873	0.939
9	700.0	0.769	0.751	0.770	0.783	0.959	0.941	0.877	0.943
10	800.0	0.772	0.754	0.773	0.785	0.962	0.945	0.880	0.946
11	900.0	0.776	0.758	0.776	0.789	0.966	0.949	0.884	0.951
12	1000.0	0.780	0.762	0.780	0.793	0.970	0.953	0.888	0.955
13	1100.0	0.784	0.766	0.784	0.797	0.975	0.958	0.893	0.959
14	1200.0	0.788	0.770	0.789	0.802	0.980	0.962	0.897	0.964
15	1300.0	0.793	0.774	0.793	0.806	0.985	0.968	0.902	0.969

Table 7.92. Problem 6.2.1 reference solution power peaking factors in element 4 for charge-pan IV (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.894	0.874	0.872	0.895	0.937	0.941	0.943	0.935
1	25.0	0.864	0.842	0.843	0.865	0.909	0.910	0.910	0.905
2	50.0	0.865	0.844	0.844	0.865	0.909	0.911	0.911	0.905
3	100.0	0.873	0.851	0.852	0.874	0.915	0.921	0.919	0.915
4	200.0	0.885	0.864	0.865	0.887	0.932	0.935	0.932	0.929
5	300.0	0.898	0.877	0.877	0.899	0.941	0.946	0.948	0.942
6	400.0	0.906	0.883	0.882	0.904	0.949	0.954	0.954	0.948
7	500.0	0.908	0.885	0.886	0.908	0.952	0.956	0.958	0.952
8	600.0	0.911	0.887	0.887	0.910	0.952	0.956	0.959	0.953
9	700.0	0.911	0.890	0.888	0.911	0.955	0.959	0.959	0.957
10	800.0	0.905	0.885	0.885	0.908	0.953	0.958	0.959	0.955
11	900.0	0.905	0.883	0.883	0.904	0.953	0.954	0.955	0.950
12	1000.0	0.898	0.879	0.877	0.902	0.947	0.951	0.950	0.943
13	1100.0	0.894	0.874	0.872	0.897	0.943	0.945	0.947	0.942
14	1200.0	0.891	0.871	0.871	0.891	0.940	0.941	0.942	0.934
15	1300.0	0.888	0.866	0.866	0.888	0.935	0.937	0.938	0.930
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.921	0.916	0.875	0.854	0.854	0.876	0.917	0.922
1	25.0	0.941	0.936	0.894	0.873	0.874	0.895	0.937	0.942
2	50.0	0.938	0.933	0.892	0.871	0.872	0.893	0.934	0.939
3	100.0	0.932	0.927	0.886	0.865	0.866	0.887	0.929	0.933
4	200.0	0.926	0.920	0.880	0.859	0.859	0.880	0.921	0.926
5	300.0	0.922	0.916	0.876	0.856	0.856	0.876	0.918	0.922
6	400.0	0.921	0.915	0.875	0.855	0.855	0.876	0.917	0.921
7	500.0	0.922	0.917	0.876	0.855	0.856	0.877	0.917	0.923
8	600.0	0.924	0.918	0.878	0.857	0.857	0.878	0.920	0.924
9	700.0	0.927	0.921	0.881	0.860	0.861	0.881	0.923	0.927
10	800.0	0.930	0.925	0.884	0.863	0.864	0.885	0.926	0.930
11	900.0	0.934	0.929	0.888	0.868	0.868	0.889	0.930	0.935
12	1000.0	0.938	0.933	0.892	0.871	0.872	0.893	0.935	0.939
13	1100.0	0.943	0.938	0.897	0.876	0.877	0.897	0.939	0.943
14	1200.0	0.947	0.942	0.902	0.880	0.881	0.902	0.944	0.948
15	1300.0	0.952	0.947	0.907	0.885	0.885	0.907	0.949	0.953

