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OAK RIDGE NATIONAL LABORATORY

LOCKHEED MARTIN

Neutronics Benchmarks for the Utilization of Mixed-Oxide Fuel: Joint U.S./Russian Progress Report for Fiscal Year 1997

Volume 3—Calculations Performed in the Russian Federation

Fissile Materials Disposition Program

MANAGED AND OPERATED BY
LOCKHEED MARTIN ENERGY RESEARCH CORPORATION
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NEUTRONICS BENCHMARKS FOR THE UTILIZATION OF MIXED-OXIDE FUEL: JOINT U.S./RUSSIAN PROGRESS REPORT FOR FISCAL YEAR 1997

Volume 3—Calculations Performed in the Russian Federation

Prepared by the Staffs of the Russian Research Center "Kurchatov Institute"
and the Institute of Physics and Power Engineering

Coordinated in the United States by R.T. Primm III

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CONTENTS

	Page
LIST OF FIGURES	vii
LIST OF TABLES	ix
ACRONYMS	xix
ACKNOWLEDGMENTS	xxi
ABSTRACT	1-1
1. INTRODUCTION	1-1
2. BENCHMARK NEEDS FOR MOX FUEL CYCLES	2-1
2.1 PLUTONIUM-PROCESSING OPERATIONS	2-1
2.2 MOX FUEL FABRICATION OPERATIONS	2-1
2.3 REACTOR	2-1
2.4 TRANSPORTATION	2-2
3. COMPUTATIONAL METHODS AND DATA	3-1
3.1 THE MCU-RFFI/A MONTE CARLO CODE AND ITS LIBRARY COLLECTION DLC/MCUDAT-1.0	3-1
3.2 DESCRIPTION OF METHODICAL BASIS OF THE TVS-M CODE	3-4
3.3 KENO-V.a/ABBN-93 CODE-CONSTANTS COMPLEX	3-6
3.4 MCNP/FOND-2 CODE-CONSTANTS COMPLEX	3-6
3.5 TWODANT/ABBN-93 CODE-CONSTANTS COMPLEX	3-6
3.6 WIMS-ABBN	3-6
3.6.1 Updating and Supplementing the WIMS-D4 Library	3-6
3.6.2 WIMS-D4 Improvements	3-7
3.7 INDECS—A CODE-CONSTANT SYSTEM FOR CALCULATIONAL UNCERTAINTY ESTIMATION	3-9
3.8 PARSEC—A CODE TO PARAMETERIZE MACROCONSTANTS FOR VVER REACTORS	3-9
3.9 THE PROGRAM COMPLEX TRIANG-PWR	3-10
3.10 TRIANG-PIN CODE	3-11
3.11 MAYAK—A COMPUTER PROGRAM TO LINK TRANSPORT AND DEPLETION COMPUTER PROGRAMS	3-12
3.12 INPUT DATASETS	3-12
REFERENCES	3-13
4. COMPUTATIONAL BENCHMARKS FOR VERIFICATION AND VALIDATION OF COMPUTER PROGRAMS	4-1
4.1 DESCRIPTION OF THE PWR COMPUTATIONAL BENCHMARK	4-1
4.1.1 Introduction	4-1
4.1.2 Benchmark Specifications	4-1
4.1.2.1 Geometry data	4-1
4.1.2.2 Material data	4-3
4.1.3 Modeling Instructions	4-5
4.1.4 Calculational Definitions and Desired Results	4-5
4.1.4.1 Beginning-of-life (BOL) calculations	4-5
4.1.4.2 Burnup calculations	4-5
4.1.4.3 End-of-life (EOL) calculations	4-6
4.2 CALCULATED REACTOR PHYSICS PARAMETERS FOR THE PWR BENCHMARK	4-7
4.2.1 Monte Carlo (MCU) Calculations	4-7
4.2.1.1 Description of problem and procedure	4-7
4.2.1.2 Calculational results	4-7
4.2.2 Discrete Ordinates and Monte Carlo Calculations	4-9

4.2.2.1 Cross section processing 4-18
4.2.2.2 TWODANT assembly calculations 4-18
4.2.2.3 KENO assembly calculations 4-18
4.2.2.4 MCNP assembly calculations 4-18
4.2.3 Results of PWR Benchmark Verification/Validation Studies 4-18
4.3 DESCRIPTION OF THE VVER COMPUTATIONAL BENCHMARK 4-18
4.3.1 Materials Specification 4-18
4.3.2 Geometry Description 4-20
4.3.2.1 Assembly K331 4-21
4.3.2.2 Multiassembly structure MK2 4-22
4.3.3 Specification of Calculations to be Performed 4-22
4.3.4 Parameters to be Calculated 4-23
4.4 CALCULATED REACTOR PHYSICS PARAMETERS FOR THE VVER BENCHMARK 4-23
4.4.1 Calculations with the Monte Carlo (MCU) Method 4-23
4.4.1.1 Procedure for analyses 4-26
4.4.1.2 Results and output description 4-26
4.4.2 Calculations with Deterministic Methods 4-113
4.4.2.1 Spectral code (TVS-M) calculations 4-113
4.4.2.2 Collision probability cell and assembly (WIMS-ABBN) calculations 4-205
4.4.2.3 Fine mesh diffusion theory assembly/core (TRIANG-PWR) calculations 4-245
REFERENCES 4-279
5. EXPERIMENTAL BENCHMARKS 5-1
5.1 INTRODUCTION 5-1
5.2 BARE SPHERE OF ^{239}Pu METAL 5-3
5.3 WATER-REFLECTED 9-, 11-, AND 12-in.-diam CYLINDERS OF PLUTONIUM NITRATE SOLUTION 5-4
5.4 HOMOGENEOUS PuO_2-POLYSTYRENE AT LOW HYDROGEN CONTENT 5-24
5.5 LOW-MODERATED MIXTURES OF PLUTONIUM AND URANIUM OXIDES WITH 8, 15, AND 30 wt % PLUTONIUM 5-30
5.6 WATER-REFLECTED 11.5-, 12-, AND 13-in.-diam SPHERES OF PLUTONIUM NITRATE SOLUTION 5-37
5.7 PLUTONIUM NITRATE SOLUTION WITH A HIGH ^{240}Pu CONTENT 5-48
5.8 MIXED PLUTONIUM AND URANIUM SOLUTION AT A PLUTONIUM FRACTION OF 0.2 AND 0.5 5-60
5.9 MIXED PLUTONIUM AND URANIUM NITRATE SOLUTION IN ANNULAR CYLINDRICAL GEOMETRY 5-65
5.10 SQUARE LATTICE OF (PuO_2 + UO_2) RODS IN A WATER TANK WITH 20 wt % PLUTONIUM 5-77
5.11 SQUARE LATTICE OF (PuO_2 + UO_2) RODS IN A WATER TANK WITH 2 wt % PLUTONIUM 5-87
5.12 CONCLUSIONS FROM THE CALCULATION OF EXPERIMENTAL BENCHMARKS 5-97
5.12.1 Benchmark Experiments Suggested by the United States 5-97
5.12.1.1 Jezebel and Godiva 5-97
5.12.1.2 Solutions of plutonium nitrate or high enrichment uranyl nitrate with water reflectors 5-97
5.12.1.3 Homogeneous PuO_2-polystyrene parallelepipeds with H/Pu = 5 5-98
5.12.1.4 Homogeneous MOX-polystyrene parallelepipeds with Pu/(Pu + U) from 8 to 30 wt % in H/(Pu + U) of 3 to 7 5-99
5.12.2 Benchmark Experiments Suggested by the Russian Researchers 5-100

5.12.2.1 Spheres with solutions of weapons-grade plutonium nitrate surrounded by water reflectors 5-100
5.12.2.2 Solutions of plutonium nitrate with a high content of ^{240}Pu poisoned with gadolinium 5-101
5.12.2.3 Plutonium nitrate solutions in cylindrical tanks without a reflector 5-102
5.12.2.4 Solutions of high burn-up plutonium nitrates 5-103
5.12.2.5 Fuel element lattices containing plutonium and uranium dioxides mixture in water: MIX-COMP-THERM-001 5-103
5.12.2.6 Fuel element lattices containing plutonium and uranium dioxides mixture in water: PNL-30-35 5-104
5.12.2.7 Mixed uranium-plutonium solutions: MIX-SOL-THERM-001, -002 ... 5-105
5.12.2.8 Observations on results from experimental benchmarks 5-105
REFERENCES 5-106
6. OBSERVATIONS AND RECOMMENDATIONS 6-1
6.1 OBSERVATIONS ON THE NEED FOR EXPERIMENTS FOR REACTOR CORE PHYSICS CALCULATIONS 6-1
6.2 REQUIREMENT FOR EXPERIMENTS IN SUPPORT OF CRITICALITY SAFETY ANALYSES AT AWAY-FROM-REACTOR FUEL CYCLE FACILITIES 6-3
6.3 SUBCRITICAL MEASUREMENTS IN SUPPORT OF CRITICALITY SAFETY 6-3

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LIST OF FIGURES

Figure		Page
3.1	Nuclide generation/depletion chains included in CREDE computer program	3-8
4.1	PWR lattice geometry	4-2
4.2	Comparison of k-effectives calculated with various code packages	4-19
4.3	Map of K331 assembly	4-21
4.4	MK2 multiassembly structure	4-22
4.5	Numbering scheme for assembly type K1 (see Fig. 4.4) for normalized pin powers reported in Table 4.135	4-109
4.6	Numbering scheme for assembly type K2 (see Fig. 4.4) for normalized pin powers reported in Table 4.135	4-109
4.7	Positions and numbers of cells in fuel assembly (60° symmetry angle)	4-154
4.8	Pin-by-pin power distribution, Variant 11, State 1, at burnup = 0.0 MWd/kg	4-155
4.9	Pin-by-pin power distribution, Variant 11, State 1, at burnup = 10.0 MWd/kg	4-156
4.10	Pin-by-pin power distribution, Variant 11, State 1, at burnup = 20.0 MWd/kg	4-157
4.11	Pin-by-pin power distribution, Variant 11, State 1, at burnup = 30.0 MWd/kg	4-158
4.12	Pin-by-pin power distribution, Variant 11, State 1, at burnup = 40.0 MWd/kg	4-159
4.13	Pin-by-pin power distribution, Variant 11, State 1, at burnup = 50.0 MWd/kg	4-160
4.14	Pin-by-pin power distribution, Variant 11, State 1, at burnup = 60.0 MWd/kg	4-161
4.15	Pin-by-pin power distribution, Variant 11, State 2, at burnup = 0.0 MWd/kg	4-162
4.16	Pin-by-pin power distribution, Variant 11, State 2, at burnup = 10.0 MWd/kg	4-163
4.17	Pin-by-pin power distribution, Variant 11, State 2, at burnup = 20.0 MWd/kg	4-164
4.18	Pin-by-pin power distribution, Variant 11, State 2, at burnup = 30.0 MWd/kg	4-165
4.19	Pin-by-pin power distribution, Variant 11, State 2, at burnup = 40.0 MWd/kg	4-166
4.20	Pin-by-pin power distribution, Variant 11, State 2, at burnup = 50.0 MWd/kg	4-167
4.21	Pin-by-pin power distribution, Variant 11, State 2, at burnup = 60.0 MWd/kg	4-168
4.22	Pin-by-pin power distribution, Variant 12, State 1, at burnup = 0.0 MWd/kg	4-169
4.23	Pin-by-pin power distribution, Variant 12, State 1, at burnup = 10.0 MWd/kg	4-170
4.24	Pin-by-pin power distribution, Variant 12, State 1, at burnup = 20.0 MWd/kg	4-171
4.25	Pin-by-pin power distribution, Variant 12, State 1, at burnup = 30.0 MWd/kg	4-172
4.26	Pin-by-pin power distribution, Variant 12, State 1, at burnup = 40.0 MWd/kg	4-173
4.27	Pin-by-pin power distribution, Variant 12, State 1, at burnup = 50.0 MWd/kg	4-174
4.28	Pin-by-pin power distribution, Variant 12, State 1, at burnup = 60.0 MWd/kg	4-175
4.29	Pin-by-pin power distribution, Variant 12, State 2, at burnup = 0.0 MWd/kg	4-176
4.30	Pin-by-pin power distribution, Variant 12, State 2, at burnup = 10.0 MWd/kg	4-177
4.31	Pin-by-pin power distribution, Variant 12, State 2, at burnup = 20.0 MWd/kg	4-178
4.32	Pin-by-pin power distribution, Variant 12, State 2, at burnup = 30.0 MWd/kg	4-179
4.33	Pin-by-pin power distribution, Variant 12, State 2, at burnup = 40.0 MWd/kg	4-180
4.34	Pin-by-pin power distribution, Variant 12, State 2, at burnup = 50.0 MWd/kg	4-181
4.35	Pin-by-pin power distribution, Variant 12, State 2, at burnup = 60.0 MWd/kg	4-182
4.36	Positions and types of cells in multiassembly structure (30° symmetry angle)	4-183
4.37	Variant 13, pin-by-pin power distribution, burnup W = 0.0 MWd/kg, State S1	4-184
4.38	Variant 13, pin-by-pin power distribution, burnup W = 10.0 MWd/kg, State S1	4-185
4.39	Variant 13, pin-by-pin power distribution, burnup W = 20.0 MWd/kg, State S1	4-186
4.40	Variant 13, pin-by-pin power distribution, burnup W = 30.0 MWd/kg, State S1	4-187
4.41	Variant 13, pin-by-pin power distribution, burnup W = 40.0 MWd/kg, State S1	4-188
4.42	Variant 13, pin-by-pin power distribution, burnup W = 50.0 MWd/kg, State S1	4-189
4.43	Variant 13, pin-by-pin power distribution, burnup W = 60.0 MWd/kg, State S1	4-190
4.44	Variant 13, pin-by-pin power distribution, burnup W = 0.0 MWd/kg, State S4	4-191
4.45	Variant 13, pin-by-pin power distribution, burnup W = 10.0 MWd/kg, State S4	4-192
4.46	Variant 13, pin-by-pin power distribution, burnup W = 20.0 MWd/kg, State S4	4-193

4.47 Variant 13, pin-by-pin power distribution, burnup W = 30.0 MWd/kg, State S4 4-194
4.48 Variant 13, pin-by-pin power distribution, burnup W = 40.0 MWd/kg, State S4 4-195
4.49 Variant 13, pin-by-pin power distribution, burnup W = 50.0 MWd/kg, State S4 4-196
4.50 Variant 13, pin-by-pin power distribution, burnup W = 60.0 MWd/kg, State S4 4-197
4.51 Variant 13, pin-by-pin power distribution, burnup W = 0.0 MWd/kg, State S6 4-198
4.52 Variant 13, pin-by-pin power distribution, burnup W = 10.0 MWd/kg, State S6 4-199
4.53 Variant 13, pin-by-pin power distribution, burnup W = 20.0 MWd/kg, State S6 4-200
4.54 Variant 13, pin-by-pin power distribution, burnup W = 30.0 MWd/kg, State S6 4-201
4.55 Variant 13, pin-by-pin power distribution, burnup W = 40.0 MWd/kg, State S6 4-202
4.56 Variant 13, pin-by-pin power distribution, burnup W = 50.0 MWd/kg, State S6 4-203
4.57 Variant 13, pin-by-pin power distribution, burnup W = 60.0 MWd/kg, State S6 4-204
4.58 Pin power distribution, Variant 11, State 1, at burnup = 0 MWd/kg U 4-258
4.59 Pin power distribution, Variant 11, State 1, at burnup = 10 MWd/kg U 4-259
4.60 Pin power distribution, Variant 11, State 1, at burnup = 20 MWd/kg U 4-260
4.61 Pin power distribution, Variant 11, State 1, at burnup = 30 MWd/kg U 4-261
4.62 Pin power distribution, Variant 11, State 1, at burnup = 40 MWd/kg U 4-262
4.63 Pin power distribution, Variant 11, State 1, at burnup = 50 MWd/kg U 4-263
4.64 Pin power distribution, Variant 11, State 1, at burnup = 60 MWd/kg U 4-264
4.65 Pin power distribution, Variant 12, State 1, at burnup = 0 MWd/kg U 4-265
4.66 Pin power distribution, Variant 12, State 1, at burnup = 10 MWd/kg U 4-266
4.67 Pin power distribution, Variant 12, State 1, at burnup = 20 MWd/kg U 4-267
4.68 Pin power distribution, Variant 12, State 1, at burnup = 30 MWd/kg U 4-268
4.69 Pin power distribution, Variant 12, State 1, at burnup = 40 MWd/kg U 4-269
4.70 Pin power distribution, Variant 12, State 1, at burnup = 50 MWd/kg U 4-270
4.71 Pin power distribution, Variant 12, State 1, at burnup = 60 MWd/kg U 4-271
4.72 Pin power distribution, Variant 13, State 1, at burnup = 0 MWd/kg U 4-272
4.73 Pin power distribution, Variant 13, State 1, at burnup = 10 MWd/kg U 4-273
4.74 Pin power distribution, Variant 13, State 1, at burnup = 20 MWd/kg U 4-274
4.75 Pin power distribution, Variant 13, State 1, at burnup = 30 MWd/kg U 4-275
4.76 Pin power distribution, Variant 13, State 1, at burnup = 40 MWd/kg U 4-276
4.77 Pin power distribution, Variant 13, State 1, at burnup = 50 MWd/kg U 4-277
4.78 Pin power distribution, Variant 13, State 1, at burnup = 60 MWd/kg U 4-278
5.1 K-effective for plutonium nitrate solutions 5-5
5.2 K-effective vs critical mass for plutonium oxide powder experiments 5-24
5.3 K-effectives for low moderated MOX experiments 5-31
5.4 K-effectives for water-reflected spheres of plutonium nitrate solution 5-38
5.5 Multiplication factors for water-reflected spheres of plutonium nitrate solution 5-39
5.6 K-effective vs plutonium concentration for plutonium nitrate solution spheres and cylinders 5-49
5.7 K-effectives for gadolinium-poisoned, plutonium nitrate solutions with a high ^{240}Pu content (116 g/L of plutonium) 5-51
5.8 K-effectives for gadolinium-poisoned, plutonium nitrate solutions with a high ^{240}Pu content and high plutonium concentration (363 g/L) 5-52
5.9 Unreflected plutonium nitrate solution cylinders of 13.4 in. and 17.9 in. diameter (4.88 wt % ^{240}Pu) 5-53
5.10 Unreflected plutonium nitrate solution cylinders of 13.4 in. and 17.9 in. diameter (13.74 wt % ^{240}Pu) 5-54
5.11 Calculated k-effectives for mixed plutonium and uranium nitrate solution experiments 5-66
5.12 Calculated k-effectives for water-reflected MOX pins (20 wt % plutonium) 5-78
5.13 K-effectives for low plutonium content MOX fuel rods 5-88

LIST OF TABLES

Table		Page
3.1	The DLC/MCUDAT-1.0 library isotope list	3-2
3.2	Nuclides representing fuel composition	3-7
4.1	General assembly data	4-3
4.2	Annular BP rod geometry specifications (axial length of 365.76 cm)	4-3
4.3	BOL atom densities	4-4
4.4	Conditions for BOL calculations to be performed with guide tube assembly and BP rod assembly	4-6
4.5	Conditions for EOL calculations	4-6
4.6	Material data in 10^{24} atoms/cm^3 units	4-7
4.7	The k_{eff} calculational results	4-7
4.8	U.S. PWR computational benchmark variant map	4-8
4.9	BOL1 fission rates	4-8
4.10	BOL2 fission rates	4-8
4.11	BOL3 fission rates	4-9
4.12	BOL4 fission rates	4-9
4.13	Multiplication factors for BOL cases	4-9
4.14	Case BOL1 WIMS-TWODANT results	4-10
4.15	Case BOL2 WIMS-TWODANT results	4-11
4.16	Case BOL3 WIMS-TWODANT results	4-12
4.17	Case BOL4 WIMS-TWODANT results	4-13
4.18	Case BOL1 ABBN93-KENO-V.a results	4-14
4.19	Case BOL2 ABBN93-KENO-V.a results	4-15
4.20	Case BOL3 ABBN93-KENO-V.a results	4-16
4.21	Case BOL4 ABBN93-KENO-V.a results	4-17
4.22	Materials description for fresh fuel	4-19
4.23	Materials specification for variants with spent fuel	4-20
4.24	Cell types used in different configurations of K331 assemblies	4-22
4.25	State parameters for VVER computational benchmarks	4-23
4.26	Set of calculation variants	4-24
4.27	Four-group energy boundaries	4-25
4.28	List of variants calculated	4-25
4.29	The k_{eff}, k_{inf}, and k_0 values	4-27
4.30	Upper boundaries of 26 groups	4-27
4.31	The cell one-group cross section and flux values for Variant V1S1	4-28
4.32	Reaction rates for every region of cell for Variant V1S1	4-28
4.33	Region 1 four-group fluxes (cm) and nuclear data (cm^{-1}) for Variant V1S1	4-29
4.34	Region 2 absorption reaction rate in Zr for Variant V1S1	4-30
4.35	Region 3 absorption reaction rates for Variant V1S1	4-30
4.36	The cell one-group cross section and flux values for Variant V1S3	4-30
4.37	Reaction rates for every region of cell for Variant V1S3	4-30
4.38	The cell one-group cross section and flux values for Variant V1S4	4-30
4.39	Reaction rates for every region of cell for Variant V1S4	4-31
4.40	The cell one-group cross section and flux values for Variant V1S5	4-31
4.41	Reaction rates for every region of cell for Variant V1S5	4-31
4.42	The cell one-group cross section and flux values for Variant V1S6	4-31
4.43	Reaction rates for every region of cell for Variant V1S6	4-31
4.44	Multigroup cross sections of nuclides (cm^{-1}) for Region 1 for Variant V1S6	4-32
4.45	Multigroup cross sections of nuclides (cm^{-1}) for Regions 1 and 2 for Variant V1S6	4-33
4.46	Multigroup cross sections of nuclides (cm^{-1}) for Region 3 for Variant V1S6	4-34

4.47 The cell one-group cross section and flux values for Variant V2S1 4-34
4.48 Reaction rates for every region of cell for Variant V2S1 4-34
4.49 Four-group cross sections (cm^{-1}) and fluxes (cm) of cell regions for Region 1, Variant V2S1 4-35
4.50 Four-group cross sections (cm^{-1}) and fluxes (cm) of cell region for Region 2 for Variant V2S1 4-36
4.51 Four-group cross sections (cm^{-1}) and fluxes (cm) of cell regions for Region 3 for Variant V2S1 4-36
4.52 The cell one-group cross section and flux values for Variant V2S3 4-36
4.53 Reaction rates for every region of cell for Variant V2S3 4-36
4.54 The cell one-group cross section and flux values for Variant V2S4 4-36
4.55 Reaction rates for every region of cell for Variant V2S4 4-37
4.56 The cell one-group cross section and flux values for Variant V2S5 4-37
4.57 Reaction rates for every region of cell for Variant V2S5 4-37
4.58 The cell one-group cross section and flux values for Variant V2S6 4-37
4.59 Reaction rates for every region of cell for Variant V2S6 4-37
4.60 Multigroup cross sections of nuclides (cm^{-1}) for Region 1 for Variant V2S6 4-38
4.61 Multigroup cross sections of nuclides (cm^{-1}) for Regions 1 and 2 for Variant V2S6 4-39
4.62 Multigroup cross sections of nuclides (cm^{-1}) for Region 3 for Variant V2S6 4-40
4.63 The cell one-group cross section and flux values for Variant V3S6 4-41
4.64 Reaction rates for every region of cell for Variant V3S6 4-41
4.65 Multigroup cross sections of nuclides (cm^{-1}) for Region 1 for Variant V3S6 4-41
4.66 Multigroup cross sections of nuclides (cm^{-1}) for Regions 2 and 3 for Variant V3S6 4-46
4.67 The cell one-group cross section and flux values for Variant V4S3 4-47
4.68 Reaction rates for every region of cell for Variant V4S3 4-47
4.69 Multigroup cross sections of nuclides (cm^{-1}) for Region 1 for Variant V4S3 4-47
4.70 Multigroup cross sections of nuclides (cm^{-1}) for Regions 2 and 3 for Variant V4S3 4-54
4.71 The cell one-group cross section and flux values for Variant V4S4 4-54
4.72 Reaction rates for every region of cell for Variant V4S4 4-54
4.73 Multigroup cross sections of nuclides (s^{-1}) for Region 1 for Variant V4S4 4-55
4.74 The cell one-group cross section and flux values for Variant V4S5 4-62
4.75 Reaction rates for every region of cell for Variant V4S5 4-62
4.76 Multigroup cross sections of nuclides (cm^{-1}) for Region 1 for Variant V4S5 4-63
4.77 The cell one-group cross section and flux values for Variant V4S6 4-70
4.78 Reaction rates for every region of cell for Variant V4S6 4-70
4.79 Multigroup cross sections of nuclides (cm^{-1}) for Region 1 for Variant V4S6 4-71
4.80 The cell one-group cross section and flux values for Variant V7S6 4-78
4.81 Reaction rates for every region of cell for Variant V7S6 4-78
4.82 The cell one-group cross section and flux values for Variant V8S6 4-78
4.83 Reaction rates for every region of cell for Variant V8S6 4-79
4.84 The cell one-group cross section and flux values for Variant V9S6 4-79
4.85 Reaction rates for every region of cell for Variant V9S6 4-79
4.86 The assembly cross section and flux values for Variant V11S4 4-79
4.87 Relative cell fission rates normalized to the average cell fission rate of 1 for Variant V11S4 4-79
4.88 The cross section (cm^{-1}) and flux values (cm) of Cells 1, 29, and 72 for Variant V11S4 4-81
4.89 Reaction rates for every region of cell for Variant V11S4 4-81
4.90 Cross sections (cm^{-1}) and fluxes (cm) for Region 1 of Cell 1 for Variant V11S4 4-82
4.91 Cross sections (cm^{-1}) and fluxes (cm) for Region 2 of Cell 1 for Variant V11S4 4-83
4.92 Cross sections (cm^{-1}) and fluxes (cm) for Region 3 of Cell 1 for Variant V11S4 4-83

4.93 Cross sections and fluxes for Region 1 of Cell 29 for Variant V11S4 4-84
4.94 Cross sections and fluxes of every region of Cell 29 for Variant V11S4 4-84
4.95 Cross sections and fluxes for Region 1 of Cell 72 for Variant V11S4 4-85
4.96 Cross sections and fluxes for every region of Cell 72 for Variant V11S4 4-85
4.97 The assembly cross section and flux values for Variant V11S2 4-86
4.98 Relative cell fission rates normalized to the average cell fission rate of 1 for Variant V11S2 4-86
4.99 The cross section and flux values of Cells 1, 29, and 72 for Variant V11S2 4-87
4.100 Reaction rates for every region of Cells 1, 29, 72 for Variant V11S2 4-87
4.101 Cross sections and fluxes for Region 1 of Cell 1 for Variant V11S2 4-88
4.102 Cross sections and fluxes for every region of Cell 1 for Variant V11S2 4-88
4.103 Cross sections and fluxes for Region 1 of Cell 29 for Variant V11S2 4-89
4.104 Cross sections and fluxes for every region of Cell 29 for Variant V11S2 4-89
4.105 Cross sections and fluxes for Region 1 of Cell 72 for Variant V11S2 4-90
4.106 Cross sections and fluxes for every region of Cell 72 for Variant V11S2 4-90
4.107 The assembly cross section and flux values for Variant V11S6 4-91
4.108 Relative cell fission rates normalized to the average cell fission rate of 1 for Variant V11S6 4-91
4.109 The cross section and flux values of Cells 1, 29, and 72 for Variant V11S6 4-92
4.110 Reaction rates for every region of Cells 1, 29, and 72 for Variant V11S6 4-92
4.111 The assembly cross section and flux values for Variant V12S4 4-93
4.112 Relative cell fission rates normalized to the average cell fission rate of 1 for Variant V12S4 4-93
4.113 The cross section and flux values of Cells 1, 29, and 72 for Variant V12S4 4-94
4.114 Reaction rates for every region of Cells 1, 29, and 72 for Variant V12S4 4-94
4.115 Cross sections and fluxes for Region 1 of Cell 1 for Variant V12S4 4-95
4.116 Cross sections and fluxes for every region of Cell 1 for Variant V12S4 4-96
4.117 Cross sections and fluxes for Region 1 of Cell 29 for Variant V12S4 4-96
4.118 Cross sections and fluxes for every region of Cell 29 for Variant V12S4 4-97
4.119 Cross sections and fluxes for Region 1 of Cell 72 for Variant V12S4 4-97
4.120 Cross sections and fluxes for every region of Cell 72 of Variant V12S4 4-98
4.121 The assembly cross section and flux values for Variant V12S2 4-99
4.122 Relative cell fission rates normalized to the average cell fission rate of 1 for Variant V12S2 4-99
4.123 The cross section and flux values of Cells 1, 29, and 72 for Variant V12S2 4-100
4.124 Reaction rates for every region of Cells 1, 29, and 72 for Variant V12S2 4-100
4.125 Cross sections and fluxes for Region 1 of Cell 1 for Variant V12S2 4-101
4.126 Cross sections and fluxes for every region of Cell 1 for Variant V12S2 4-102
4.127 Cross sections and fluxes for Region 1 of Cell 29 for Variant V12S2 4-103
4.128 Cross sections and fluxes for every region of Cell 29 for Variant V12S2 4-104
4.129 Cross sections and fluxes for Region 1 of Cell 72 for Variant V12S2 4-105
4.130 Cross sections and fluxes for every region of Cell 72 for Variant V12S2 4-106
4.131 The assembly cross section and flux values for Variant V12S6 4-107
4.132 Relative cell fission rates normalized to the average cell fission rate of 1 for Variant V12S6 4-107
4.133 The cross section and flux values of Cells 1, 29, and 72 for Variant V12S6 4-108
4.134 Reaction rates for every region of Cells 1, 29, and 72 for Variant V12S6 4-108
4.135 Relative cell fission rates normalized to the average cell fission rate of 1 for Variant V13 4-110
4.136 Normalized pin powers for Variant 11 with variance reduction due to symmetry 4-111
4.137 Normalized pin powers for Variant 12 with variance reduction due to symmetry 4-112

4.138 Values of k_{eff} and k_0 at zero burnup point for Variants 1–13, States 1–6 4-115
4.139 Values of k_{eff} and k_0 vs burnup for Variants 1, 2, 10, 11, and 12; State 1 4-116
4.140 Values of k_{eff} and k_0 vs burnup for Variants 1, 2, 10, 11, and 12; States 2–6 4-117
4.141 Cell macro sections and flux relations, Variants 1–4 and 7–10, State 1 4-118
4.142 Cell macro sections and flux relations, Variant 11, States 1 and 2 4-119
4.143 Cell macro sections and flux relations, Variant 12, States 1 and 2 4-120
4.144 Absorption and production microscopic cross sections (b) of main isotopes, Variants 1–4 and 7–10 4-121
4.145 Absorption and production reaction rates, Variants 1–4 and 7–10 4-124
4.146 Absorption and production microscopic cross sections (b) of main isotopes, Variant 11, State 1 4-127
4.147 Absorption and production microscopic cross sections (b) of main isotopes, Variant 11, State 2 4-129
4.148 Absorption and production reaction rates, Variant 11, State 1 4-131
4.149 Absorption and production reaction rates, Variant 11, State 2 4-133
4.150 Absorption and production reaction rates, Variant 12, State 1 4-135
4.151 Absorption and production reaction rates, Variant 12, State 2 4-137
4.152 Absorption and production microscopic cross sections (b) of main isotopes, Variant 12, State 1 4-139
4.153 Absorption and production microscopic cross sections (b) of main isotopes, Variant 12, State 2 4-141
4.154 Nuclide concentration [atoms/(b·cm)] vs burnup, Variant 1 4-143
4.155 Nuclide concentration [atoms/(b·cm)] vs burnup, Variant 2 4-144
4.156 Nuclide concentration [atoms/(b·cm)] vs burnup, Variant 10 4-145
4.157 Nuclide concentration [atoms/(b·cm)] in fuel pin 1 vs burnup, Variant 11 4-146
4.158 Nuclide concentration [atoms/(b·cm)] in fuel pin 29 vs burnup, Variant 11 4-147
4.159 Nuclide concentration [atoms/(b·cm)] in fuel pin 72 vs burnup, Variant 11 4-148
4.160 Nuclide concentration [atoms/(b·cm)] in fuel pin 1 vs burnup, Variant 12 4-149
4.161 Nuclide concentration [atoms/(b·cm)] in fuel pin 29 vs burnup, Variant 12 4-150
4.162 Nuclide concentration [atoms/(b·cm)] in fuel pin 72 vs burnup, Variant 12 4-151
4.163 Burnup-dependent physics parameters for Variant 13, State S1 4-152
4.164 Burnup-dependent physics parameters for Variant 13, State S4 4-153
4.165 Burnup-dependent physics parameters for Variant 13, State S6 4-153
4.166 Values of k_{eff} , k_0, and M^2 for Variant 1, State 1, at burnup intervals 4-206
4.167 Nuclide concentration [atoms/(b·cm)] at specific burnup levels for Variant 1, State 1 4-207
4.168 Variant 1, State 1 4-210
4.169 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 1, State 1, 0.00 MWd/kg HM 4-211
4.170 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 1, State 1, 10.00 MWd/kg HM 4-211
4.171 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 1, State 1, 20.00 MWd/kg HM 4-211
4.172 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 1, State 1, 30.00 MWd/kg HM 4-212
4.173 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 1, State 1, 40.00 MWd/kg HM 4-212
4.174 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 1, State 1, 50.00 MWd/kg HM 4-212
4.175 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 1, State 1, 60.00 MWd/kg HM 4-213
4.176 Values of k_{eff}, k_0, and M^2 for Variant 1, States 3–6, at burnup intervals 4-214
4.177 Values of k_{eff}, k_0, and M^2 for Variant 2, State 1, at burnup intervals 4-215

4.178 Nuclide concentration [atoms/(b·cm)] at specific burnup levels for Variant 2, State 1 4-216
4.179 Variant 2, State 1 4-220
4.180 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 2, State 1, 0.00 MWd/kg HM 4-220
4.181 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 2, State 1, 10.00 MWd/kg HM 4-220
4.182 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 2, State 1, 20.00 MWd/kg HM 4-221
4.183 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 2, State 1, 30.00 MWd/kg HM 4-221
4.184 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 2, State 1, 40.00 MWd/kg HM 4-221
4.185 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 2, State 1, 50.00 MWd/kg HM 4-222
4.186 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 2, State 1, 60.00 MWd/kg HM 4-222
4.187 Values of k_{eff}, k_0, and M^2 for Variant 2, States 3–6, at burnup intervals 4-223
4.188 Values of k_{eff}, k_0, and M^2 for Variant 3 (spent fuel), State 1 4-223
4.189 Atom densities for nuclides in Variant 3 (spent fuel), State 1 4-224
4.190 Variant 3 (spent fuel), State 1 4-224
4.191 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 3 (spent fuel), State 1 4-225
4.192 Values of k_{eff}, k_0, and M^2 for Variant 3 (spent fuel), States 3–6 4-225
4.193 Values of k_{eff}, k_0, and M^2 for Variant 4 (spent fuel), State 1 4-225
4.194 Atom densities for nuclides in Variant 4 (spent fuel), State 1 4-226
4.195 Variant 4 (spent fuel), State 1 4-227
4.196 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 4 (spent fuel), State 1 4-227
4.197 Values of k_{eff}, k_0, and M^2 for Variant 4 (spent fuel), States 3–6 4-227
4.198 Values of k_{eff}, k_0, and M^2 for Variant 7, State 1, at burnup 0.00 MWd/kg HM 4-227
4.199 Atom densities for nuclides in Variant 7, State 1 4-228
4.200 Variant 7, State 1 4-228
4.201 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 7, State 1 4-228
4.202 Values of k_{eff}, k_0, and M^2 for Variant 7, States 3–6 4-229
4.203 Values of k_{eff}, k_0, and M^2 for Variant 8, State 1, at burnup 0.00 MWd/kg HM 4-229
4.204 Atom densities for nuclides in Variant 8, State 1 4-229
4.205 Calculated reactor physics parameters for Variant 8, State 1 4-229
4.206 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 8, State 1 4-230
4.207 Values of k_{eff}, k_0, and M^2 for Variant 8, States 3–6 4-230
4.208 Values of k_{eff}, k_0, and M^2 for Variant 9, State 1, at burnup 0.00 MWd/kg HM 4-230
4.209 Atom densities for nuclides in Variant 9, State 1 4-230
4.210 Calculated reactor physics parameters for Variant 9, State 1 4-231
4.211 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 9, State 1 4-231
4.212 Values of k_{eff}, k_0, and M^2 for Variant 9, States 3–6 4-231
4.213 Values of k_{eff}, k_0, and M^2 for Variant 10, State 1, at burnup intervals 4-232
4.214 Nuclide concentration [atoms/(b·cm)] at specific burnup levels for Variant 10, State 1 4-233
4.215 Variant 10, State 1 4-237
4.216 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 10, State 1, 0.00 MWd/kg HM 4-237

4.217 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 10, State 1, 10.00 MWd/kg HM 4-237
4.218 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 10, State 1, 20.00 MWd/kg HM 4-238
4.219 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 10, State 1, 30.00 MWd/kg HM 4-238
4.220 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 10, State 1, 40.00 MWd/kg HM 4-238
4.221 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 10, State 1, 50.00 MWd/kg HM 4-239
4.222 One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 10, State 1, 60.00 MWd/kg HM 4-239
4.223 Values of k_{eff}, k_0, and M^2 for Variant 10, States 3–6, at burnup intervals 4-240
4.224 Values of k_{eff}, k_0, and M^2 for Variant 11, State 1, at burnup intervals 4-241
4.225 Values of k_{eff}, k_0, and M^2 for Variant 11, States 2–6, at burnup intervals 4-242
4.226 Values of k_{eff}, k_0, and M^2 for Variant 12, State 1, at burnup intervals 4-243
4.227 Values of k_{eff}, k_0, and M^2 for Variant 12, States 2–6, at burnup intervals 4-244
4.228 Atom densities for nuclides in Variant 11, State 1, for pins at burnup intervals 4-246
4.229 Atom densities for nuclides in Variant 12, State 1, for pins at burnup intervals 4-252
5.1 Multiplication factor for plutonium metal sphere 5-3
5.2 MCU reaction rates for plutonium metal sphere 5-4
5.3 Multiplication factors for cylindrical, plutonium nitrate critical experiments 5-4
5.4 Reaction rates for PU-SOL-THERM-010, Case 9-1 5-6
5.5 Reaction rates for PU-SOL-THERM-010, Case 9-2 5-6
5.6 Reaction rates for PU-SOL-THERM-010, Case 9-3 5-6
5.7 Reaction rates for PU-SOL-THERM-010, Case 11-1 5-6
5.8 Reaction rates for PU-SOL-THERM-010, Case 11-2 5-7
5.9 Reaction rates for PU-SOL-THERM-010, Case 11-3 5-7
5.10 Reaction rates for PU-SOL-THERM-010, Case 11-4 5-7
5.11 Reaction rates for PU-SOL-THERM-010, Case 11-5 5-7
5.12 Reaction rates for PU-SOL-THERM-010, Case 11-6 5-8
5.13 Reaction rates for PU-SOL-THERM-010, Case 11-7 5-8
5.14 Reaction rates for PU-SOL-THERM-010, Case 11-8 5-8
5.15 Reaction rates for PU-SOL-THERM-010, Case 12-1 5-8
5.16 Reaction rates for PU-SOL-THERM-010, Case 12-2 5-9
5.17 Reaction rates for PU-SOL-THERM-010, Case 12-3 5-9
5.18 Reaction rates for PU-SOL-THERM-010, Case 12-4 5-9
5.19 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 9-1 5-10
5.20 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 9-2 5-11
5.21 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 9-3 5-12
5.22 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 11-1 5-13
5.23 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 11-2 5-14
5.24 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 11-3 5-15
5.25 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 11-4 5-16
5.26 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 11-5 5-17
5.27 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 11-6 5-18
5.28 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 11-7 5-19
5.29 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 12-1 5-20
5.30 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 12-2 5-21
5.31 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 12-3 5-22
5.32 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 12-4 5-23
5.33 Multiplication factors for low moderation PuO_2 experiments 5-24
5.34 Reaction rates for Case CS3-1 5-25
5.35 Reaction rates for Case CS3-2 5-25