Table 7.93. Problem 6.2.1 reference solution power peaking factors in element 5 for charge-pan IV (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	0.400	0.411	0.423	0.415	0.522	0.469	0.517	0.531
1	25.0	0.376	0.391	0.399	0.392	0.492	0.441	0.491	0.502
2	50.0	0.379	0.391	0.403	0.391	0.491	0.443	0.492	0.504
3	100.0	0.383	0.396	0.407	0.397	0.500	0.449	0.498	0.511
4	200.0	0.393	0.406	0.418	0.409	0.512	0.461	0.511	0.524
5	300.0	0.402	0.414	0.426	0.416	0.523	0.469	0.519	0.535
6	400.0	0.407	0.421	0.432	0.421	0.530	0.477	0.527	0.540
7	500.0	0.410	0.423	0.435	0.424	0.535	0.481	0.531	0.545
8	600.0	0.412	0.423	0.435	0.427	0.535	0.482	0.530	0.546
9	700.0	0.413	0.427	0.437	0.430	0.536	0.485	0.534	0.548
10	800.0	0.410	0.424	0.434	0.425	0.531	0.482	0.531	0.543
11	900.0	0.411	0.424	0.434	0.424	0.532	0.480	0.534	0.545
12	1000.0	0.408	0.422	0.431	0.423	0.530	0.480	0.530	0.541
13	1100.0	0.405	0.417	0.428	0.418	0.524	0.474	0.523	0.535
14	1200.0	0.403	0.414	0.425	0.417	0.522	0.471	0.523	0.535
15	1300.0	0.401	0.414	0.423	0.415	0.519	0.470	0.520	0.530
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	0.388	0.376	0.390	0.398	0.500	0.486	0.441	0.491
1	25.0	0.419	0.406	0.422	0.430	0.540	0.524	0.476	0.530
2	50.0	0.416	0.403	0.418	0.427	0.535	0.519	0.473	0.525
3	100.0	0.406	0.394	0.408	0.417	0.523	0.508	0.462	0.513
4	200.0	0.393	0.381	0.395	0.404	0.507	0.492	0.447	0.497
5	300.0	0.385	0.373	0.387	0.396	0.497	0.482	0.438	0.487
6	400.0	0.382	0.370	0.384	0.392	0.492	0.478	0.434	0.483
7	500.0	0.381	0.369	0.383	0.391	0.491	0.477	0.433	0.481
8	600.0	0.381	0.369	0.383	0.391	0.492	0.478	0.433	0.482
9	700.0	0.383	0.371	0.385	0.393	0.495	0.480	0.436	0.485
10	800.0	0.386	0.374	0.388	0.396	0.498	0.484	0.439	0.488
11	900.0	0.390	0.378	0.392	0.400	0.503	0.489	0.443	0.493
12	1000.0	0.394	0.382	0.396	0.404	0.508	0.494	0.448	0.499
13	1100.0	0.399	0.387	0.401	0.410	0.515	0.500	0.454	0.505
14	1200.0	0.404	0.392	0.407	0.415	0.521	0.506	0.460	0.511
15	1300.0	0.410	0.398	0.412	0.421	0.529	0.514	0.467	0.519

Table 7.94. Problem 6.2.1 reference solution power peaking factors in element 5 for charge-pan IV (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.479	0.461	0.459	0.474	0.504	0.510	0.512	0.509
1	25.0	0.451	0.435	0.435	0.449	0.479	0.484	0.484	0.480
2	50.0	0.451	0.435	0.435	0.450	0.481	0.484	0.485	0.482
3	100.0	0.460	0.442	0.441	0.456	0.487	0.490	0.490	0.488
4	200.0	0.469	0.453	0.452	0.467	0.500	0.503	0.506	0.501
5	300.0	0.481	0.463	0.461	0.478	0.509	0.512	0.514	0.512
6	400.0	0.486	0.471	0.467	0.483	0.516	0.520	0.522	0.518
7	500.0	0.491	0.472	0.472	0.488	0.517	0.521	0.526	0.523
8	600.0	0.493	0.475	0.471	0.488	0.520	0.524	0.526	0.522
9	700.0	0.494	0.478	0.476	0.490	0.522	0.526	0.528	0.523
10	800.0	0.489	0.472	0.473	0.485	0.519	0.521	0.525	0.522
11	900.0	0.492	0.472	0.473	0.488	0.522	0.522	0.523	0.522
12	1000.0	0.488	0.472	0.469	0.483	0.515	0.520	0.521	0.518
13	1100.0	0.482	0.467	0.464	0.480	0.512	0.515	0.517	0.513
14	1200.0	0.480	0.466	0.463	0.478	0.509	0.513	0.514	0.511
15	1300.0	0.477	0.463	0.460	0.474	0.507	0.511	0.512	0.509
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{MWd}{MtU}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.480	0.475	0.446	0.432	0.433	0.449	0.478	0.481
1	25.0	0.518	0.513	0.482	0.467	0.469	0.486	0.518	0.520
2	50.0	0.513	0.508	0.478	0.463	0.465	0.482	0.513	0.515
3	100.0	0.502	0.497	0.467	0.453	0.454	0.471	0.501	0.504
4	200.0	0.486	0.482	0.453	0.439	0.440	0.457	0.486	0.488
5	300.0	0.477	0.472	0.444	0.430	0.431	0.447	0.476	0.478
6	400.0	0.473	0.468	0.440	0.426	0.427	0.443	0.471	0.474
7	500.0	0.471	0.467	0.438	0.425	0.426	0.442	0.470	0.472
8	600.0	0.472	0.467	0.439	0.425	0.427	0.442	0.471	0.473
9	700.0	0.475	0.470	0.441	0.428	0.429	0.444	0.473	0.476
10	800.0	0.478	0.473	0.445	0.431	0.432	0.448	0.477	0.479
11	900.0	0.483	0.478	0.449	0.435	0.436	0.452	0.482	0.484
12	1000.0	0.488	0.483	0.454	0.440	0.441	0.457	0.487	0.489
13	1100.0	0.494	0.489	0.460	0.445	0.447	0.463	0.493	0.495
14	1200.0	0.501	0.495	0.465	0.451	0.453	0.469	0.499	0.502
15	1300.0	0.508	0.502	0.473	0.458	0.459	0.476	0.506	0.509