5.36 Reaction rates for Case CS3-3 5-25
5.37 Reaction rates for Case CS3-4 5-25
5.38 KENO-ABBN balance table for CS3-1 5-26
5.39 KENO-ABBN balance table for CS3-2 5-27
5.40 KENO-ABBN balance table for CS3-3 5-28
5.41 KENO-ABBN balance table for CS3-4 5-29
5.42 Multiplication factors for low moderation MOX powder experiments 5-30
5.43 Reaction rates for Case 1 5-31
5.44 Reaction rates for Case 2 5-32
5.45 Reaction rates for Case 3 5-32
5.46 Reaction rates for Case 4 5-32
5.47 Reaction rates for Case 5 5-33
5.48 Reaction rates for Case 6 5-33
5.49 Reaction rates for Case 7 5-33
5.50 Reaction rates for Case 8 5-34
5.51 Reaction rates for Case 9 5-34
5.52 Reaction rates for Case 10 5-34
5.53 Reaction rates for Case 11 5-35
5.54 Reaction rates for Case 12 5-35
5.55 Reaction rates for Case 13 5-35
5.56 Reaction rates for Case 14 5-36
5.57 Reaction rates for Case 15 5-36
5.58 Reaction rates for Case 16 5-36
5.59 Reaction rates for Case 17 5-37
5.60 Multiplication factors 5-37
5.61 Reaction rates for PU-SOL-THERM-001, Case 1 5-40
5.62 Reaction rates for PU-SOL-THERM-001, Case 5 5-40
5.63 Reaction rates for PU-SOL-THERM-001, Case 6 5-40
5.64 Reaction rates for PU-SOL-THERM-002, Case 1 5-41
5.65 Reaction rates for PU-SOL-THERM-002, Case 4 5-41
5.66 Reaction rates for PU-SOL-THERM-002, Case 7 5-41
5.67 Reaction rates for PU-SOL-THERM-003, Case 1 5-42
5.68 Reaction rates for PU-SOL-THERM-003, Case 4 5-42
5.69 Reaction rates for PU-SOL-THERM-003, Case 6 5-42
5.70 KENO-ABBN balance table for PU-SOL-THERM-001, Case 1 5-43
5.71 KENO-ABBN balance table for PU-SOL-THERM-002, Case 1 5-44
5.72 KENO-ABBN balance table for PU-SOL-THERM-003, Case 1 5-45
5.73 KENO-ABBN balance table for PU-SOL-THERM-001, Case 6 5-46
5.74 KENO-ABBN balance table for PU-SOL-THERM-001, Case 5 5-47
5.75 Multiplication factors 5-48
5.76 Calculation results of k_{eff} for gadolinium-poisoned plutonium nitrate solutions in 24-in.-diam water-reflected cylinder 5-50
5.77 Calculation results of k_{eff} for unreflected plutonium nitrate solution in 13.4-in. and 17.9-in.-diam cylinders 5-50
5.78 Calculation results of k_{eff} for plutonium nitrate solutions in 24-in.-diam water-reflected cylinder 5-51
5.79 Reaction rates for PNL-6 5-55
5.80 Reaction rates for PNL-7 5-55
5.81 Reaction rates for PNL-9 5-55
5.82 Reaction rates for PNL-10 5-56
5.83 Reaction rates for PNL-11 5-56
5.84 KENO-ABBN balance table for PNL-9 5-57
5.85 KENO-ABBN balance table for PNL-10 5-58
5.86 KENO-ABBN balance table for PNL-11 5-59

5.87 Multiplication factors for mixed uranium/plutonium nitrate solution experiments 5-60
5.88 MCU reaction rates for Case 58 5-60
5.89 Reaction rates for Case 59 5-61
5.90 MCU reaction rates for Case 61 5-61
5.91 KENO-ABBN balance table for MIX-SOL-THERM-002, Case 58 5-62
5.92 KENO-ABBN balance table for MIX-SOL-THERM-002, Case 59 5-63
5.93 KENO-ABBN balance table for MIX-SOL-THERM-002, Case 61 5-64
5.94 Multiplication factors for annular geometry uranium/plutonium solution experiments 5-65
5.95 MCU reaction rates for Case 87 5-67
5.96 MCU reaction rates for Case 95 5-68
5.97 MCU reaction rates for Case 97 5-69
5.98 MCU reaction rates for Case 99 5-70
5.99 MCU reaction rates for Case 108 5-71
5.100 KENO-ABBN balance table for MIX-SOL-THERM-001, Experiment 87 5-72
5.101 KENO-ABBN balance table for MIX-SOL-THERM-001, Experiment 95 5-73
5.102 KENO-ABBN balance table for MIX-SOL-THERM-001, Experiment 97 5-74
5.103 KENO-ABBN balance table for MIX-SOL-THERM-001, Experiment 99 5-75
5.104 KENO-ABBN balance table for MIX-SOL-THERM-001, Experiment 108 5-76
5.105 Multiplication factors for MOX pins with 20 wt % plutonium in MOX 5-77
5.106 MCU reaction rates for Case 1 5-79
5.107 MCU reaction rates for Case 2 5-80
5.108 MCU reaction rates for Case 3 5-81
5.109 MCU reaction rates for Case 4 5-82
5.110 KENO-ABBN balance table for MIX-COMP-THERM-001, Case 1 5-83
5.111 KENO-ABBN balance table for MIX-COMP-THERM-001, Case 2 5-84
5.112 KENO-ABBN balance table for MIX-COMP-THERM-001, Case 3 5-85
5.113 KENO-ABBN balance table for MIX-COMP-THERM-001, Case 4 5-86
5.114 Multiplication factors for MOX pin arrays with low plutonium content 5-87
5.115 MCU reaction rates for assembly PNL-30 5-89
5.116 MCU reaction rates for assembly PNL-31 5-89
5.117 MCU reaction rates for assembly PNL-32 5-89
5.118 MCU reaction rates for assembly PNL-33 5-90
5.119 MCU reaction rates for assembly PNL-34 5-90
5.120 MCU reaction rates for assembly PNL-35 5-90
5.121 KENO-ABBN balance table for PNL-30 5-91
5.122 KENO-ABBN balance table for PNL-31 5-92
5.123 KENO-ABBN balance table for PNL-32 5-93
5.124 KENO-ABBN balance table for PNL-33 5-94
5.125 KENO-ABBN balance table for PNL-34 5-95
5.126 KENO-ABBN balance table for PNL-35 5-96
5.127 Calculated values of k_{eff} for metallic bare critical masses 5-97
5.128 Calculated values of k_{eff} for plutonium solutions PU-SOL-THERM-010 5-98
5.129 Calculated values of k_{eff} for high-enrichment uranium solutions 5-98
5.130 Calculated values of k_{eff} for PuO_2-polystyrene systems 5-99
5.131 Calculated values of k_{eff} for MOX-polystyrene systems 5-100
5.132 Calculated values of k_{eff} for spheres with solutions of weapons-grade plutonium 5-100
5.133 Calculated values of k_{eff} for solutions of plutonium, 116-g/L concentration, poisoned by gadolinium 5-101
5.134 Calculated values of k_{eff} for solutions of plutonium, 636-g/L concentration, poisoned by gadolinium 5-101
5.135 Calculated values of k_{eff} for plutonium solutions containing 4.88 wt % of ^{240}Pu in 34-cm-diam (13.4-in.) tank 5-102

5.136 Calculated k_{eff} values for plutonium solutions containing 4.88 wt % of ^{240}Pu in 45.5-cm-diam (17.9-in.) tank 5-102
5.137 Calculated k_{eff} values for plutonium solutions containing 13.74 wt % of ^{240}Pu in 34-cm-diam (13.4-in.) tank 5-103
5.138 Calculated k_{eff} values for plutonium solutions containing 13.74 wt % of ^{240}Pu in 45.5-cm-diam (17.9-in.) tank 5-103
5.139 Calculated k_{eff} values for solutions of high-burnup plutonium 5-104
5.140 Calculated k_{eff} values for MIX-COMP-THERM-001 5-104
5.141 Calculated k_{eff} values for PNL-30-35 5-105
5.142 Calculated k_{eff} values for MIX-SOL-THERM-001 5-105
5.143 Calculated k_{eff} values for MIX-SOL-THERM-002 5-106

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ACRONYMS

BOL	beginning of life
BP	burnable poison
CZP	cold, zero power
DLC	data library collection
ENDF/B-6/B-V	Evaluated Nuclear Data File B Version 6 (VI) or 5 (V)
EOL	end of life
EP	executable program variant
FMDP	Fissile Materials Disposition Program
FP	fission product
GAN	Russian Safety and Licensing Authority, Gosatomnadzer
HFP	hot full power
HM	heavy metal
HZP	hot, zero power
IPPE	Institute for Physics and Power Engineering
LEMEX	Library of the Evaluated Macroscopic Experiments
LEU	low-enriched uranium
LSENS	Library of Sensitivities
LTA	lead test assembly
LUND	Library of Uncertainty of the Neutron Data
MINATOM	Ministry of Atomic Energy
MOX	mixed oxide
PWR	pressurized-water reactor
VVER	Russian water-water reactor

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NEUTRONICS BENCHMARKS FOR THE UTILIZATION OF MIXED-OXIDE FUEL: JOINT U.S./RUSSIAN PROGRESS REPORT FOR FISCAL YEAR 1997

Volume 3—Calculations Performed in the Russian Federation

ABSTRACT

This volume of the progress report provides documentation of reactor physics and criticality safety studies conducted in the Russian Federation during fiscal year 1997 and sponsored by the Fissile Materials Disposition Program of the U.S. Department of Energy. Descriptions of computational and experimental benchmarks for the verification and validation of computer programs for neutron physics analyses are included. All benchmarks include either plutonium, uranium, or mixed uranium and plutonium fuels. Calculated physics parameters are reported for all of the computational benchmarks and for those experimental benchmarks that the United States and Russia mutually agreed in November 1996 were applicable to mixed-oxide fuel cycles for light-water reactors.

1. INTRODUCTION

(R. T. Primm III)

In January 1994, President Yeltsin of the Russian Federation and President Clinton of the United States of America issued a joint statement in which both leaders pledged their countries to seek to eliminate, where possible, the accumulation of stockpiles of highly enriched uranium or plutonium. In April 1996, a Nuclear Safety Summit was held in Moscow, Russia. Participants at the summit agreed that the spent fuel standard, which makes weapons-usable plutonium as inaccessible as reactor-grade plutonium in spent, low-enriched uranium (LEU) fuel, should be adopted as the goal for plutonium disposition. Summit participants also endorsed a technology program composed of small-scale equipment and process demonstrations. Almost concurrently, a joint U.S./Russian commission, commonly called the Holdren/ Velikhov Commission, concluded that disposition of weapons-usable plutonium in light-water reactors should be one of the technological options pursued by both the Russian Federation and the United States.

The disposition of plutonium in existing, power-generating reactors will require the establishment of a plutonium-processing and mixed-oxide (MOX) fabrication facility. This facility will contain the necessary equipment and chemical processes to convert surplus plutonium from its current physical form (metal) to plutonium oxide. The facility will also contain the necessary equipment and chemical processes to fabricate MOX fuel rods from plutonium and uranium oxide powders.

The design of the plutonium-handling facility will be the responsibility of the Ministry of Atomic Energy (MINATOM). Irradiation of three MOX lead test assemblies (LTAs) and an unspecified number of "production" MOX assemblies are planned for the Balakovo Nuclear Plant. MINATOM will be responsible for the transportation of fuel to and from the reactor site and will be responsible for the ultimate disposal of the MOX assemblies.

All fuel cycle facilities and reactors will be required to submit a request-for-operation to the Russian Safety and Licensing Authority, Gosatomnadzer (GAN). The request consists of an application form and supporting documentation. Part of the supporting documentation must be validation studies for any software used in safety-related analyses.

Validation is the process of demonstrating that the as-built software meets its requirements. In the context of neutron physics software, any biases in computer program/data library *combinations* are identified by comparison of calculated to experimentally measured physics parameters. Included in this

report are a variety of experimental measurements that are used to validate programs and data libraries for application to MOX facilities and reactors fueled with MOX fuel.

Although computer program verification is usually considered separately, the authors have chosen to include this verification as a part of the validation. Verification, in the context of neutron physics computer programs, is the process of ensuring that the software solves the problem that was intended to be solved. That is, the encoded algorithms should produce an accurate approximation to the true solution for the problem. Verification of neutron physics software should be performed in such a manner so as to be independent of the nuclear data that are input to the analyses. Consequently, physicist-created computational benchmarks provide the simplest mechanism for verifying computer programs.

This report provides documentation of validation studies conducted during calendar year 1997. It partially fulfills the documentation required for regulatory approval of MOX facilities.

2. BENCHMARK NEEDS FOR MOX FUEL CYCLES

(R. T. Primm III)

The design and operation of all fuel cycle facilities and the operation of power reactors with MOX fuel require the calculation of various nuclear physics parameters. Reactors must be designed to attain criticality safely, and all other fuel cycle facilities must be designed to avoid criticality. Because criticality can be attained within a single mass of material (single-unit configurations) or by interaction among individual masses that are in proximity to each other (multiunit or array criticality) and since the physical form of the plutonium will change as the material progresses through the fuel cycle, a comprehensive set of benchmarks must include a variety of critical configurations. The following sections provide observations as to the types of experimental data that would be applicable to each fuel cycle facility/operation.

2.1 PLUTONIUM-PROCESSING OPERATIONS

In these operations, weapon parts will be disassembled, and plutonium will be formed into metal ingots. The processing operations will be conducted with plutonium metal—no mixtures of plutonium and uranium. Benchmarks applicable to these operations are critical configurations with plutonium metal. Although it is expected that most or all of the processes will be nonaqueous, accidents or abnormal conditions may result in the introduction of hydrogen moderation to the operations. Hence, a range of moderation ratios should be examined in the experimental configurations. Because storage configurations will likely exist for weapons parts and processed plutonium metal in the facility, both single-unit and array critical experiment configurations will be required for computer program validation.

2.2 MOX FUEL FABRICATION OPERATIONS

The fuel assembly fabrication operations will receive plutonium metal from the processing operations. Metal ingots will be dissolved in a mixture of nitric and fluoric acids. The solution containing the dissolved plutonium will be processed using solvent extraction to remove impurities from the plutonium (aqueous to organic to aqueous solution transfer of plutonium). The plutonium will then be precipitated as plutonium oxide. Depleted or natural uranium oxide will be blended with the plutonium oxide. The blending may be conducted in stages. An interim storage facility for the blended MOX will likely be provided. MOX powder will be taken from the storage facility and pressed into fuel pellets. These pellets will be sintered and then loaded into fuel rods. The rods will then be loaded into assemblies, and the assemblies will be stored in a dry storage facility.

Many types of critical experiment data will be required to benchmark computer programs and nuclear data for application to fuel fabrication operations. Critical experiments conducted with plutonium nitrate solution in a variety of geometries will be needed. Plutonium oxide and MOX configurations must be studied. Arrays of MOX fuel pins must be considered. A variety of moderating conditions to span both normal and credible abnormal conditions must be considered.

Blending operations for the production of MOX powder, MOX pellet production, and fuel rod fabrication operations will use single-unit MOX critical configurations as benchmarks. Intermediate storage of MOX powders, fuel rod assembly into bundles, and bundle storage at the facility will require interacting array data for MOX powders and for arrays of fuel pins.

2.3 REACTOR

Fresh fuel storage will require criticality data for water-moderated arrays of MOX pins. These same data should be applicable to certifying some of the physics parameters of MOX fuel in the reactor core. However, configurations that are to be used for certifying reactor physics codes for reactor core design must include accurate measurement of the relative power generation among the pins that compose the critical configuration. Furthermore, kinetics measurements will be required for certifying that the transient performance of MOX fuel in a reactor is understood.

Certification of the reactor core configuration will require critical experiments in which the reactivity worth of the reactor control materials are verified, the effect of cold-to-operating temperature change on reactivity can be verified, and the effect of moderator voiding can be verified. While the establishment of critical configurations of irradiated fuel may not be feasible, some data regarding the composition of the fuel as a function of burnup [both actinides and fission products (FPs)] should be generated.

If cores are to be partially loaded with MOX assemblies, critical experiment benchmarks containing both LEU and MOX fuel pins will be required. Flux and power measurements at the LEU-MOX interfaces will be especially important because these locations are typically the ones with the highest local power densities. Consequently, operating conditions at these locations are typically those that must be compared to the approved, limiting conditions of operation for the reactor.

Spent fuel storage can be licensed based on the same data as for fresh fuel storage. However, it should be possible to economically justify procuring critical experiment data that would allow the incorporation of burnup-credit analyses in the spent fuel storage design.

2.4 TRANSPORTATION

The same data used for the analyses of fresh and spent fuel storage at the reactor will be applicable to transportation analyses. Some additional experiments to verify the reactivity effects of reflecting materials that compose the shipping casks may be required or may be economically justifiable.

3. COMPUTATIONAL METHODS AND DATA

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This section contains descriptions of the computer programs and nuclear data libraries that are used in studies reported in this document. Generally, Monte Carlo methods are used for certifying that outside-of-reactor configurations are safely subcritical. However, these methods may also be used to confirm the accuracy of the diffusion or transport theory methods that are used to design reactors and estimate their operating conditions.

3.1 THE MCU-RFFI/A MONTE CARLO CODE AND ITS LIBRARY COLLECTION DLC/MCUDAT-1.0

MCU-RFFI/A[1] is a general-purpose Monte Carlo code for solving the neutron transport problems in the energy range between 20 MeV and 10^{-5} eV.

The main fields of the MCU-RFFI/A applications are (1) nuclear safety assessment, (2) nuclear data validation, (3) design calculations, and (4) verification of design codes.

MCU-RFFI/A is a continuous-energy Monte Carlo code. It is used with both pointwise and step function representations of cross sections. To describe the unresolved resonance cross section, the subgroup method (analogous to the probability table method) is used. It is possible to use a detailed description of cross sections in the resolved resonance region. For the most important isotopes, an "infinite" number of energy points is used to describe the resonance curve. In this case, cross sections are calculated during the Monte Carlo run at every energy point on the basis of the resonance parameter library. The calculations can be performed without preliminary tabulation of cross sections, and the user can estimate temperature effects independent of the cross section library state. Special fast algorithms to calculate resonance cross sections are used. For the thermal energy region, the Monte Carlo game is played using the $S(\alpha, \beta)$ scattering laws and the coherent elastic cross sections or free gas model. One may solve the problems, taking into account both the prompt neutron and the delayed neutron fission spectra.

The accuracy of modern Monte Carlo codes is limited mainly by the accuracy of the nuclear data used. The MCU-RFFI/A code verification and validation was based on the data library collection DLC/MCUDAT-1.0. This library collection includes

- the ACE library prepared by the NJOY code on the base of ENDF/B-VI evaluations,
- the ABBN 26-group library,
- the LIPAR library of nuclear resonance parameters for the resolved resonances region,
- the VESTA library of continuous-energy thermal neutron cross sections, and
- the TEPCON thermal neutron data multigroup library, which is an alternative to the VESTA library.

The collection contains cross sections for energies less than 1 eV at various temperatures and includes the zero and the first angular moments of the scattering cross sections. The scattering laws for the VESTA and TEPCON libraries are calculated using the ENDF phonon spectra set.

Although the ACE library may be used up to the boundary of the thermal region in criticality calculations, it is used only in fast regions above 100 keV. Alternatively, the ABBN library is used to describe smooth cross sections (via step functions) for energies above the resolved resonance region during a continuous-energy Monte Carlo run. The inelastic scattering is modeled using the probability density step functions. The LIPAR data are directly utilized in the Monte Carlo run for calculating the continuous energy cross sections, taking into account Doppler broadening.

Both continuous energy and multigroup approximation can be applied in the thermalization region. The VESTA library is used in the first case, and the TEPCON library is used in the latter case. For the most important moderators, the scattering cross sections are calculated using Gauss's incoherent approximation. The elastic coherent cross sections are used if necessary. The DLC/MCUDAT-1.0 includes the DOSIM library, which also contains the data for dosimetry reaction rate calculations. The DOSIM library is prepared by the NJOY code using IRDF, ENDF/B-VI, and other files.

The DLC/MCUDAT-1.0 library contains information for 131 isotopes (see Table 3.1).

Table 3.1. The DLC/MCUDAT-1.0 library isotope list

Isotope No.	Atomic No.	Isotope	Isotope No.	Atomic No.	Isotope	Isotope No.	Atomic No.	Isotope
1	1	^{1}H	45	54	^{131}Xe	89	72	^{178}Hf
2	1	^{2}H	46	54	^{135}Xe	90	72	^{179}Hf
3	2	^{3}He	47	55	^{133}Cs	91	72	^{180}Hf
4	2	^{4}He	48	56	^{134}Cs	92	73	Ta
5	3	^{6}Li	49	56	^{135}Cs	93	73	^{181}Ta
6	3	^{7}Li	50	59	^{141}Pr	94	74	W
7	4	Be	51	60	^{143}Nd	95	74	^{180}W
8	5	^{10}B	52	60	^{145}Nd	96	74	^{182}W
9	5	^{11}B	53	61	^{147}Pm	97	74	^{183}W
10	6	C	54	61	^{148m}Pm	98	74	^{184}W
11	7	N	55	61	^{149}Pm	99	74	^{186}W
12	8	O	56	62	^{149}Sm	100	75	Re
13	9	F	57	62	^{150}Sm	101	79	Au
14	11	Na	58	62	^{151}Sm	102	82	Pb
15	12	Mg	59	62	^{152}Sm	103	83	Bi
16	13	Al	60	63	Eu	104	90	^{232}Th
17	14	Si	61	63	^{151}Eu	105	91	^{233}Pa
18	17	Cl	62	63	^{153}Eu	106	92	^{233}U
19	19	K	63	63	^{154}Eu	107	92	^{234}U
20	20	Ca	64	63	^{154}Eu	108	92	^{235}U
21	22	Ti	65	64	Gd	109	92	^{236}U
22	23	V	66	64	^{152}Gd	110	92	^{238}U
23	24	Cr	67	64	^{154}Gd	111	93	^{237}Np
24	25	^{55}Mn	68	64	^{155}Gd	112	93	^{239}Np
25	26	Fe	69	64	^{156}Gd	113	94	^{238}Pu
26	27	Co	70	64	^{157}Gd	114	94	^{239}Pu
27	28	Ni	71	64	^{158}Gd	115	94	^{240}Pu
28	29	Cu	72	64	^{160}Gd	116	94	^{241}Pu
29	31	Ga	73	66	Dy	117	94	^{242}Pu
30	36	^{83}Kr	74	66	^{156}Dy	118	95	^{241}Am
31	39	Y	75	66	^{158}Dy	119	95	^{242m}Am
32	40	Zr	76	66	^{160}Dy	120	95	^{243}Am
33	41	^{93}Nb	77	66	^{161}Dy	121	96	^{242}Cm
34	42	Mo	78	66	^{162}Dy	122	96	^{243}Cm
35	42	^{95}Mo	79	66	^{163}Dy	123	96	^{244}Cm
36	43	^{99}Tc	80	66	^{164}Dy	124	96	^{245}Cm
37	44	Rh	81	68	Er	125	96	^{246}Cm
38	44	^{101}Ru	82	68	^{166}Er	126	96	^{247}Cm
39	45	^{103}Rh	83	68	^{167}Er	127	96	^{248}Cm
40	45	^{105}Rh	84	68	^{168}Er	128	98	^{252}Cf
41	46	^{105}Pd	85	72	Hf	129		^{233}U FP
42	47	^{109}Ag	86	72	^{174}Hf	130		^{235}U FP
43	48	Cd	87	72	^{176}Hf	131		^{239}Pu FP
44	48	^{113}Cd	88	72	^{177}Hf			

MCU-RFFI/A permits the user to model an arbitrary, complex, three-dimensional (3-D) system described by combinatorial geometry. The geometry zones are represented by Boolean combinations of 13 different bodies. The lattices with repeated elements can be described by defining the repeated elements and translation vectors. Each similar lattice may also include nonuniformities, which are given as applications. For zones and repeated elements, the following attributes are defined by the user: tally zone number, tally object number, material number, etc. Any number of geometric zones may be united into one tally zone or tally object. For lattices, these attributes may be generated automatically

Boundary conditions include vacuum, white and specular reflection, the condition of translational symmetry, and the symmetry planes. The criticals with the neutron leakage given by the buckling vector may be calculated by solving Benoist's problem. Double heterogeneous systems with fuel elements containing many thousands of sphere microcells can be modeled.

By default, MCU-RFFI/A calculates a set of flux functionals integrated over the entire system and over the tally zones or tally objects. Energy bins are specified by the user. The following parameters are calculated: effective multiplication factor, migration lengths, neutron lifetime, generation time, effective fraction of delayed neutrons, fluxes and reactions rates for isotopes in the tally zones, the few group constants for tally objects, and spectral indexes. The user may also calculate the currents, the surface fluxes, and the other surface flux functionals for the edges of the tally objects. MCU permits determination of the diffusion coefficients of reactor cells depending on their definition, the cell position, and the edge number.

For Benoist's problem, the multiplying factor dependence on buckling is calculated. The curve of criticality coefficient dependence on buckling may be determined during the single code run, and critical buckling may be determined. The solution of this problem is used to calculate Benoist- and Bonalumi-type diffusion coefficients. The variances of all the functionals are calculated, including the fraction functionals similar to spectral indexes or average cross sections.

The external source distribution is specified by functions defined in geometry zones and may be quite general.

Standard variance reduction techniques are used: splitting, roulette, weight window, and various combined estimators of multiplying factor. The new ALIGR technique[2] was elaborated to determine the reaction rates in very small monitors placed into the experimental channels of large investigative reactors. It seems that the ALIGR technique may be applied to solve other difficult problems, including the shielding problems.

The programming language of the code is FORTRAN 77. The full description of the code and its constant base is available in Russian. The *MCU-RFFI/A User's Guide* is translated into English.

MCU-RFFI/A is a part of the MCU project. This project includes developing the nuclear data libraries and the codes for processing the library data, designing and updating the Monte Carlo code package, and supporting and updating the CLAD library containing the MCU input lists and the results of the MCU calculations of various problems. The MCU-RFFI/A code is assembled from modules of the MCU code package. The modular code architecture allows the user to solve transport problems using a set of various algorithms and mutually changeable program modules, while also utilizing the different data libraries. The MCU package module is a set of segments, where each segment has its functional destination and interfaces strictly determined by the code architecture. The MCU module types are classified as follows: C = control, P = physical, G = geometric, T = tallies, and S = sources. As a rule, every type of module has alternative versions corresponding to its different modeling algorithms. The executable program variant (EP) is assembled according to the equation:

$$EP = C + P + G + T + S \ ,$$

where C, P, G, T, and S are the modules previously described. The package architecture permits the code to be assembled to simulate random walk for several types of particles. The module interfaces are very simple ones that permit the modules to be included into different codes or the memory distribution between the modules to be changed in the framework of one code.

The TERMAC and STEN codes elaborated within the MCU project are used for calculating scattering laws and the thermal neutron elastic coherent cross sections (VESTA and TEPCON libraries) by utilizing the phonon spectrum library.

GRAF is a two-dimensional (2-D) color-graphics solid-geometry modeler. It permits one to check initial geometry data and look through any plane section of the system being considered. The materials distribution, geometry zones, tally zones, and tally objects may be seen.

The CLAD library contains more than 300 descriptions of different experimental assemblies.

The MCU project has been developed at Kurchatov Institute beginning in 1982. Four freely distributed MCU code versions have been issued earlier: MCU-1 (1985), MCU-2 (1990), MCU-3 (1993), and MCU-RFFI (1995). MCU has been validated using about 300 assemblies (including all known before 1995 benchmarks) and was verified by solving thousands of practical problems. MCU is widely used in Russia for calculating parameters of Russian reactors of practically all types and calculating parameters of in-pool storage and shipping casks, etc.

The authors of the code are L. P. Abagyan, N. I. Alexeyev, V. I. Bryzgalov, V. V. Veretenov, A. E. Glushkov, E. A. Gomin, M. I. Gurevich, M. A. Kalugin, L. V. Maiorov, S. V. Marin, and M. S. Yudkevich. In 1996 the MCU-RFFI/A code with its library DLC/MCUDAT-1.0 were certified by GAN as a tool to perform the criticality calculations of practically any type of neutron multiplying systems, including the ones with plutonium and mixed uranium-plutonium fuel.

3.2 DESCRIPTION OF METHODICAL BASIS OF THE TVS-M CODE

TVS-M is the spectral code for calculations of neutronic constants of cells, supercells, and fuel assemblies of VVER reactors. It is a component of the code package for VVER calculations.

A constants library used by TVS-M is based on almost the same nuclear data as the MCU-RFFI/A code (see Sect. 3.1) and has the following main features:

- In the fast energy region (E_n > 4.65 keV), the multigroup cross sections library ABBN is applied. This energy range includes 12 groups of the library. In parallel with the nuclides group constants, the subgroup ones are used.

  The subgroup method allows one to express in a simplified form the average of any function g of, say, the total cross section σ_t, which is given by

  $$\langle g \rangle = \int_{\sigma_{t_L}}^{\sigma_{t_u}} g(\sigma_t)\, P(\sigma_t)\, d\sigma_t$$

  where σ_{t_L} and σ_{t_u} are the lower and upper limits of the σ_t variation in an energy interval ΔE and $P(\sigma_t)$ is the probability that the total cross section has a value σ_t in that interval.[3]

- The resonance energy range (4.65 keV > E_n> 0.625 eV) includes the ABBN groups from 13th to 24th (the cross sections of the 24th group are modified because the lower boundary of this group is not coincident with the one of the ABBN library). In this energy range the TVS-M code also uses both subgroup and group constants. Besides, the files of resonance parameters from the LIPAR-3 library are applied for resonance nuclides. For most of these nuclides, the cross section calculation is based on the Breit-Wigner multilevel model (and on the Adler-Adler model for fissile nuclides).
- The thermal energy range (E_n < 0.625 eV) is subdivided into 24 groups. A set of scattering matrices calculated for various temperatures by the Koppel-Young model is applied for hydrogen bonded in a water molecule. Group cross sections of nuclides and the scattering matrixes have been obtained with the use of the same algorithms and nuclear data (TEPCON library) as in the case of the MCU-RFFI/A code.
- Ninety-six FPs are taken into account under burnup calculation. The TVS-M code uses a library of their yields based on ENDF/B-VI data and group cross sections from the MCU data library.

The TVS-M calculation technique consists of the following main stages: (1) a detailed calculation of all cell types forming a fuel assembly (such as fuel cell, absorber cell, and so on) is performed, and corresponding sets of few-group constants are computed (number of the groups is arbitrary); then (2) these group-effective constants are used in a group nodal diffusion calculation of the whole assembly.

Computing of the neutron's spatial distribution in the specified energy group structure (or at a specified energy point) is performed by the method of passing through probability (similar to the first collision probability method). At the present time, an angular distribution of the one-direction neutrons current at a given zone boundary is described by six angular harmonics. A neutron's reflection at a cell boundary takes into account a real hexagonal form of the boundary. For a calculation of an effective diffusion coefficient, both isotropic and anisotropic probabilities in R and Z directions are computed in the same manner.

In the fast energy region, a detailed calculation is carried out with the use of group and subgroup microscopic cross sections from the ABBN library. In doing so, each energy group is subdivided into an arbitrary number of intervals of uniform width. The energy loss of a neutron on nonelastic slowing down is described by a continuous function specified by the group matrix of nonelastic transfers. The neutron energy loss on elastic slowing down is also described continuously, taking into account scattering anisotropy in a system of inertia centers. In the resonance region, the slowing down of neutrons is calculated in the same manner as in the fast energy region. Cross sections of resonance nuclides at each energy point are calculated with the CROSS code using the file of resonance parameters for each nuclide. Interference between potential and resonance scattering, the cross sections' temperature dependence, and p-wave contribution into scattering cross sections are strictly taken into consideration. An effect of mutual overlapping of different resonance nuclides is also taken into account.

A calculation technique applied in the thermal energy region is traditional. The group thermalization equation is solved by the method of passing through probability. The sources are shaped when the upper energy groups are calculated, with the Nelkine asymptotic limit of scattering applied for hydrogen.

A nodal diffusion approach with asymptotic and transient trial functions (both for flux and current) is applied for pin-by-pin calculation of the fuel assembly. The asymptotic solution corresponds to the problem with a nonzero source (slowing down or fission) and zero current at the cell boundary. The transient trial function corresponds to the problem of finding the neutron distribution in the cell placed at the center of a supercell when a source in it is equal to zero. And in such a supercell, a fuel cell is surrounded by the water and a cell of the other type—by homogenized fuel cells. A correction for mesh width is also involved in the balance equation. This correction takes into account the difference between an average flux and a flux at the cell boundary. The similar correction for a current flowing through the cell also appears in the balance equation.

The burnup equations are solved for every fuel pin, which can be subdivided into several concentric rings forming separate burnup zones. Concentration changing of the following heavy nuclides is taken into consideration:

^{232}Th	^{233}Pa	^{233}U	^{234}U	^{235}U	^{236}U	^{238}U	^{237}Np	^{238}Pu	^{239}Np
^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{241}Am	^{242m}Am	^{243}Am	^{242}Cm	^{243}Cm	^{244}Cm

Equilibrium concentrations of ^{135}Xe and ^{149}Sm are also calculated.

Calculation of the accumulation of the following 96 FPs is performed for each fuel pin:

^{82}Kr	^{83}Kr	^{84}Kr	^{85}Kr	^{85}Rb	^{86}Sr	^{86}Kr	^{87}Kr	^{87}Rb	^{88}Sr
^{89}Y	^{90}Sr	^{90}Zr	^{91}Zr	^{92}Zr	^{93}Zr	^{94}Zr	^{95}Mo	^{96}Zr	^{96}Mo
^{97}Mo	^{98}Mo	^{99}Tc	^{100}Mo	^{100}Ru	^{101}Ru	^{102}Ru	^{103}Rh	^{104}Ru	^{104}Pd
^{105}Pd	^{106}Pd	^{106}Ru	^{107}Pd	^{108}Pd	^{109}Ag	^{110}Cd	^{111}Cd	^{113}Cd	^{114}Cd
^{115}In	^{116}Sn	^{117}Sn	^{123}Te	^{124}Sn	^{124}Te	^{125}Sb	^{125}Te	^{126}Te	^{127}I
^{128}Xe	^{128}Te	^{129}I	^{129}Xe	^{130}Te	^{130}Xe	^{131}Xe	^{132}Xe	^{133}Cs	^{134}Cs
^{134}Xe	^{135}Cs	^{136}Ba	^{136}Xe	^{137}Cs	^{137}Ba	^{138}Ba	^{139}La	^{140}Ce	^{141}Pr
^{142}Ce	^{142}Nd	^{143}Nd	^{144}Ce	^{144}Nd	^{145}Nd	^{146}Nd	^{147}Pm	^{148}Nd	^{148}Sm
^{149}Sm	^{150}Nd	^{150}Sm	^{151}Sm	^{152}Sm	^{153}Eu	^{154}Sm	^{154}Eu	^{155}Eu	^{156}Gd
^{157}Gd	^{159}Tb	^{160}Dy	^{161}Dy	^{162}Dy	^{163}Dy				

3.3 KENO-V.a/ABBN-93 CODE-CONSTANTS COMPLEX

This code-constants complex is used for multiplying system neutronic calculations. The ABBN-93 group constant set is used as the neutronic database. This set is the modern option of the ABBN-90 group constant set (see DLC-182 in the RSIC Data Library Collection). The CONSYST code is used for preparation of the group cross sections for neutron fluxes and criticality calculations by the Monte Carlo method. The ANISN output of CONSYST is used; then prepared group cross sections are converted to the AMPX working format by the LAVA module of the SCALE-4.3 system (see CCC-545 in the RSIC Computer Code Collection). The KENO-V.a code from the same system uses the neutron data for criticality, leakage, and neutron flux calculations. Average neutron reaction rates for the prescribed region may be calculated after this stage using group neutron fluxes obtained and isotopic reaction cross sections prepared by CONSYST.

3.4 MCNP/FOND-2 CODE-CONSTANTS COMPLEX

This code-constants complex is used for multiplying system neutronic calculations. The FOND-2 evaluated nuclear data file is used as the neutronic database. This library was used as the basis for calculation of the ABBN-93 group constant set, which is the modern option of the ABBN-90 group constant set (see DLC-182 in the RSIC Data Library Collection). The ENDF/B-VI format is used for presentation of the evaluated data. Data are transferred from this format to the ACE format acceptable for the MCNP Monte Carlo code by the NJOY code (see PSR-171 in the RSIC Peripheral Shielding Routines). Then the MCNP-4A code (see CCC-200 in the RSIC Computer Code Collection) is used for neutronic calculations for criticality, leakage, and neutron flux calculation.

3.5 TWODANT/ABBN-93 CODE-CONSTANTS COMPLEX

This code-constants complex is used for multiplying system neutronic calculations. The neutron transport equation is solved in two dimensions by the method of discrete ordinates. The ABBN-93 group constant set is used as the neutron database. This set is the modern option of the ABBN-90 group constant set (see DLC-182 in the RSIC Data Library Catalogue). The CONSYST code is used for preparation of the group constants for neutron fluxes and criticality calculations by Sn method. The ANISN output of CONSYST is used. The TWODANT code uses the neutron data prepared for criticality and neutron flux calculations. Leakage and average neutron reaction rates are calculated after this stage using group neutron fluxes obtained and isotopic reaction cross sections prepared by CONSYST.

3.6 WIMS-ABBN

The WIMS-ABBN code is an updated, English WIMS-D4 code. The modernization mainly was done to introduce minor actinide chains and to update the library.

3.6.1 Updating and Supplementing the WIMS-D4 Library

Data for almost all structural materials, all neutron moderators, and all actinides were updated in the WIMS-D4 library. Data for Sn, Mo, Hf, Ta, and W were added. Data for minor actinides ^{237}Np, ^{238}Pu, ^{241}Am, ^{242}Am, ^{242m}Am, ^{243}Am, ^{242}Cm, ^{243}Cm, ^{244}Cm, and ^{245}Cm were also added.

The FP list was preserved as in the original version, but all the neutron data for FPs were updated and replenished. Now, full neutron constant sets are included in the library, not simply the capture cross sections as in earlier versions of the library. The FP yields are updated for ^{235}U and ^{239}Pu, and the yields for all other fissile materials are added.

Group constants for the new WIMS-D4 library were calculated on the basis of the FOND-2 evaluated neutron data library. In many cases, the evaluated nuclear data libraries of ENDF/B-6 and JEF-2 are also used.

Resonance self-shielding data were calculated using the GRUCON code but only in the cases when the narrow resonance approximation may be considered as adequate. The NJOY code was used for

calculation of resonance self-shielding, taking into account the fluctuations of collision density in the vicinities of resonance. The NJOY calculations were performed for all fuel nuclides.

Thermalization matrices for moderators were calculated on the basis of ENDF/B-6 data by the NJOY code. Anisotropy of scattering is described in P1 approximation. Average group cross section and matrices of intergroup transitions were calculated using the NJOY code.

The additional neutron reaction cross section library ACTWIMS is compiled. This library includes the data for many more nuclides and reaction types than does the main WIMS-D4 library. But energy grids in these libraries are the same, and thus the ACTWIMS data can be collapsed using the neutron spectra calculated by WIMS.

In WIMS calculations, a set of 48 nuclides, consisting of 16 actinides, 31 FPs, and oxygen, were used to represent fuel composition and are listed in Table 3.2.

3.6.2 WIMS-D4 Improvements

Improvements were introduced in WIMS-D4. Resonance self-shielding of neutron cross sections is extended to the thermal region. This improvement is especially important for the accurate treatment of neutron capture in ^{242}Pu, which has a resonance at very low energy. The second improvement consists of the addition of a special module (AVERAGE) for collapsing the ACTWIMS cross sections using WIMS's cell-averaged neutron spectra. Collapsed one-group cross sections are then used in kinetics calculations.

The number of nuclear reactions considered in the WIMS library during actinide generation was considerably extended. However, the structure of the WIMS-D4 library does not allow the inclusion of some nuclear reactions.

The production of ^{242}Am and ^{242m}Am by the ^{241}Am neutron capture cannot be taken into account today because the current version of the WIMS-D4 code cannot treat branching in the capture process. Thus, channels for the production of ^{242}Cm and ^{243}Cm are closed. For this reason, for any nuclide, the reaction (n, 2n) cannot be considered if the reaction (n, γ) has been included.

The CREDE code was produced to correct these flaws. This code works together with WIMS and AVERAGE. The CREDE code is used for calculations of heavy metal (HM) concentrations during burnup and over a long period after unloading.

Figure 3.1 shows the nuclide chains that are taken into account in the CREDE code depletion calculations. The required one-group microscopic cross sections are taken from the WIMS library if they are present in it, and, if not, they are taken from the ACTWIMS library. Neutron flux needed in CREDE for depletion calculations comes from WIMS or is computed by CREDE from specified power. Microscopic cross sections and neutron flux are updated at each burnup step. The system of equations corresponding to Fig. 3.1 is solved numerically.