Table 7.95. Problem 6.2.1 reference solution power peaking factors in element 6 for charge-pan IV (1/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	0.171	0.179	0.185	0.179	0.228	0.202	0.246	0.248
1	25.0	0.162	0.168	0.174	0.169	0.214	0.190	0.232	0.234
2	50.0	0.162	0.169	0.175	0.170	0.214	0.190	0.232	0.234
3	100.0	0.163	0.170	0.176	0.171	0.216	0.191	0.235	0.237
4	200.0	0.167	0.175	0.181	0.175	0.222	0.197	0.240	0.242
5	300.0	0.170	0.179	0.185	0.179	0.226	0.201	0.246	0.248
6	400.0	0.174	0.182	0.188	0.182	0.229	0.205	0.251	0.252
7	500.0	0.176	0.183	0.189	0.183	0.232	0.206	0.253	0.254
8	600.0	0.177	0.185	0.191	0.185	0.233	0.208	0.253	0.255
9	700.0	0.178	0.186	0.192	0.185	0.235	0.210	0.255	0.257
10	800.0	0.176	0.185	0.190	0.185	0.233	0.207	0.253	0.257
11	900.0	0.178	0.186	0.192	0.186	0.234	0.208	0.255	0.256
12	1000.0	0.177	0.185	0.191	0.185	0.233	0.208	0.253	0.256
13	1100.0	0.175	0.183	0.190	0.183	0.231	0.206	0.251	0.254
14	1200.0	0.176	0.183	0.189	0.183	0.231	0.205	0.251	0.252
15	1300.0	0.176	0.183	0.188	0.183	0.229	0.206	0.250	0.252
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	A	B	C	D	P	Q	R	S
0	0.0	0.162	0.155	0.162	0.168	0.225	0.223	0.182	0.205
1	25.0	0.184	0.176	0.184	0.190	0.254	0.251	0.206	0.233
2	50.0	0.182	0.174	0.182	0.188	0.251	0.248	0.204	0.230
3	100.0	0.175	0.168	0.175	0.181	0.242	0.240	0.197	0.223
4	200.0	0.167	0.159	0.166	0.172	0.230	0.228	0.187	0.211
5	300.0	0.161	0.153	0.160	0.166	0.222	0.220	0.180	0.203
6	400.0	0.158	0.151	0.157	0.163	0.218	0.217	0.177	0.200
7	500.0	0.156	0.149	0.156	0.161	0.216	0.215	0.175	0.198
8	600.0	0.156	0.149	0.155	0.161	0.216	0.214	0.175	0.197
9	700.0	0.157	0.149	0.156	0.162	0.217	0.215	0.175	0.198
10	800.0	0.158	0.150	0.157	0.163	0.218	0.217	0.176	0.199
11	900.0	0.159	0.152	0.159	0.165	0.221	0.219	0.179	0.202
12	1000.0	0.162	0.154	0.161	0.167	0.224	0.222	0.181	0.204
13	1100.0	0.164	0.157	0.164	0.169	0.227	0.225	0.184	0.208
14	1200.0	0.167	0.159	0.166	0.172	0.231	0.229	0.187	0.211
15	1300.0	0.170	0.162	0.170	0.175	0.235	0.233	0.190	0.215

Table 7.96. Problem 6.2.1 reference solution power peaking factors in element 6 for charge-pan IV (2/2).