Table 3.2. Nuclides representing fuel composition

				Actinides			
^{234}U	^{235}U	^{236}U	^{238}U	^{237}Np	^{238}Pu	^{239}Pu	^{240}Pu
^{241}Pu	^{242}Pu	^{241}Am	^{243}Am	^{242}Cm	^{243}Cm	^{244}Cm	^{245}Cm
				FPs			
^{83}Kr	^{95}Mo	^{99}Tc	^{101}Ru	^{103}Ru	^{103}Rh	^{105}Rh	^{105}Pd
^{108}Pd	^{109}Ag	^{113}Cd	^{115}In	^{127}I	^{131}Xe	^{133}Cs	^{134}Cs
^{135}Xe	^{143}Nd	^{145}Nd	^{147}Pm	^{147}Sm	^{148}Pm	^{149}Sm	^{150}Sm
^{151}Sm	^{152}Sm	^{153}Eu	^{154}Eu	^{155}Eu	^{157}Gd	Lumped FP	
				Oxygen			
^{16}O							

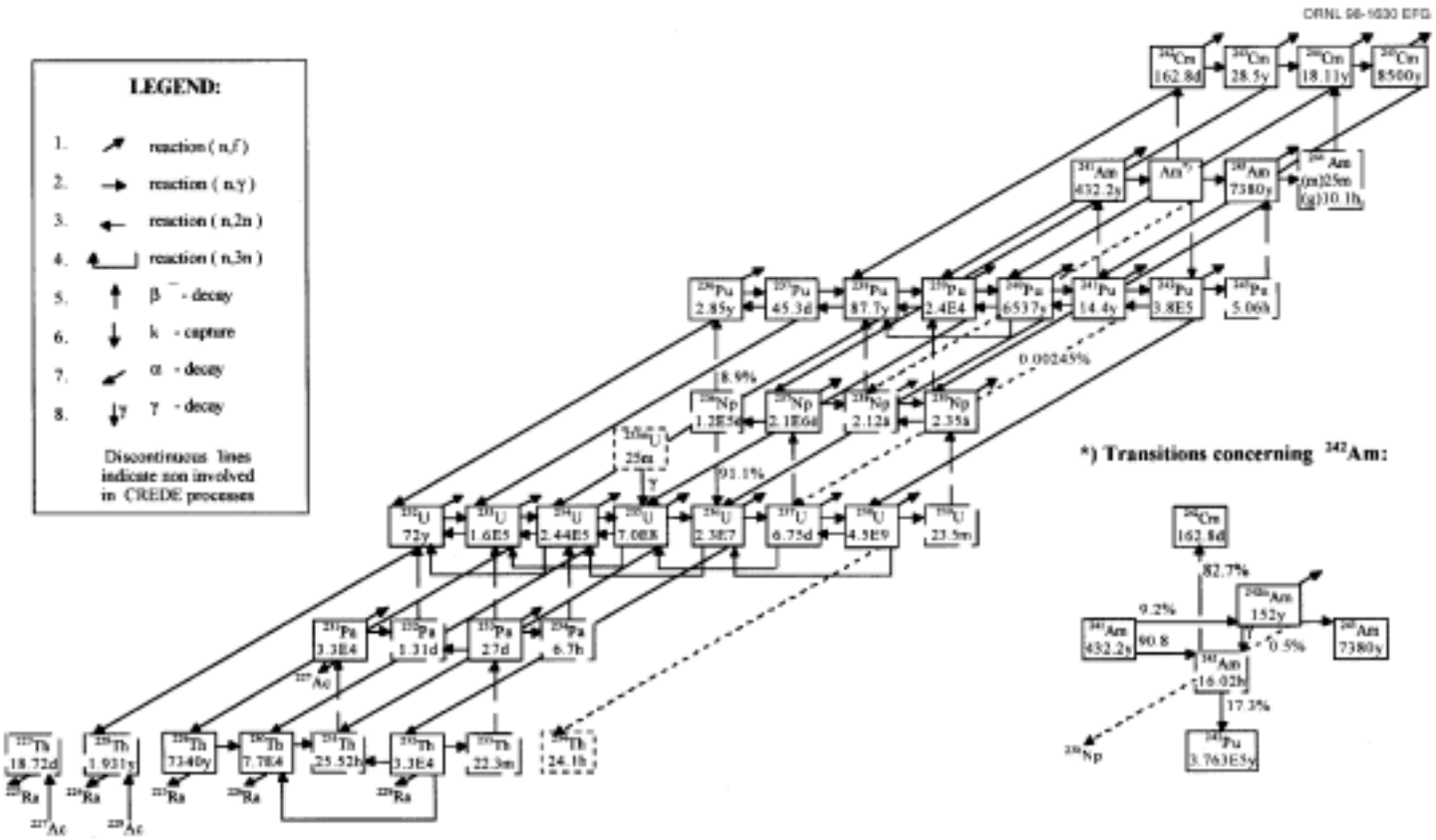

Fig. 3.1. Nuclide generation/depletion chains included in CREDE computer program.

3.7 INDECS—A CODE-CONSTANT SYSTEM FOR CALCULATIONAL UNCERTAINTY ESTIMATION

The system INDECS was developed for the estimation of neutronic calculation uncertainties caused by uncertainties of the neutron data and for some other purposes. Three main data libraries are used for such estimations. The first is LUND—Library of Uncertainty of the Neutron Data. The ABBN-93 group cross section set uncertainty covariance matrix is the present content of this library. Evaluated uncertainty data for all materials important from the reactor physics point of view are included in this matrix in 26-group representation. Correlations between uncertainties of some reaction cross sections in different energy groups as well as between cross sections of different reactions and different materials were evaluated and taken into account in the covariance matrix. Data included in LUND reflect only the uncertainty of evaluated neutron data used for the calculation of the ABBN-93 group constant set, which is the revised version of the ABBN-90 set (see DLC-182 in the RSIC Data Library Catalogue). The second library is LEMEX—Library of the Evaluated Macroscopic Experiments. Experimental data (criticality, central reaction rates, and central reactivity worth ratios) measured in a number of critical assemblies with different neutron spectra and core contents are included in this library with their uncertainties. All these data are applied to the conditions corresponding to the benchmark model for each experiment (i.e., all necessary corrections are introduced into experimental data, and uncertainties of these corrections are added to the uncertainties of measurements). Results of benchmark model calculations are also included in LEMEX.

These results were obtained using the ABBN-93 group constant set with neutronic codes having computational uncertainties much smaller than uncertainties due to the neutron data (described by the covariance matrix stored in LUND). Results of sample calculations for a number of typical nuclear reactors are also included in LEMEX. Of course, experimental data are absent in these cases. For each calculational result included in LEMEX, sensitivities of these results to the neutron group constants used were calculated and included in LSENS—Library of Sensitivities.

Uncertainties of calculations caused by uncertainties of evaluated data used can be estimated using a covariance matrix from LUND and sensitivities from LSENS. These calculations may be carried out by the code CORE included in the INDECS system. But such a calculation overestimates the calculational uncertainties because results of comparisons between experimental and calculated data for selected critical assemblies were taken into account when evaluated neutron data files were selected for ABBN-93 calculations. As a result of these modifications, the experiment-to-calculation differences for critical assemblies considered become tiny because neutron constant adjustment was performed on the basis of these same selected critical assemblies. Thus, for more realistic uncertainty estimation, the adjustment procedure is fulfilled using the selected experimental results mentioned, and the covariance matrix of adjusted constants obtained in this procedure is used as an estimation of the covariance matrix of the ABBN-93 constants. Comparison of experiment-to-calculation differences for experiments that were not considered in the adjustment process for ABBN-93 with estimates desired using LUND and LSENS allows confirmation of the validity of this uncertainty estimation.

3.8 PARSEC—A CODE TO PARAMETERIZE MACROCONSTANTS FOR VVER REACTORS

The two-group macroconstants are represented as an expansion in Taylor series in the following seven variables:

- water density,
- water temperature,
- fuel temperature,
- boron concentration in water,
- ^{135}Xe concentration,
- ^{149}Sm concentration, and
- burnup.

Burnup is a special variable because an infinitely large number of expansion terms can be considered. This is achieved by moving the initial ("0th") point of expansion with burnup.

The number of expansion terms in other variables and the number of mixed terms are chosen on condition that the cell K_{inf} values and their derivatives with respect to water density, water temperature, fuel temperature, and soluble boron concentration are described correctly. The expansion coefficients are found on the condition that the polynomial passes through a specified number of points.

The VVER-1000 pin-cell calculations have shown that it is possible to approximate the macroconstants by a single polynomial over the range of parameters corresponding to a normal operating state. The exception is the burnup. The interval of accurate approximation for burnup using this single polynomial corresponds to 1 effective full-power year. The maximum error in K_{inf} in two states on ^{135}Xe is no more than 0.1% over the VVER cycle length. A comparison of the derivatives calculated with the use of approximated values of macroconstants to exact macroconstant values shows a good agreement. To approximate the macroconstants in an extended range of parameters so that both the normal and the accident states can be accurately modeled, it is necessary to divide the water density and boron concentration ranges into intervals.

3.9 THE PROGRAM COMPLEX TRIANG-PWR

The program complex TRIANG-PWR is a new version of the TRIANG code for 3-D calculations of VVER reactors. TRIANG-PWR is used for simulation of (1) reactor burnup while maintaining criticality by adjusting the concentration of dissolved boron in the coolant and (2) refueling.

The 3-D neutron fluxes are calculated by the diffusion approximation. Angles of a symmetry from 30° to 180° on a triangular (in a plane) grid are accepted. The maximum number of planes is 50.

To save computation time, the few-group approach is utilized. Full reactor burnup calculation is carried out stage by stage. In the beginning, calculations of cells during a burnup are carried out; then the 3-D calculation is executed.

The acceleration of internal iterations of group neutron fluxes is performed by a method of sequential overrelaxation. For acceleration of external iterations, a method of Chebyshev polynomials is used.

TRIANG-PWR is used mainly for 3-D, rough mesh calculations of VVER reactors. A grid with seven nodes per one fuel assembly is usually used. If needed, more detailed geometric descriptions with tighter grids are possible. Fine mesh (pin-by-pin) calculations are possible too.

The homogenized macroscopic cross sections of zones of a 3-D model are determined from cell (fuel assembly) calculations. The macroconstants, generally speaking, depend on instantaneous conditions of fuel assembly operation: specific power, temperature of water and fuel, concentration of a dissolved boron, etc. To obtain accurate macroscopic cross sections, an iterative process is required. In a complex TRIANG mode, the correction of constants can be produced through a given number of external iterations.

The procedure for correction of constants depending on parameters of a reactor state is entered into the module for the neutron flux calculation. This correction allows feedback between the neutronic and thermal and hydraulic characteristics to be taken into account, while maintaining a reactor in a critical condition by a change of the concentration of dissolved boron. The constants of the physical zones are calculated by approximating formulas that take into account their dependence on density and temperature of coolant, temperature of fuel, concentration of dissolved boron, and concentration of xenon, samarium, and burnup. The program PARSEC determines approximating coefficients according to input sets of macroconstants and number of approximating intervals.

As the main cell (fuel assembly) program, the well-known code WIMS/D4 (in modified version) is used. Program WIMS forms a binary file, used by the program PARSEC. Two more programs, AVERAGE and CREDE2, are used to prepare auxiliary information for every cell.

The complex (or system) contains a great many programs, facilitating preparation and input of the source information. The calculation results are output in digital and graphics modes. The output module is based on a graphics package similar to GRAFOR. This module is supplemented by units for calculation of such important VVER characteristics as nonuniformity factor, isotopic structure of spent fuel, conversion ratio, effective delayed neutron fraction, and other parameters.

3.10 TRIANG-PIN CODE

The TRIANG-PIN code is used to perform 2-D, pin-by-pin calculations at various time intervals. The calculations are carried out for the layers throughout the height of the core in which the maximum of volumetric power density is expected.

This code was created on the base of the TRIANG-PWR code, which was designed for 3-D calculations of MOX-fueled VVER reactors.

The algorithm includes these points:

1. The 3-D (Z, hex-geometry) burning computation uses the TRIANG-PWR code with rough mesh (7 or 19 nodes per fuel assembly) and macroconstants fixed within assemblies. The 3-D calculation at every time step provides the parameters that are necessary for 2-D, pin-by-pin calculation:
   - linear power [MW(t)/cm] of the layer calculated,
   - critical boron content in water (ppm),
   - water temperature in a layer for every assembly, and
   - neutron leakage (or source) through the layer bottom and top faces for every assembly.
2. The macroconstants and approximations for all types of fuel pins are calculated using codes WIMS and PARSEC. The macroconstants of the other core structural elements [burnable poison (BP) rods, "water holes"] are calculated also. Adsorber pins of control rods are taken into account by means of effective boundary conditions.
3. For a beginning-of-life (BOL) cycle, the pin-by-pin 2-D diffusion calculation is performed; in doing so, the macroconstants are fixed within assemblies. Initial burnup (power production) in every assembly needed for macroconstant calculation is set by a user.
4. Using the calculated pin-by-pin power distribution and the information transmitted from 3-D calculation (see item 1) as a base, the next parameters are determined for every node (fuel pin):
   - water temperature (power distribution below the layer is assumed to be the same as in the layer),
   - water density,
   - boron concentration (nuclear density),
   - fuel temperature, and
   - ^{135}Xe concentration.
5. The macroconstants are calculated from the known power production and the parameters calculated in the previous item.
6. Using the macroconstants determined in a such manner, the 2-D, pin-by-pin calculation is performed.
7. The items 4, 5, and 6 are repeated until the process is converged to within specific tolerance. In doing so, linear layer power, neutron source (leakage), boron content in water, and average layer water temperature are invariant.
8. Pin-by-pin power production and ^{149}Sm concentration as well as ^{10}B concentration in boric BP are calculated at time step Δt. The boron content in water, layer water temperature, and neutron source (leakage) for every assembly are taken from 3-D calculations corresponding to this instant of time.
9. Iterative process according to items 4, 5, and 6 is performed similarly to item 7.
10. Items 8 and 9 are performed for a specified number of time steps.
11. If the reloading mode is on, the macroconstants of the fresh fuel rods are calculated. Then the algorithm governing the fuel assembly rearrangement is brought into use. If the reloading mode is off, the computation is stopped.
12. The calculation according to items 6–11 for specified time steps is performed.
13. The next assembly rearrangement is made, and it is checked if changes in positions occur. If so, items 11 and 12 are repeated; otherwise, the task is finished.
14. The main results of 2-D, pin-by-pin calculations are

    (a) K_Q^L = maximum value of power density nonuniformity over assemblies (power peaking factor) in layer L,

$$K_Q^L = \max\left(K_{Q_m}^L\right),$$

$$K_{Q_m}^L = \frac{Q_m^L}{\overline{Q^L}},$$

where

Q_m^L = specific power in mth assembly,

$\overline{Q^L} = \dfrac{\sum_m Q_m^L \cdot V_m}{\sum V_m}$ = average specific power within core,

V_m = volume of mth assembly.

(b) K_{Km} = maximum value of power density nonuniformity within assembly m (power peaking factor within assembly m),

$$K_{Km} = \max\left(K_{Kim}\right),$$

where

$$K_{Kim} = \frac{q_{im}}{\overline{q_m}},$$

q_{im} = specific power in ith fuel rod of mth assembly,

$\overline{q_m}$ = average specific power in fuel rod of mth assembly.

The values mentioned above may be determined at every time step.

3.11 MAYAK—A COMPUTER PROGRAM TO LINK TRANSPORT AND DEPLETION COMPUTER PROGRAMS (A. A. Tsyboulia)

MAYAK makes possible the joint use of some transport codes (TWODANT, KENO, and, eventually, MCNP) with burnup codes (ORIGEN and CARE). The program is intended for use with the Russian cross section library BNAB and the nuclear constant processing system CONSYST. MAYAK receives information about averaged fluxes and volumes of the geometric zones in the computational model from a transport code. CONSYST provides MAYAK with isotopic and microscopic cross sections. Some external libraries are also used. MAYAK formats the information for the burnup code and provides the interaction of different parts of the program complex. The transport, depletion, and MAYAK codes are driven by a system of batch files that provide the possibility of multistep burnup calculations.

MAYAK calculates weighted cross sections and reaction rates and writes these values to external files. One of these files contains a set of balance tables, some of which are reproduced in this document. Balance tables are generated for every "physical zone" for each material from CONSYST output.

3.12 INPUT DATASETS

The input datasets for all calculations reported herein are stored on a diskette attached to the back cover of this report. The datasets are in directories whose names correspond to the section numbers of this report. The diskette is in DOS format, and the files are ASCII text files.

REFERENCES

1. MCU-RFFI/A is a proprietary computer program For purchasing the code, call E. A. Gomin (telephone: 095 1969811, E-mail address: gomin@atis.kiae.su).

2. M. A. Kalugin and L. V. Maiorov, "Application of the Monte Carlo Method for Analyzing the JGR Reactor Experiment," *Proceedings of the 1996 Topical Meeting on Radiation Protection and Shielding, North Falmouth, Massachusetts, April 21–25, 1996*, American Nuclear Society, April 1996.

3. Yigal Ronen, ed., *CRC Handbook of Nuclear Reactor Calculations, Volume III*, CRC Press, Inc., 1986, p. 278.

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4. COMPUTATIONAL BENCHMARKS FOR VERIFICATION AND VALIDATION OF COMPUTER PROGRAMS

Verification, in the context of neutron physics computer programs, is the process of ensuring that the software solves the problem that was intended to be solved. That is, the encoded algorithms produce an accurate approximation to the true solution for the problem. Verification of neutron physics software should be performed in such a manner so as to be independent of the nuclear data that are input to the analyses and independent of any measurement uncertainty for physical systems. Consequently, physicist-created analytical problems and computational benchmarks provide the mechanisms for verifying computer programs.

Problems for which there are analytical solutions provide the most precise verification of a computer program. However, most practical problems are too complex to be solved by an analytical solution. Otherwise, a computer program would never have been written and there would be no program to verify. Therefore, verification of the coded algorithms is achieved by using multiple computer programs of independent authorship to solve the same problem with the same nuclear data library. The greater the number of programs used in the solution of the problem, the higher the degree of confidence in the verification procedure.

During November 1996, delegations from the United States and Russia agreed to conduct code verification studies using two computational benchmarks. A pressurized-water reactor (PWR) computational benchmark was submitted by the United States. A VVER computational benchmark was submitted by the Russian Federation. Using the computer programs and data libraries described in Chap. 3, reactor physics parameters were calculated for these benchmarks and are reported in this section.

In these studies, the nuclear data libraries did not have a common source. Furthermore, the numerical algorithms in the programs were different—three employing the Monte Carlo method of modeling neutron transport and the other based on discrete ordinates transport theory. The difference in theoretical bases is permissible provided the results from the programs are in good agreement. Poor agreement would leave the user with no guidance as to where errors might be. The differing sources of nuclear data are a more difficult problem. To account for data differences, it is necessary to couple results from experimental measurements (discussed in Chap. 5) with those presented in this chapter.

4.1 DESCRIPTION OF THE PWR COMPUTATIONAL BENCHMARK (J. C. Gehin)

4.1.1 Introduction

These benchmark specifications are designed to provide a simple calculational benchmark problem for a mixed-oxide lattice that is typical of that which might be used for fissile materials disposition. The model chosen was that of a PWR in a 17 by 17 assembly lattice of pins all of which have the same initial composition. The assembly contains 24 control rod guide tubes, some of which may contain annular BP rods at various times during the assembly irradiation. A central instrumentation channel is also present.

Several calculations are to be performed at BOL to provide k_{eff}, the pin power distribution, and isotopic reaction rates. BOL calculations will be performed at cold zero power (CZP), hot zero power (HZP), and hot full power (HFP) with various soluble boron concentrations. A three-cycle irradiation is performed to a discharge burnup of 45 GWd/MTHM. The k_{eff}, pin power distribution, reaction rates, and isotopic concentrations are to be provided at the middle and end of each cycle.

4.1.2 Benchmark Specifications

4.1.2.1 Geometry data

The geometry is typical of a U.S. PWR assembly and is shown in Fig. 4.1. The lattice consists of a 17 by 17 array with 24 guide tubes containing water or BP rods and 1 instrumentation tube. The geometric specifications are presented in Tables 4.1 and 4.2. The basic geometry description was taken from Ref. 1.

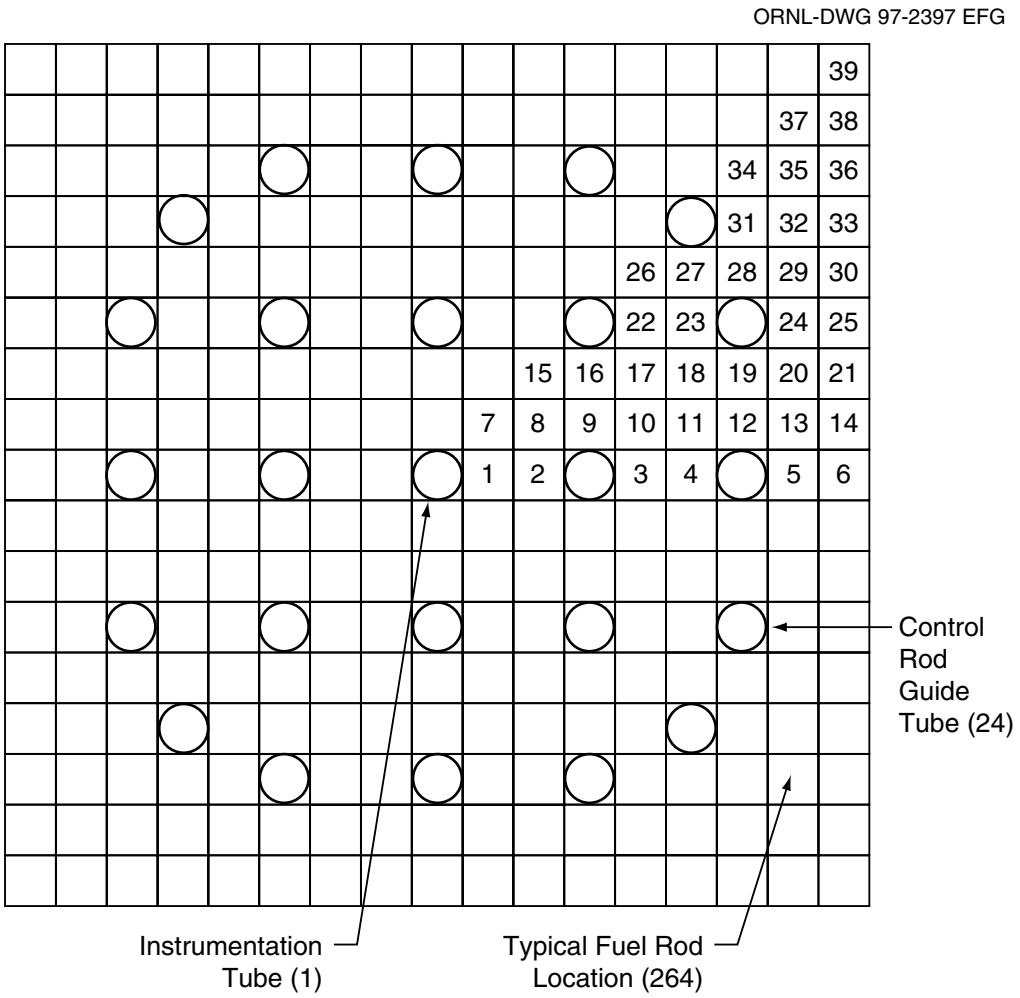

Fig. 4.1. PWR lattice geometry. When present, BP rod locations are the same as for the guide tubes.

Table 4.1. General assembly data

Parameter	Value
Lattice	17 by 17
Number of fuel pins	264
Number of guide tubes	24
Number of instrumentation tubes	1
Assembly pitch, cm	21.41728
Pin pitch, cm	1.25984
Fuel rod	
Pellet diameter, cm	0.81915
Clad inside diameter, cm	0.83566
Clad outside diameter, cm	0.94996
Pellet stack density, % TD	94.5
Clad material	Zircaloy-4
Active fuel length, cm	365.76
Guide tubes	
Inside diameter, cm	1.143
Outside diameter, cm	1.224
Material	Zircaloy-4

Table 4.2. Annular BP rod geometry specifications (axial length of 365.76 cm)

Region No.	Material	Outside diameter (cm)
1	Water	0.35
2	Zircaloy-4	0.50
3	BP (Al_2O_3-B_4C)	0.65
4	Zircaloy-4	0.80
5	Water	1.143
6 (guide tube)	Zircaloy-4	1.224

4.1.2.2 Material data

The following material data were obtained from Refs. 2 and 3. Atom densities derived from the following data using SCALE 4.3 are presented in Table 4.3.

Zircaloy-4. For simplicity, a typical Zircaloy composition is assumed.

Density, g/cm^3	6.44
Composition, wt %	
Zr	97.91
Sn	1.59
Fe	0.5

Table 4.3. BOL atom densities [atoms/(b·cm)]

Fuel		Coolant (300 K, 1200 ppm)	
O	4.63586E-02	H	6.68093E-02
^{235}U	4.50785E-05	^{10}B	1.33014E-05
^{238}U	2.22106E-02	^{11}B	5.35430E-05
^{239}Pu	8.68469E-04	O	3.34047E-02
^{240}Pu	4.60024E-05	Coolant (570 K, 0 ppm)	
^{241}Pu	9.16253E-06	H	4.87959E-02
Zircaloy-4		O	2.43980E-02
Fe	3.47236E-04	Coolant (570 K, 550 ppm)	
Zr	4.16270E-02	H	4.87691E-02
Sn	5.19451E-04	^{10}B	4.44738E-06
Burnable absorber		^{11}B	1.79023E-05
C	1.38414E-03	O	2.43846E-02
^{10}B	1.10172E-03	Coolant (570 K, 1100 ppm)	
^{11}B	4.43486E-03	H	4.87423E-02
O	2.02497E-02	^{10}B	8.89475E-06
Al	1.35036E-02	^{11}B	3.58046E-05
Coolant (300 K, 0 ppm)		O	2.43711E-02
H	6.68896E-02	Coolant (570 K, 1200 ppm)	
O	3.34448E-02	H	4.87374E-02
Coolant (300 K, 550 ppm)		^{10}B	9.70337E-06
H	6.68528E-02	^{11}B	3.90596E-05
^{10}B	6.09647E-06	O	2.43687E-02
^{11}B	2.45405E-05		
O	3.34264E-02		

Fuel.

Theoretical density,* g/cm^3	11.00
Composition, wt %	
PuO_2	4
UO_2	96
Plutonium isotopics, wt %	
^{239}Pu	94
^{240}Pu	5
^{241}Pu	1
Uranium isotopics, wt %	
^{235}U	0.2
^{238}U	99.8

Coolant/moderator. Light-water coolant density is a function of temperature as indicated below. The soluble boron concentration is given in the calculation definitions in Sect. 4.1.4 in terms of parts per million of boron by weight.

*The actual fuel density is taken to be the theoretical density multiplied by the pellet stack density given in Table 4.1.

Density, g/cm^3	1.0 at 300 K
	0.7295 at 570 K
Boron isotopics, wt %	
^{10}B	18.43
^{11}B	81.57

Burnable poison. The BP consists of Al_2O_3–B_4C with the following composition:

Density, g/cm^3	1.27
Composition, wt %	
Al_2O_3	90
B_4C	10 (natural boron, isotopics as stated above)

4.1.3 Modeling Instructions

Using the specifications given in Sect. 4.1.2, the 2-D calculations are to be performed to provide key quantities given in Sect. 4.1.4 at the reactor midplane. The assembly is assumed to be in an infinite array of similar assemblies so that reflective boundary conditions can be used. Also, note that the assembly geometry is symmetric such that only one- fourth or one-eighth of the assembly needs to be modeled. In the 2-D calculations, the buckling height is taken to be that of the active height of the fuel (365.76 cm).

The assembly power is 17.5 MW and is assumed to be constant over the entire irradiation period. In the CZP condition, all temperatures are 300 K. In the HZP condition, all temperatures are 570 K. In the HFP condition, the average fuel temperature is 1100 K, the clad temperature is 620 K, and the coolant temperature is 570 K. In the HFP condition, equilibrium xenon effects are included, and the soluble boron concentration is reduced to offset some of the reactivity loss from the xenon. The guide tubes and BP rods have the same temperature as the coolant in all conditions. For Monte Carlo calculations of the BOL cases at HFP, the xenon concentrations should be obtained from the methods employed for the burnup calculations.

4.1.4 Calculational Definitions and Desired Results

4.1.4.1 Beginning-of-life (BOL) calculations

Table 4.4 lists calculations that are to be performed at BOL with fresh fuel material. The calculations are to be performed both for the assembly configuration with only water in the guide tubes and with BP rods in the guide tubes.

The desired results for the BOL calculations are:

1. ratio of total neutron production to total absorption;
2. effective multiplication factor (k_{eff});
3. pin power distribution;
4. total capture and fission rates and fraction of the total capture and fission rates by ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{135}Xe in each pin; and
5. the ^{135}Xe concentration in each pin for the HFP cases only.

4.1.4.2 Burnup calculations

A three-cycle irradiation of the assembly is to be performed in HFP conditions using a constant soluble boron concentration of 550 ppm. Each cycle burnup is 15 GWd/MTHM and results in a discharge burnup of 45 GWd/MTHM. The BP rods are present in the first cycle and are removed for

Table 4.4. Conditions for BOL calculations to be performed with guide tube assembly and BP rod assembly

Calculation	BP rods present?	Operational condition	Boron concentration (ppm)
BOL1	No	CZP	1200
BOL2	Yes	CZP	1200
BOL3	No	HZP	1200
BOL4	Yes	HZP	1200
BOL5	No	HFP	1100
BOL6	Yes	HFP	1100
BOL7	No	HFP	550
BOL8	Yes	HFP	550
BOL9	No	HFP	0
BOL10	Yes	HFP	0

the subsequent two cycles (the guide tubes remain). The following results are desired at each 1.5 GWd/MTHM increment (30 intervals over the three-cycle irradiation):

1. ratio of total neutron production to total absorption;
2. effective multiplication factor (k_{eff});
3. total capture and fission rates and fraction of the total capture and fission rates by ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{135}Xe, and total FPs for the entire assembly; and
4. U, Np, Pu, Am, and Cm content (mass) and isotopics for the entire assembly.

In addition, at each 7.5 GWd/MTHM increment (middle and end of cycle) the following quantities are desired (six intervals over the three-cycle irradiation):

5. pin power distribution;
6. total capture and fission rates and fraction of the total capture and fission rates by ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{135}Xe, and total FPs in each pin; and
7. U, Np, Pu, Am, and Cm content and isotopics in each pin.

4.1.4.3 End-of-life (EOL) calculations

Using the EOL conditions from Sect. 4.1.4.2, the calculations given in Table 4.5 can be performed. For the EOL cases, the ratio of production to absorption and the effective multiplication factor (k_{eff}) are to be calculated.

Table 4.5. Conditions for EOL calculations

Calculation	Operational condition	Boron concentration (ppm)	Other conditions
EOL1	HFP	1100	None
EOL2	HFP	550	No FPs
EOL3	HFP	550	No ^{135}Xe
EOL4	HFP	0	None
EOL5	CZP	1200	None
EOL6	CZP	550	None
EOL7	CZP	0	None

4.2 CALCULATED REACTOR PHYSICS PARAMETERS FOR THE PWR BENCHMARK

Because of a lack of depletion capability with both the Monte Carlo theory computer programs and the discrete ordinates program, TWODANT, only BOL calculations were performed.

4.2.1 Monte Carlo (MCU) Calculations (M. Kalugin and L. Maiorov)

4.2.1.1 Description of problem and procedure

The PWR calculational benchmarks BOL1–BOL4 were calculated using the MCU-RFFI/A Monte Carlo code with the MCUDAT library. The material data used in MCU calculations are presented in Table 4.6.

4.2.1.2 Calculational results

The MCU results of the k_{eff} calculation are given in Table 4.7.

The relative fission rates of cells were calculated. The rod number map is shown in Table 4.8.

The fission rate distributions are given in Tables 4.9–4.12. The results are normalized to the average cell fission rate of 1.

Table 4.6. Material data in 10^{24} atoms/cm^3 units

Zircaloy-4		Coolant/moderator (300 K, 1200 ppm B)	
Zr	0.41625E–1	H	0.66856E–1
Sn	0.51945E–3	O	0.33428E–1
Fe	0.34722E–3	^{10}B	0.13301E–4
Fuel		^{11}B	0.53543E–4
^{239}Pu	0.86841E–3	Coolant/moderator (570 K, 1200 ppm B)	
^{240}Pu	0.45999E–4	H	0.48771E–1
^{241}Pu	0.91616E–5	O	0.24386E–1
O	0.18471E–2	^{10}B	0.97033E–5
^{235}U	0.45076E–4	^{11}B	0.39059E–4
^{238}U	0.22209E–1		
O	0.44508E–1		
BP rods			
Al	0.13502E–1		
O	0.20253E–1		
^{10}B	0.11017E–2		
^{11}B	0.44348E–2		
C	0.13841E–2		

Table 4.7. The k_{eff} calculational results[a]

Variant	BOL1	BOL2	BOL3	BOL4
k_{eff}	1.3082	1.2373	1.2705	1.2017

[a]MCU statistical errors are about 0.1%.

Table 4.8. U.S. PWR computational benchmark variant map

								39
							37	38
						34	35	36
					0	31	32	33
				26	27	28	29	30
			0	22	23	0	24	25
		15	16	17	18	19	20	21
	7	8	9	10	11	12	13	14
0	1	2	0	3	4	0	5	6

Note: Map contains rod numbers. The BP rod positions are numbered by zeros.

Table 4.9. BOL1 fission rates

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
1	1.055	2	1.074	3	1.077	4	1.070	5	1.057
6	0.936	7	0.995	8	0.999	9	1.072	10	0.995
11	0.979	12	1.052	13	0.974	14	0.922	15	1.014
16	1.079	17	1.003	18	1.002	19	1.062	20	0.977
21	0.933	22	1.083	23	1.096	24	1.048	25	0.913
26	1.052	27	1.126	28	1.100	29	0.986	30	0.912
31	1.057	32	0.921	33	0.910	34	0.975	35	0.913
36	0.908	37	0.895	38	0.895	39	0.879		

Table 4.10. BOL2 fission rates

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
1	1.117	2	1.037	3	1.010	4	1.029	5	0.999
6	0.989	7	1.044	8	1.012	9	1.022	10	0.972
11	1.010	12	1.013	13	1.005	14	0.969	15	1.001
16	1.002	17	0.995	18	0.988	19	1.005	20	0.982
21	0.992	22	1.017	23	1.020	24	1.014	25	0.996
26	1.005	27	1.015	28	1.013	29	0.988	30	0.977
31	1.015	32	0.980	33	0.970	34	0.988	35	0.974
36	0.952	37	0.964	38	0.950	39	0.970		

Table 4.11. BOL3 fission rates

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
1	1.066	2	1.060	3	1.070	4	1.064	5	1.037
6	0.941	7	1.021	8	1.026	9	1.080	10	0.998
11	1.015	12	1.057	13	0.985	14	0.929	15	1.026
16	1.077	17	1.012	18	1.003	19	1.060	20	0.990
21	0.916	22	1.088	23	1.078	24	1.031	25	0.920
26	1.052	27	1.121	28	1.075	29	0.981	30	0.917
31	1.040	32	0.949	33	0.918	34	0.954	35	0.910
36	0.890	37	0.898	38	0.875	39	0.875		

Table 4.12. BOL4 fission rates

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
1	1.111	2	1.010	3	1.010	4	1.014	5	0.997
6	0.969	7	1.042	8	1.028	9	1.013	10	1.003
11	0.997	12	0.999	13	0.990	14	0.980	15	1.008
16	1.018	17	1.006	18	0.994	19	1.014	20	0.992
21	0.991	22	1.023	23	1.008	24	1.016	25	0.984
26	1.006	27	1.028	28	1.015	29	0.992	30	0.970
31	1.017	32	0.972	33	0.974	34	0.992	35	0.962
36	0.964	37	0.964	38	0.963	39	0.961		

4.2.2 Discrete Ordinates and Monte Carlo Calculations (T. I. Bagretsova, Z. N. Chizhikova, V. M. Dekoussar, G. M. Jerdev, A. G. Kalashnikov, E. N. Kapranova, V. E. Korobitsin, G. N. Manturov, A. L. Moseev, M. N. Nikolaev, Y. V. Rozhikhin, M. Y. Semenov, A. A. Tsyboulia, and A. M. Tsiboulia)

Calculations of the PWR MOX benchmark problem have been performed with the TWODANT (CCC-547) code in discrete ordinate transport theory for the BOL1, BOL2, BOL3, and BOL4 cases. In addition, Monte Carlo calculations were performed using the KENO-V.a (CCC-545) code. MCNP4A (CCC-200) calculations have been performed using the ENDF/B-V (DLC-105) libraries for the purpose of comparison. The multiplication factor results for the calculated cases are summarized in Table 4.13. Tabulations of all the results requested in the benchmark specifications are given in Tables 4.14–4.21.

Table 4.13. Multiplication factors for BOL cases

Case	BP rods present	Operational condition[a]	Boron concentration (ppm)	k_{eff}		
				TWODANT	KENO[b]	MCNP[c]
BOL1	No	CZP	1200	1.3007	1.3031	1.3064
BOL2	Yes	CZP	1200	1.2241	1.2341	1.2358
BOL3	No	HZP	1200	1.2593	1.2729	1.2650
BOL4	Yes	HZP	1200	1.1842	1.2016	1.1931

[a]CZP = cold, zero power; HZP = hot, zero power.
[b]Statistical uncertainty (one standard deviation) is 0.0002.
[c]Statistical uncertainty (one standard deviation) is 0.0007.

Table 4.14. Case BOL1 WIMS-TWODANT results[a,b]