Step	Burnup	Shift Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.207	0.198	0.197	0.206	0.242	0.242	0.224	0.222
1	25.0	0.194	0.187	0.186	0.193	0.227	0.230	0.211	0.208
2	50.0	0.195	0.188	0.186	0.194	0.228	0.230	0.211	0.208
3	100.0	0.197	0.190	0.186	0.196	0.229	0.233	0.213	0.210
4	200.0	0.203	0.195	0.193	0.201	0.236	0.238	0.219	0.218
5	300.0	0.207	0.199	0.195	0.206	0.242	0.244	0.222	0.221
6	400.0	0.211	0.202	0.200	0.209	0.245	0.249	0.227	0.224
7	500.0	0.212	0.203	0.201	0.212	0.248	0.250	0.227	0.225
8	600.0	0.214	0.205	0.203	0.212	0.251	0.252	0.229	0.227
9	700.0	0.216	0.207	0.204	0.213	0.251	0.253	0.231	0.228
10	800.0	0.214	0.205	0.202	0.211	0.249	0.251	0.230	0.227
11	900.0	0.215	0.204	0.203	0.212	0.250	0.253	0.231	0.228
12	1000.0	0.214	0.205	0.203	0.211	0.250	0.252	0.230	0.227
13	1100.0	0.213	0.204	0.201	0.208	0.247	0.248	0.229	0.225
14	1200.0	0.211	0.204	0.201	0.210	0.247	0.249	0.227	0.225
15	1300.0	0.211	0.203	0.201	0.208	0.246	0.247	0.226	0.223
Step	Burnup	MPACT Power Peaking Factors							
	$\left[\frac{\text{MWd}}{\text{MtU}}\right]$	E	F	G	H	J	K	L	M
0	0.0	0.221	0.219	0.186	0.178	0.179	0.187	0.200	0.202
1	25.0	0.249	0.247	0.210	0.201	0.204	0.213	0.227	0.229
2	50.0	0.246	0.244	0.208	0.199	0.201	0.210	0.224	0.227
3	100.0	0.238	0.236	0.201	0.192	0.194	0.203	0.216	0.219
4	200.0	0.226	0.224	0.191	0.183	0.184	0.192	0.206	0.208
5	300.0	0.218	0.217	0.184	0.176	0.178	0.185	0.198	0.200
6	400.0	0.215	0.213	0.181	0.173	0.174	0.182	0.194	0.197
7	500.0	0.213	0.211	0.179	0.171	0.172	0.180	0.192	0.195
8	600.0	0.212	0.211	0.179	0.171	0.172	0.180	0.192	0.194
9	700.0	0.213	0.212	0.179	0.171	0.173	0.180	0.193	0.195
10	800.0	0.215	0.213	0.180	0.173	0.174	0.182	0.194	0.197
11	900.0	0.217	0.215	0.183	0.175	0.176	0.184	0.196	0.199
12	1000.0	0.220	0.218	0.185	0.177	0.178	0.186	0.199	0.201
13	1100.0	0.223	0.221	0.188	0.180	0.181	0.189	0.202	0.205
14	1200.0	0.227	0.225	0.191	0.183	0.184	0.192	0.206	0.208
15	1300.0	0.231	0.229	0.195	0.186	0.188	0.196	0.210	0.212

8. CONCLUSIONS

This report documents progression problems for a graphite-moderated, gas-cooled reactor for two state-of-the-art neutronics codes. The configuration of all problems were modeled and simulated successfully in both the Shift Monte Carlo and MPACT codes. The parameters calculated are listed in detail and include: eigenvalue, peaking factors, and isotope concentrations. The values for these can be compared with those calculated by other neutron transport codes or other Magnox-style reactors. Despite being originally developed for LWR calculations, MPACT is suitable for modeling graphite-moderated reactors, especially with the newly developed 69-group library. Shift, a Monte Carlo code, can already model general geometries. With MPACT, pin-resolved neutron transport equations can be solved and sub-pin isotopics can be resolved.

The volume of data generated across all simulations is large. Not all information can be compared in this report. Tables 8.1 and 8.2 summarize the eigenvalue for the BOC and depletion simulations, respectively. The BOC values all compared well. For the depletion simulations, large deviations existed for $<$ 0.25 GWd/t, but the differences tended to lessen with increasing burnup. It is speculated that at these low burnups, which correspond to weeks in operating time, that small differences in the solution result in relatively large differences in fission product poisons compared to later in the cycle.