Pin	Relative pin power	Total capture rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu
1	1.0715	2.4006E+15	0.00596	0.32163	0.40450	0.09019	0.00363	2.1113E+15	0.02750	0.05006	0.90971	0.00055	0.01219
2	1.0717	2.4008E+15	0.00596	0.32161	0.40451	0.09019	0.00363	2.1116E+15	0.02750	0.05008	0.90969	0.00055	0.01219
3	1.0714	2.4009E+15	0.00596	0.32172	0.40445	0.09020	0.00363	2.1109E+15	0.02750	0.04997	0.90979	0.00055	0.01219
4	1.0692	2.3972E+15	0.00596	0.32208	0.40420	0.09023	0.00362	2.1067E+15	0.02749	0.05025	0.90952	0.00055	0.01219
5	1.0402	2.3517E+15	0.00595	0.32612	0.40156	0.09083	0.00359	2.0496E+15	0.02742	0.05125	0.90859	0.00056	0.01217
6	0.9265	2.1654E+15	0.00591	0.34401	0.38924	0.09270	0.00345	1.8254E+15	0.02721	0.05802	0.90201	0.00064	0.01213
7	1.0038	2.2899E+15	0.00595	0.33158	0.39766	0.09100	0.00355	1.9777E+15	0.02743	0.05319	0.90661	0.00059	0.01218
8	1.0041	2.2903E+15	0.00595	0.33154	0.39767	0.09099	0.00355	1.9784E+15	0.02743	0.05321	0.90658	0.00059	0.01218
9	1.0722	2.4017E+15	0.00596	0.32156	0.40455	0.09018	0.00363	2.1126E+15	0.02750	0.05006	0.90970	0.00055	0.01219
10	1.0042	2.2912E+15	0.00595	0.33159	0.39767	0.09100	0.00355	1.9785E+15	0.02744	0.05304	0.90675	0.00058	0.01219
11	1.0024	2.2880E+15	0.00595	0.33192	0.39743	0.09101	0.00355	1.9750E+15	0.02743	0.05338	0.90643	0.00059	0.01218
12	1.0632	2.3888E+15	0.00596	0.32293	0.40372	0.09035	0.00362	2.0949E+15	0.02749	0.05003	0.90974	0.00055	0.01219
13	0.9773	2.2488E+15	0.00594	0.33577	0.39493	0.09156	0.00352	1.9256E+15	0.02737	0.05429	0.90557	0.00060	0.01217
14	0.9217	2.1586E+15	0.00591	0.34475	0.38878	0.09283	0.00345	1.8160E+15	0.02721	0.05780	0.90222	0.00064	0.01213
15	1.0048	2.2916E+15	0.00595	0.33144	0.39777	0.09098	0.00356	1.9797E+15	0.02744	0.05305	0.90674	0.00058	0.01219
16	1.0742	2.4050E+15	0.00596	0.32129	0.40472	0.09014	0.00363	2.1165E+15	0.02750	0.04994	0.90982	0.00055	0.01219
17	1.0076	2.2966E+15	0.00595	0.33111	0.39797	0.09092	0.00356	1.9853E+15	0.02745	0.05293	0.90685	0.00058	0.01219
18	1.0064	2.2943E+15	0.00595	0.33135	0.39781	0.09091	0.00356	1.9828E+15	0.02744	0.05316	0.90663	0.00058	0.01219
19	1.0663	2.3938E+15	0.00596	0.32252	0.40396	0.09028	0.00362	2.1010E+15	0.02750	0.04994	0.90982	0.00055	0.01219
20	0.9784	2.2504E+15	0.00594	0.33563	0.39501	0.09153	0.00352	1.9277E+15	0.02737	0.05433	0.90553	0.00060	0.01217
21	0.9217	2.1589E+15	0.00591	0.34476	0.38879	0.09283	0.00345	1.8160E+15	0.02722	0.05766	0.90235	0.00064	0.01214
22	1.0873	2.4265E+15	0.00597	0.31967	0.40581	0.08982	0.00364	2.1424E+15	0.02755	0.04931	0.91040	0.00054	0.01220
23	1.0909	2.4323E+15	0.00597	0.31928	0.40610	0.08973	0.00365	2.1494E+15	0.02755	0.04917	0.91053	0.00054	0.01220
24	1.0433	2.3570E+15	0.00595	0.32574	0.40183	0.09075	0.00359	2.0556E+15	0.02744	0.05100	0.90882	0.00056	0.01218
25	0.9260	2.1647E+15	0.00591	0.34415	0.38913	0.09269	0.00345	1.8245E+15	0.02721	0.05816	0.90187	0.00064	0.01213
26	1.0631	2.3861E+15	0.00597	0.32331	0.40329	0.08973	0.00362	2.0946E+15	0.02758	0.05021	0.90944	0.00055	0.01222
27	1.1249	2.4883E+15	0.00598	0.31484	0.40917	0.08909	0.00369	2.2164E+15	0.02764	0.04710	0.91251	0.00052	0.01223
28	1.1048	2.4563E+15	0.00597	0.31745	0.40744	0.08950	0.00366	2.1768E+15	0.02759	0.04801	0.91166	0.00053	0.01221
29	0.9761	2.2477E+15	0.00594	0.33607	0.39478	0.09157	0.00352	1.9231E+15	0.02738	0.05403	0.90582	0.00060	0.01218
30	0.9165	2.1513E+15	0.00591	0.34572	0.38817	0.09295	0.00344	1.8058E+15	0.02721	0.05783	0.90220	0.00064	0.01213
31	1.0614	2.3860E+15	0.00596	0.32334	0.40343	0.09031	0.00362	2.0912E+15	0.02749	0.05017	0.90960	0.00055	0.01219
32	0.9332	2.1776E+15	0.00592	0.34305	0.38995	0.09248	0.00346	1.8387E+15	0.02725	0.05715	0.90282	0.00063	0.01214
33	0.9044	2.1315E+15	0.00590	0.34780	0.38678	0.09324	0.00342	1.7819E+15	0.02716	0.05875	0.90132	0.00065	0.01212
34	0.9670	2.2322E+15	0.00593	0.33759	0.39368	0.09175	0.00351	1.9053E+15	0.02733	0.05522	0.90468	0.00061	0.01216
35	0.9110	2.1424E+15	0.00591	0.34681	0.38744	0.09303	0.00343	1.7949E+15	0.02719	0.05842	0.90163	0.00064	0.01213
36	0.8953	2.1176E+15	0.00590	0.34946	0.38570	0.09344	0.00341	1.7641E+15	0.02714	0.05916	0.90093	0.00065	0.01212
37	0.8958	2.1189E+15	0.00590	0.34941	0.38578	0.09342	0.00341	1.7650E+15	0.02715	0.05888	0.90120	0.00065	0.01212
38	0.8895	2.1083E+15	0.00590	0.35054	0.38498	0.09354	0.00340	1.7527E+15	0.02712	0.05962	0.90050	0.00066	0.01211
39	0.8864	2.1039E+15	0.00590	0.35109	0.38468	0.09360	0.00340	1.7465E+15	0.02712	0.05939	0.90072	0.00066	0.01212
Assembly total		6.2330E+17	0.00575	0.32161	0.38463	0.08835	0.00343	5.2016E+17	0.02739	0.05329	0.90656	0.00059	0.01217

[a]Total production/total absorption = 1.30377.

[b]Multiplication factor (k_{eff}) = 1.30070.

Table 4.15. Case BOL2 WIMS-TWODANT results[a,b]

Pin	Relative pin power	Total capture rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu
1	1.1265	2.5525E+15	0.00594	0.32696	0.40113	0.09113	0.00358	2.2195E+15	0.02739	0.05130	0.90858	0.00057	0.01217
2	1.0290	2.4005E+15	0.00588	0.34054	0.39258	0.09379	0.00346	2.0274E+15	0.02702	0.05577	0.90449	0.00062	0.01211
3	1.0101	2.3725E+15	0.00587	0.34350	0.39070	0.09438	0.00344	1.9901E+15	0.02695	0.05648	0.90385	0.00062	0.01210
4	1.0097	2.3726E+15	0.00587	0.34381	0.39047	0.09439	0.00343	1.9894E+15	0.02694	0.05676	0.90358	0.00063	0.01209
5	1.0036	2.3642E+15	0.00587	0.34531	0.38943	0.09440	0.00342	1.9773E+15	0.02694	0.05722	0.90311	0.00063	0.01209
6	0.9795	2.3178E+15	0.00590	0.34972	0.38559	0.09360	0.00341	1.9299E+15	0.02710	0.05959	0.90055	0.00066	0.01211
7	1.0495	2.4269E+15	0.00593	0.33787	0.39366	0.09209	0.00350	2.0679E+15	0.02730	0.05475	0.90518	0.00060	0.01216
8	1.0083	2.3629E+15	0.00590	0.34393	0.38980	0.09332	0.00345	1.9866E+15	0.02714	0.05674	0.90337	0.00063	0.01213
9	1.0125	2.3755E+15	0.00587	0.34299	0.39101	0.09432	0.00344	1.9949E+15	0.02696	0.05640	0.90392	0.00062	0.01210
10	0.9957	2.3451E+15	0.00589	0.34602	0.38849	0.09374	0.00343	1.9619E+15	0.02709	0.05711	0.90304	0.00063	0.01213
11	0.9956	2.3455E+15	0.00589	0.34630	0.38827	0.09374	0.00343	1.9616E+15	0.02708	0.05743	0.90273	0.00063	0.01212
12	1.0086	2.3729E+15	0.00587	0.34426	0.39023	0.09441	0.00343	1.9873E+15	0.02695	0.05647	0.90385	0.00062	0.01210
13	0.9903	2.3387E+15	0.00589	0.34772	0.38731	0.09375	0.00342	1.9512E+15	0.02708	0.05787	0.90228	0.00064	0.01212
14	0.9783	2.3165E+15	0.00590	0.34991	0.38548	0.09361	0.00341	1.9275E+15	0.02711	0.05925	0.90087	0.00065	0.01212
15	1.0003	2.3511E+15	0.00590	0.34513	0.38906	0.09360	0.00344	1.9708E+15	0.02711	0.05689	0.90324	0.00063	0.01213
16	1.0114	2.3742E+15	0.00587	0.34318	0.39090	0.09436	0.00344	1.9928E+15	0.02695	0.05640	0.90393	0.00062	0.01210
17	0.9966	2.3470E+15	0.00589	0.34594	0.38854	0.09374	0.00343	1.9637E+15	0.02709	0.05711	0.90304	0.00063	0.01213
18	0.9970	2.3483E+15	0.00589	0.34617	0.38838	0.09374	0.00343	1.9643E+15	0.02709	0.05732	0.90283	0.00063	0.01212
19	1.0100	2.3757E+15	0.00587	0.34417	0.39029	0.09441	0.00343	1.9900E+15	0.02695	0.05646	0.90386	0.00062	0.01210
20	0.9913	2.3408E+15	0.00589	0.34769	0.38733	0.09375	0.00342	1.9531E+15	0.02708	0.05794	0.90222	0.00064	0.01212
21	0.9788	2.3182E+15	0.00590	0.34994	0.38548	0.09361	0.00341	1.9286E+15	0.02711	0.05915	0.90097	0.00065	0.01212
22	1.0143	2.3812E+15	0.00587	0.34307	0.39104	0.09438	0.00344	1.9985E+15	0.02695	0.05614	0.90418	0.00062	0.01210
23	1.0159	2.3853E+15	0.00587	0.34313	0.39102	0.09438	0.00344	2.0017E+15	0.02695	0.05618	0.90415	0.00062	0.01210
24	1.0060	2.3702E+15	0.00587	0.34530	0.38946	0.09440	0.00342	1.9822E+15	0.02695	0.05712	0.90321	0.00063	0.01209
25	0.9814	2.3224E+15	0.00590	0.34984	0.38549	0.09359	0.00341	1.9336E+15	0.02709	0.05976	0.90038	0.00066	0.01211
26	1.0102	2.3735E+15	0.00589	0.34417	0.39005	0.09386	0.00344	1.9904E+15	0.02706	0.05615	0.90405	0.00062	0.01213
27	1.0236	2.4017E+15	0.00587	0.34211	0.39201	0.09452	0.00344	2.0168E+15	0.02693	0.05510	0.90526	0.00061	0.01211
28	1.0200	2.3963E+15	0.00586	0.34306	0.39131	0.09452	0.00344	2.0096E+15	0.02692	0.05572	0.90464	0.00062	0.01210
29	0.9926	2.3457E+15	0.00589	0.34802	0.38715	0.09374	0.00342	1.9557E+15	0.02709	0.05774	0.90241	0.00064	0.01212
30	0.9797	2.3221E+15	0.00590	0.35038	0.38519	0.09360	0.00341	1.9304E+15	0.02712	0.05925	0.90086	0.00066	0.01212
31	1.0120	2.3822E+15	0.00587	0.34476	0.38989	0.09438	0.00343	1.9939E+15	0.02695	0.05680	0.90353	0.00063	0.01210
32	0.9849	2.3316E+15	0.00590	0.34977	0.38564	0.09357	0.00341	1.9405E+15	0.02711	0.05919	0.90093	0.00065	0.01212
33	0.9782	2.3204E+15	0.00590	0.35102	0.38471	0.09360	0.00340	1.9274E+15	0.02711	0.05976	0.90036	0.00066	0.01211
34	0.9927	2.3463E+15	0.00589	0.34853	0.38669	0.09371	0.00341	1.9560E+15	0.02707	0.05871	0.90146	0.00065	0.01211
35	0.9808	2.3256E+15	0.00590	0.35089	0.38481	0.09356	0.00340	1.9324E+15	0.02710	0.05983	0.90030	0.00066	0.01211
36	0.9772	2.3202E+15	0.00590	0.35166	0.38428	0.09358	0.00340	1.9254E+15	0.02710	0.06006	0.90006	0.00066	0.01211
37	0.9777	2.3219E+15	0.00590	0.35172	0.38427	0.09358	0.00340	1.9263E+15	0.02711	0.05990	0.90022	0.00066	0.01211
38	0.9767	2.3204E+15	0.00590	0.35209	0.38397	0.09356	0.00339	1.9244E+15	0.02710	0.06036	0.89977	0.00067	0.01211
39	0.9761	2.3207E+15	0.00590	0.35236	0.38385	0.09356	0.00339	1.9233E+15	0.02711	0.06011	0.90000	0.00067	0.01211
Assembly total		6.9371E+17	0.00527	0.330999	0.34775	0.08402	0.00307	5.2016E+17	0.02705	0.05755	0.90265	0.00064	0.01211

[a]Total production/total absorption = 1.22709.

[b]Multiplication factor (k_{eff}) = 1.22412.

Table 4.16. Case BOL3 WIMS-TWODANT results[a,b]

Pin	Relative pin power	Total capture rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu
1	1.0696	2.5641E+15	0.00569	0.37735	0.40299	0.10060	0.00326	2.1075E+15	0.02463	0.06289	0.89996	0.00071	0.01182
2	1.0696	2.5639E+15	0.00569	0.37735	0.40299	0.10059	0.00326	2.1074E+15	0.02463	0.06291	0.89993	0.00071	0.01182
3	1.0680	2.5620E+15	0.00569	0.37765	0.40277	0.10060	0.00326	2.1042E+15	0.02464	0.06283	0.90000	0.00071	0.01182
4	1.0637	2.5544E+15	0.00569	0.37829	0.40220	0.10062	0.00326	2.0957E+15	0.02463	0.06325	0.89959	0.00071	0.01182
5	1.0316	2.5038E+15	0.00569	0.38321	0.39792	0.10110	0.00322	2.0325E+15	0.02466	0.06471	0.89809	0.00073	0.01181
6	0.9342	2.3433E+15	0.00573	0.40075	0.38251	0.10151	0.00312	1.8406E+15	0.02487	0.07192	0.89056	0.00081	0.01184
7	1.0134	2.4726E+15	0.00572	0.38699	0.39467	0.10054	0.00321	1.9967E+15	0.02480	0.06601	0.89659	0.00074	0.01186
8	1.0136	2.4728E+15	0.00572	0.38696	0.39469	0.10053	0.00321	1.9971E+15	0.02480	0.06605	0.89655	0.00074	0.01186
9	1.0697	2.5641E+15	0.00569	0.37734	0.40302	0.10057	0.00326	2.1076E+15	0.02463	0.06289	0.89996	0.00071	0.01182
10	1.0125	2.4716E+15	0.00572	0.38718	0.39455	0.10053	0.00321	1.9949E+15	0.02481	0.06589	0.89671	0.00074	0.01186
11	1.0088	2.4648E+15	0.00572	0.38778	0.39402	0.10053	0.00321	1.9877E+15	0.02480	0.06636	0.89624	0.00075	0.01185
12	1.0557	2.5432E+15	0.00569	0.37950	0.40124	0.10074	0.00325	2.0801E+15	0.02465	0.06311	0.89970	0.00071	0.01182
13	0.9799	2.4193E+15	0.00572	0.39252	0.38991	0.10098	0.00318	1.9307E+15	0.02483	0.06775	0.89481	0.00076	0.01185
14	0.9299	2.3379E+15	0.00573	0.40152	0.38186	0.10161	0.00312	1.8322E+15	0.02489	0.07170	0.89075	0.00081	0.01185
15	1.0142	2.4742E+15	0.00572	0.38684	0.39482	0.10052	0.00321	1.9984E+15	0.02480	0.06581	0.89679	0.00074	0.01186
16	1.0718	2.5675E+15	0.00569	0.37702	0.40332	0.10053	0.00327	2.1117E+15	0.02463	0.06270	0.90014	0.00070	0.01182
17	1.0161	2.4774E+15	0.00572	0.38662	0.39503	0.10045	0.00322	2.0021E+15	0.02480	0.06574	0.89686	0.00074	0.01186
18	1.0128	2.4711E+15	0.00572	0.38714	0.39460	0.10043	0.00321	1.9955E+15	0.02480	0.06606	0.89654	0.00074	0.01186
19	1.0588	2.5479E+15	0.00569	0.37903	0.40165	0.10068	0.00325	2.0861E+15	0.02465	0.06298	0.89984	0.00071	0.01182
20	0.9808	2.4205E+15	0.00572	0.39239	0.39003	0.10094	0.00318	1.9324E+15	0.02482	0.06781	0.89475	0.00076	0.01185
21	0.9296	2.3377E+15	0.00573	0.40157	0.38185	0.10160	0.00312	1.8315E+15	0.02490	0.07153	0.89092	0.00081	0.01185
22	1.0831	2.5858E+15	0.00570	0.37543	0.40480	0.10027	0.00328	2.1340E+15	0.02464	0.06198	0.90086	0.00070	0.01183
23	1.0836	2.5864E+15	0.00569	0.37533	0.40493	0.10022	0.00328	2.1351E+15	0.02464	0.06191	0.90093	0.00070	0.01183
24	1.0335	2.5069E+15	0.00569	0.38289	0.39826	0.10102	0.00323	2.0363E+15	0.02466	0.06443	0.89837	0.00073	0.01182
25	0.9324	2.3400E+15	0.00573	0.40108	0.38225	0.10148	0.00312	1.8371E+15	0.02487	0.07214	0.89034	0.00081	0.01184
26	1.0627	2.5519E+15	0.00572	0.37910	0.40182	0.09981	0.00327	2.0938E+15	0.02475	0.06278	0.89991	0.00071	0.01186
27	1.1105	2.6314E+15	0.00569	0.37118	0.40872	0.09998	0.00331	2.1881E+15	0.02461	0.05971	0.90317	0.00067	0.01183
28	1.0886	2.5962E+15	0.00569	0.37434	0.40592	0.10031	0.00328	2.1449E+15	0.02461	0.06096	0.90192	0.00069	0.01183
29	0.9762	2.4142E+15	0.00572	0.39316	0.38945	0.10096	0.00317	1.9235E+15	0.02484	0.06754	0.89500	0.00076	0.01186
30	0.9223	2.3265E+15	0.00573	0.40296	0.38069	0.10168	0.00311	1.8172E+15	0.02491	0.07190	0.89052	0.00081	0.01185
31	1.0495	2.5323E+15	0.00569	0.38043	0.40052	0.10068	0.00325	2.0678E+15	0.02466	0.06341	0.89939	0.00071	0.01182
32	0.9372	2.3494E+15	0.00573	0.40026	0.38310	0.10134	0.00313	1.8466E+15	0.02489	0.07111	0.89134	0.00080	0.01185
33	0.9082	2.3028E+15	0.00573	0.40546	0.37849	0.10188	0.00309	1.7894E+15	0.02492	0.07306	0.88936	0.00082	0.01184
34	0.9656	2.3949E+15	0.00572	0.39500	0.38778	0.10105	0.00316	1.9025E+15	0.02483	0.06904	0.89351	0.00078	0.01184
35	0.9135	2.3114E+15	0.00573	0.40460	0.37928	0.10172	0.00310	1.7999E+15	0.02491	0.07282	0.88960	0.00082	0.01184
36	0.8966	2.2847E+15	0.00573	0.40766	0.37661	0.10204	0.00308	1.7667E+15	0.02493	0.07379	0.88861	0.00083	0.01184
37	0.8963	2.2848E+15	0.00573	0.40771	0.37662	0.10204	0.00308	1.7660E+15	0.02494	0.07350	0.88889	0.00083	0.01184
38	0.8884	2.2709E+15	0.00573	0.40922	0.37525	0.10213	0.00306	1.7504E+15	0.02493	0.07456	0.88783	0.00084	0.01184
39	0.8839	2.2644E+15	0.00573	0.41002	0.37464	0.10219	0.00306	1.7415E+15	0.02495	0.07433	0.88804	0.00084	0.01184
Assembly total		6.5919E+17	0.00561	0.38184	0.38588	0.09909	0.00314	5.2016E+17	0.02477	0.06668	0.89597	0.00075	0.01184

[a]Total production/total absorption = 1.26382.

[b]Multiplication factor (k_{eff}) = 1.25933.