Both codes allowed for flexible calculation methods and standard output in the form of HDF5 files, which facilitated comparison between the codes. Shift showed consistent performance that held constant with depletion steps, which is typical for Monte Carlo codes. Because the convergence speed of the MPACT solution relies more on the previous time step's source distribution, each depletion step past the zeroth takes between 30% and 60% less time depending on the geometry and solution convergence parameters. However, the MPACT timing was not a cure-all as finer convergence parameters sometimes resulted in the solution taking longer Shift (as in problem 5.1.1) or not finishing due to convergence issues. For the 3D cases, challenges in the convergence of the axial solution was experienced because of the lack of fuel in the end cap layers;

This report documents the success of tools originally developed for LWRs to model Magnox reactors. Shift and MPACT (neutronic solvers in the state-of-the-art SCALE and VERA codes, respectively) demonstrate good agreement in eigenvalue and power peaking factors. Tables 8.1 and 8.2 show that the BOC differences in eigenvalue range from 10 to 200 pcm; the root mean square (RMS) for the EOC differences range from around 100 to 300 pcm.

Table 8.1. Summary of BOC cases of progression problems and eigenvalue comparisons.

Geometry	Progression Problem Number	Temperature Set Library (Tab. 2.1) Operating (Tab. 2.4)	Coolant Channel Radius	Control Rods	MPACT – Shift RMS (pcm)
2D Pin Cell	1.1.1	Library	ABC	-	33
	1.1.2	Operating	ABC	-	22
2D Charge Pan	2.1.1	Operating	C	None	28
	2.1.2	Operating	A	None	58
	2.1.3	Operating	A	Yes	20
2D Quarter Core	3.1.1	Operating	—	None	7
	3.1.2	Operating	—	ARI	-61
3D Channel	4.1.1	Operating	B	-	-98
3D Charge Pan	5.1.1	Operating	C	None	-148
	5.1.2	Operating	C	50%	126
3D Mini Core	6.1.1	Operating	A	50%	-214

Table 8.2. Summary of depletion cases of progression problems and eigenvalue comparisons with root mean square (RMS) deviations.

Geometry	Progression Problem Number	Temperature Set Library (Tab. 2.1) Operating (Tab. 2.4)	Coolant Channel Radius	Control Rods	MPACT – Shift RMS (pcm)
2D Pin Cell	1.2.1	Operating	B	-	92
2D Charge Pan	2.2.1	Operating	A	None	114
2D Quarter Core	3.2.1	Operating	—	Rods Out	197
	3.2.2	Operating	—	Main Bank	135
3D Channel	4.2.1	Operating	B	-	118
3D Charge Pan	5.2.1	Operating	C	50%	154
3D Mini Core	6.2.1	Operating	—	50%	290

9. FUTURE WORK

There are two main components of future work that have been identified.

First, one of the significant improved capabilities with MPACT is the improved capability to resolve the neutron transport equation and isotope concentrations at the sub-pin level. Further examination is still required to understand the accuracy and distributions of isotope concentrations within different radial regions of the pin. While some of the major actinides (U, Pu, Cm, Am) and major fission products (Cs, Nd, Sr-90) agreed well between Shift and MPACT, several isotopes did not agree well. These isotopes typically have concentrations $< 10^{-9}$ atoms/barn-cm and include ^{84,86,87}Sr, ^{132,134,135}Ba, and ^{85}Rb. Of those, the only two isotopes with non-negligible cumulative fission yields are ^{135}Ba and ^{85}Rb. Further examination is needed on how MPACT handles these isotopes in depletion should they need to be considered in comparison to measured data.

Second, MPACT showed a higher discrepancy with 3D problems, which could be due to issues with the axial solver in the non-fueled regions. While improvements have been made in MPACT to deal with axial reflectors, i.e., bookending of fuel regions, non-fuel regions in between fuel elements were found to stress axial methods due to leakage from the fuel regions. Convergence criteria needed loosening to reach a solution. The capability to improve the solution for non-fueled regions would be desired for faster calculations.

Third, future work involves full-core, coupled thermal hydraulic calculations with sub-pin isotopics as previously mentioned in [1]. Calculating sub-pin isotopics in small thickness fueled regions requires fine ray spacing, e.g. on the order of the smallest fuel region thickness. This report shows that small ray spacing may slow down performance of MPACT to be comparable of that to Shift or other MC codes. Follow-on calculations will need to account for this

10. REFERENCES

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