Table 4.17. Case BOL4 WIMS-TWODANT results[a,b]

Pin	Relative pin power	Total capture rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu
1	1.1128	2.7171E+15	0.00569	0.38551	0.39601	0.10149	0.00321	2.1926E+15	0.02466	0.06487	0.89792	0.00073	0.01182
2	1.0380	2.6027E+15	0.00570	0.39748	0.38550	0.10286	0.00312	2.0452E+15	0.02467	0.06924	0.89349	0.00078	0.01181
3	1.0180	2.5732E+15	0.00570	0.40087	0.38254	0.10330	0.00310	2.0057E+15	0.02468	0.07025	0.89247	0.00079	0.01181
4	1.0156	2.5692E+15	0.00570	0.40138	0.38209	0.10330	0.00310	2.0010E+15	0.02468	0.07065	0.89206	0.00080	0.01181
5	1.0057	2.5529E+15	0.00570	0.40322	0.38054	0.10327	0.00309	1.9815E+15	0.02470	0.07131	0.89137	0.00081	0.01181
6	0.9772	2.4973E+15	0.00573	0.40886	0.37562	0.10226	0.00307	1.9254E+15	0.02491	0.07426	0.88815	0.00084	0.01184
7	1.0489	2.6129E+15	0.00572	0.39614	0.38685	0.10151	0.00315	2.0666E+15	0.02483	0.06841	0.89412	0.00077	0.01186
8	1.0152	2.5617E+15	0.00572	0.40175	0.38188	0.10222	0.00311	2.0003E+15	0.02484	0.07049	0.89202	0.00080	0.01185
9	1.0217	2.5785E+15	0.00570	0.40016	0.38312	0.10325	0.00311	2.0131E+15	0.02467	0.07007	0.89265	0.00079	0.01181
10	1.0010	2.5414E+15	0.00572	0.40426	0.37972	0.10254	0.00309	1.9723E+15	0.02485	0.07111	0.89138	0.00081	0.01185
11	0.9990	2.5379E+15	0.00572	0.40471	0.37931	0.10253	0.00309	1.9684E+15	0.02484	0.07156	0.89094	0.00081	0.01185
12	1.0126	2.5660E+15	0.00570	0.40200	0.38164	0.10330	0.00309	1.9952E+15	0.02469	0.07039	0.89230	0.00080	0.01181
13	0.9900	2.5232E+15	0.00572	0.40645	0.37786	0.10250	0.00308	1.9505E+15	0.02487	0.07218	0.89029	0.00082	0.01185
14	0.9757	2.4959E+15	0.00573	0.40912	0.37544	0.10226	0.00307	1.9225E+15	0.02493	0.07390	0.88849	0.00084	0.01185
15	1.0073	2.5505E+15	0.00572	0.40306	0.38075	0.10242	0.00310	1.9847E+15	0.02484	0.07070	0.89180	0.00080	0.01185
16	1.0199	2.5761E+15	0.00570	0.40048	0.38286	0.10329	0.00310	2.0096E+15	0.02468	0.07010	0.89262	0.00079	0.01181
17	1.0014	2.5423E+15	0.00572	0.40425	0.37972	0.10253	0.00309	1.9731E+15	0.02485	0.07115	0.89134	0.00081	0.01185
18	1.0000	2.5399E+15	0.00572	0.40461	0.37942	0.10251	0.00309	1.9702E+15	0.02485	0.07144	0.89106	0.00081	0.01185
19	1.0136	2.5680E+15	0.00570	0.40191	0.38172	0.10330	0.00309	1.9971E+15	0.02469	0.07038	0.89231	0.00080	0.01181
20	0.9905	2.5242E+15	0.00572	0.40644	0.37786	0.10249	0.00308	1.9516E+15	0.02486	0.07230	0.89018	0.00082	0.01184
21	0.9757	2.4965E+15	0.00573	0.40918	0.37542	0.10226	0.00307	1.9225E+15	0.02494	0.07378	0.88860	0.00084	0.01185
22	1.0209	2.5799E+15	0.00570	0.40056	0.38285	0.10330	0.00310	2.0115E+15	0.02468	0.06991	0.89280	0.00079	0.01182
23	1.0209	2.5803E+15	0.00570	0.40071	0.38276	0.10329	0.00310	2.0114E+15	0.02467	0.07000	0.89272	0.00079	0.01181
24	1.0066	2.5557E+15	0.00570	0.40326	0.38054	0.10326	0.00309	1.9833E+15	0.02470	0.07122	0.89146	0.00081	0.01181
25	0.9774	2.4981E+15	0.00573	0.40906	0.37546	0.10223	0.00307	1.9258E+15	0.02491	0.07451	0.88791	0.00084	0.01184
26	1.0141	2.5674E+15	0.00571	0.40222	0.38160	0.10272	0.00310	1.9981E+15	0.02478	0.07002	0.89256	0.00079	0.01185
27	1.0281	2.5963E+15	0.00569	0.39950	0.38394	0.10347	0.00311	2.0256E+15	0.02464	0.06876	0.89400	0.00078	0.01182
28	1.0222	2.5858E+15	0.00569	0.40060	0.38296	0.10345	0.00310	2.0141E+15	0.02465	0.06955	0.89321	0.00079	0.01181
29	0.9893	2.5242E+15	0.00573	0.40691	0.37755	0.10245	0.00308	1.9493E+15	0.02488	0.07210	0.89035	0.00082	0.01185
30	0.9742	2.4952E+15	0.00574	0.40977	0.37494	0.10222	0.00306	1.9195E+15	0.02494	0.07403	0.88834	0.00084	0.01185
31	1.0115	2.5656E+15	0.00570	0.40268	0.38111	0.10323	0.00309	1.9929E+15	0.02469	0.07086	0.89183	0.00080	0.01181
32	0.9790	2.5036E+15	0.00573	0.40908	0.37555	0.10220	0.00307	1.9288E+15	0.02492	0.07395	0.88845	0.00084	0.01184
33	0.9705	2.4884E+15	0.00573	0.41054	0.37426	0.10219	0.00306	1.9122E+15	0.02495	0.07462	0.88775	0.00084	0.01184
34	0.9874	2.5194E+15	0.00572	0.40752	0.37694	0.10240	0.00307	1.9454E+15	0.02486	0.07330	0.88917	0.00083	0.01183
35	0.9725	2.4922E+15	0.00573	0.41041	0.37438	0.10215	0.00306	1.9160E+15	0.02494	0.07479	0.88759	0.00085	0.01184
36	0.9674	2.4837E+15	0.00573	0.41131	0.37363	0.10215	0.00305	1.9061E+15	0.02495	0.07506	0.88730	0.00085	0.01184
37	0.9673	2.4842E+15	0.00574	0.41140	0.37360	0.10215	0.00305	1.9058E+15	0.02496	0.07487	0.88748	0.00085	0.01184
38	0.9652	2.4799E+15	0.00573	0.41184	0.37317	0.10212	0.00305	1.9018E+15	0.02495	0.07550	0.88686	0.00085	0.01184
39	0.9636	2.4781E+15	0.00574	0.41217	0.37298	0.10211	0.00305	1.8985E+15	0.02496	0.07518	0.88716	0.00085	0.01184
Assembly total		7.3388E+17	0.00522	0.36985	0.34672	0.09383	0.00282	5.2016E+17	0.02481	0.07177	0.89077	0.00081	0.01183

[a]Total production/total absorption = 1.18853.

[b]Multiplication factor (k_{eff}) = 1.18422.

Table 4.18. Case BOL1 ABBN93-KENO-V.a results[a,b]

Pin	Relative pin power	Total capture rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu
1	1.0728	2.4105E+15	0.00598	0.31533	0.40899	0.09023	0.00353	2.1457E+15	0.02781	0.05164	0.90795	0.00057	0.01204
2	1.0731	2.4129E+15	0.00599	0.31482	0.40859	0.09078	0.00352	2.1463E+15	0.02785	0.05147	0.90809	0.00057	0.01203
3	1.0729	2.4112E+15	0.00600	0.31536	0.40822	0.09077	0.00354	2.1457E+15	0.02791	0.05161	0.90787	0.00057	0.01205
4	1.0707	2.4178E+15	0.00596	0.31647	0.40725	0.09129	0.00350	2.1414E+15	0.02782	0.05154	0.90805	0.00057	0.01202
5	1.0404	2.3660E+15	0.00595	0.31990	0.40493	0.09179	0.00348	2.0808E+15	0.02776	0.05289	0.90676	0.00058	0.01201
6	0.9310	2.1793E+15	0.00593	0.33424	0.39554	0.09369	0.00334	1.8620E+15	0.02752	0.05878	0.90109	0.00065	0.01198
7	1.0010	2.2944E+15	0.00595	0.32424	0.40197	0.09220	0.00343	2.0019E+15	0.02768	0.05523	0.90449	0.00061	0.01199
8	1.0009	2.2945E+15	0.00596	0.32339	0.40204	0.09241	0.00344	2.0019E+15	0.02770	0.05527	0.90442	0.00061	0.01201
9	1.0723	2.4116E+15	0.00599	0.31567	0.40785	0.09098	0.00353	2.1445E+15	0.02792	0.05167	0.90780	0.00057	0.01204
10	1.0003	2.2925E+15	0.00596	0.32443	0.40162	0.09197	0.00344	2.0006E+15	0.02773	0.05539	0.90426	0.00061	0.01201
11	0.9991	2.2956E+15	0.00595	0.32427	0.40125	0.09286	0.00343	1.9981E+15	0.02767	0.05528	0.90444	0.00061	0.01199
12	1.0634	2.3984E+15	0.00598	0.31699	0.40735	0.09058	0.00352	2.1269E+15	0.02788	0.05182	0.90769	0.00056	0.01205
13	0.9747	2.2544E+15	0.00594	0.32757	0.39904	0.09350	0.00340	1.9494E+15	0.02765	0.05648	0.90326	0.00062	0.01199
14	0.9207	2.1611E+15	0.00592	0.33642	0.39399	0.09337	0.00333	1.8414E+15	0.02753	0.05950	0.90037	0.00065	0.01195
15	1.0010	2.2951E+15	0.00596	0.32334	0.40179	0.09260	0.00343	2.0020E+15	0.02772	0.05539	0.90429	0.00061	0.01199
16	1.0765	2.4171E+15	0.00598	0.31488	0.40918	0.09004	0.00353	2.1529E+15	0.02783	0.05142	0.90817	0.00056	0.01202
17	1.0036	2.3016E+15	0.00594	0.32457	0.40149	0.09185	0.00344	2.0071E+15	0.02773	0.05514	0.90451	0.00061	0.01202
18	1.0047	2.3028E+15	0.00595	0.32341	0.40194	0.09258	0.00344	2.0095E+15	0.02773	0.05495	0.90472	0.00060	0.01200
19	1.0697	2.4115E+15	0.00597	0.31687	0.40777	0.09020	0.00351	2.1394E+15	0.02785	0.05154	0.90802	0.00057	0.01204
20	0.9738	2.2500E+15	0.00594	0.32742	0.39937	0.09291	0.00341	1.9475E+15	0.02766	0.05647	0.90326	0.00062	0.01199
21	0.9194	2.1614E+15	0.00593	0.33615	0.39345	0.09430	0.00333	1.8389E+15	0.02753	0.05958	0.90028	0.00065	0.01196
22	1.0873	2.4348E+15	0.00600	0.31317	0.40997	0.08987	0.00355	2.1746E+15	0.02788	0.05103	0.90848	0.00056	0.01204
23	1.0963	2.4515E+15	0.00600	0.31311	0.41024	0.08955	0.00356	2.1926E+15	0.02792	0.05045	0.90901	0.00055	0.01206
24	1.0409	2.3643E+15	0.00596	0.32064	0.40527	0.09062	0.00349	2.0818E+15	0.02778	0.05272	0.90690	0.00058	0.01203
25	0.9327	2.1804E+15	0.00594	0.33355	0.39601	0.09398	0.00335	1.8654E+15	0.02752	0.05869	0.90118	0.00064	0.01195
26	1.0551	2.3826E+15	0.00597	0.31566	0.40756	0.09084	0.00351	2.1101E+15	0.02780	0.05238	0.90722	0.00058	0.01203
27	1.1232	2.4990E+15	0.00599	0.30960	0.41181	0.08968	0.00358	2.2463E+15	0.02798	0.04921	0.91019	0.00054	0.01207
28	1.1001	2.4668E+15	0.00597	0.31317	0.40948	0.09043	0.00355	2.2003E+15	0.02791	0.05003	0.90944	0.00055	0.01207
29	0.9742	2.2538E+15	0.00594	0.32752	0.39890	0.09380	0.00340	1.9485E+15	0.02765	0.05639	0.90333	0.00062	0.01200
30	0.9203	2.1625E+15	0.00592	0.33546	0.39420	0.09442	0.00333	1.8406E+15	0.02751	0.05910	0.90078	0.00065	0.01196
31	1.0609	2.3955E+15	0.00598	0.31775	0.40720	0.08981	0.00351	2.1218E+15	0.02786	0.05172	0.90779	0.00057	0.01205
32	0.9372	2.1919E+15	0.00592	0.33392	0.39504	0.09397	0.00335	1.8745E+15	0.02760	0.05833	0.90146	0.00064	0.01197
33	0.9095	2.1431E+15	0.00592	0.33753	0.39325	0.09421	0.00332	1.8189E+15	0.02748	0.05988	0.90004	0.00066	0.01194
34	0.9641	2.2343E+15	0.00595	0.32975	0.39844	0.09200	0.00339	1.9282E+15	0.02767	0.05686	0.90283	0.00063	0.01200
35	0.9131	2.1525E+15	0.00593	0.33827	0.39303	0.09330	0.00332	1.8263E+15	0.02752	0.05961	0.90028	0.00066	0.01194
36	0.8994	2.1325E+15	0.00591	0.34147	0.39139	0.09342	0.00330	1.7988E+15	0.02745	0.06046	0.89949	0.00067	0.01194
37	0.8962	2.1225E+15	0.00593	0.34005	0.39168	0.09421	0.00330	1.7924E+15	0.02741	0.06080	0.89919	0.00066	0.01192
38	0.8928	2.1220E+15	0.00590	0.34157	0.39058	0.09458	0.00328	1.7856E+15	0.02744	0.06058	0.89937	0.00066	0.01194
39	0.8878	2.1115E+15	0.00590	0.34194	0.39058	0.09432	0.00327	1.7756E+15	0.02740	0.06103	0.89896	0.00067	0.01192
Assembly total		6.1203E+17	0.00589	0.32149	0.39760	0.09115	0.00340	5.2800E+17	0.02771	0.05498	0.90470	0.00060	0.01200

[a]Total production/total absorption = 1.30649 ± 0.00020.

[b]Multiplication factor (k_{eff}) = 1.30311 ± 0.00017.

Table 4.19. Case BOL2 ABBN93-KENO-V.a results[a,b]

Pin	Relative pin power	Total capture rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu
1	1.1228	2.5428E+15	0.00596	0.32139	0.40489	0.09116	0.00349	2.2342E+15	0.02776	0.05283	0.90678	0.00058	0.01204
2	1.0313	2.4004E+15	0.00590	0.33300	0.39703	0.09426	0.00335	2.0522E+15	0.02744	0.05695	0.90303	0.00062	0.01196
3	1.0163	2.3799E+15	0.00587	0.33524	0.39585	0.09485	0.00333	2.0223E+15	0.02732	0.05756	0.90254	0.00063	0.01195
4	1.0156	2.3798E+15	0.00587	0.33613	0.39551	0.09425	0.00333	2.0210E+15	0.02735	0.05766	0.90239	0.00063	0.01195
5	1.0057	2.3641E+15	0.00587	0.33863	0.39403	0.09365	0.00330	2.0012E+15	0.02733	0.05838	0.90171	0.00064	0.01193
6	0.9787	2.3037E+15	0.00591	0.33925	0.39255	0.09434	0.00330	1.9476E+15	0.02740	0.06038	0.89965	0.00067	0.01192
7	1.0400	2.4041E+15	0.00594	0.33013	0.39799	0.09300	0.00339	2.0696E+15	0.02759	0.05710	0.90270	0.00063	0.01198
8	1.0095	2.3555E+15	0.00591	0.33545	0.39582	0.09328	0.00333	2.0088E+15	0.02740	0.05841	0.90161	0.00064	0.01194
9	1.0156	2.3734E+15	0.00588	0.33505	0.39650	0.09410	0.00333	2.0210E+15	0.02731	0.05758	0.90254	0.00063	0.01193
10	0.9938	2.3341E+15	0.00591	0.33639	0.39349	0.09532	0.00331	1.9776E+15	0.02744	0.05916	0.90080	0.00065	0.01195
11	0.9966	2.3378E+15	0.00591	0.33680	0.39400	0.09426	0.00332	1.9831E+15	0.02741	0.05899	0.90099	0.00065	0.01195
12	1.0145	2.3760E+15	0.00589	0.33594	0.39550	0.09466	0.00333	2.0188E+15	0.02736	0.05776	0.90230	0.00063	0.01194
13	0.9913	2.3294E+15	0.00590	0.33794	0.39361	0.09440	0.00331	1.9726E+15	0.02738	0.05941	0.90062	0.00065	0.01194
14	0.9765	2.3021E+15	0.00590	0.33963	0.39196	0.09484	0.00329	1.9431E+15	0.02737	0.06065	0.89940	0.00066	0.01192
15	0.9980	2.3349E+15	0.00592	0.33586	0.39449	0.09378	0.00333	1.9860E+15	0.02746	0.05882	0.90110	0.00064	0.01197
16	1.0128	2.3689E+15	0.00589	0.33460	0.39607	0.09452	0.00333	2.0155E+15	0.02733	0.05768	0.90241	0.00063	0.01193
17	0.9975	2.3393E+15	0.00590	0.33664	0.39409	0.09452	0.00333	1.9849E+15	0.02743	0.05888	0.90109	0.00064	0.01195
18	0.9998	2.3394E+15	0.00592	0.33659	0.39536	0.09326	0.00333	1.9895E+15	0.02738	0.05869	0.90134	0.00065	0.01194
19	1.0157	2.3794E+15	0.00587	0.33643	0.39570	0.09417	0.00332	2.0211E+15	0.02729	0.05769	0.90247	0.00063	0.01192
20	0.9909	2.3295E+15	0.00590	0.33870	0.39348	0.09412	0.00331	1.9718E+15	0.02737	0.05952	0.90053	0.00065	0.01194
21	0.9756	2.3011E+15	0.00592	0.34060	0.39172	0.09467	0.00329	1.9414E+15	0.02741	0.06064	0.89935	0.00067	0.01193
22	1.0231	2.3900E+15	0.00588	0.33383	0.39700	0.09490	0.00334	2.0359E+15	0.02732	0.05703	0.90309	0.00063	0.01193
23	1.0214	2.3906E+15	0.00589	0.33571	0.39590	0.09403	0.00332	2.0324E+15	0.02736	0.05723	0.90284	0.00063	0.01194
24	1.0082	2.3654E+15	0.00588	0.33707	0.39503	0.09424	0.00331	2.0063E+15	0.02730	0.05830	0.90183	0.00064	0.01192
25	0.9783	2.3101E+15	0.00591	0.34191	0.39083	0.09403	0.00329	1.9466E+15	0.02743	0.06077	0.89921	0.00066	0.01193
26	1.0132	2.3673E+15	0.00589	0.33420	0.39611	0.09441	0.00334	2.0161E+15	0.02740	0.05780	0.90220	0.00063	0.01195
27	1.0283	2.4080E+15	0.00586	0.33504	0.39611	0.09472	0.00333	2.0461E+15	0.02731	0.05676	0.90337	0.00062	0.01193
28	1.0243	2.3979E+15	0.00589	0.33490	0.39585	0.09511	0.00333	2.0384E+15	0.02736	0.05704	0.90302	0.00063	0.01195
29	0.9926	2.3329E+15	0.00591	0.33787	0.39328	0.09462	0.00331	1.9751E+15	0.02743	0.05954	0.90043	0.00065	0.01195
30	0.9739	2.3040E+15	0.00590	0.34147	0.39035	0.09484	0.00328	1.9380E+15	0.02743	0.06088	0.89908	0.00067	0.01194
31	1.0139	2.3748E+15	0.00589	0.33557	0.39554	0.09479	0.00332	2.0175E+15	0.02735	0.05792	0.90216	0.00064	0.01193
32	0.9811	2.3118E+15	0.00591	0.34061	0.39187	0.09386	0.00330	1.9524E+15	0.02745	0.06050	0.89945	0.00066	0.01194
33	0.9736	2.3024E+15	0.00590	0.34176	0.39084	0.09481	0.00328	1.9374E+15	0.02738	0.06100	0.89903	0.00067	0.01192
34	0.9883	2.3356E+15	0.00588	0.33934	0.39164	0.09591	0.00329	1.9666E+15	0.02740	0.05981	0.90020	0.00066	0.01193
35	0.9773	2.3075E+15	0.00590	0.34128	0.39145	0.09435	0.00329	1.9449E+15	0.02739	0.06068	0.89933	0.00067	0.01193
36	0.9711	2.2926E+15	0.00592	0.34186	0.39110	0.09375	0.00329	1.9323E+15	0.02739	0.06138	0.89862	0.00068	0.01193
37	0.9714	2.2980E+15	0.00591	0.34265	0.39047	0.09416	0.00328	1.9330E+15	0.02743	0.06124	0.89873	0.00068	0.01192
38	0.9687	2.2954E+15	0.00591	0.34285	0.38970	0.09473	0.00328	1.9275E+15	0.02743	0.06147	0.89848	0.00068	0.01193
39	0.9672	2.2875E+15	0.00591	0.34245	0.38993	0.09430	0.00327	1.9246E+15	0.02744	0.06189	0.89807	0.00068	0.01192
Assembly total		6.8879E+17	0.00531	0.30351	0.35447	0.08485	0.00298	5.2533E+17	0.02739	0.05892	0.90110	0.00065	0.01194

[a]Total production/total absorption = 1.23754 ± 0.00021.

[b]Multiplication factor (k_{eff}) = 1.23412 ± 0.00019.

Table 4.20. Case BOL3 ABBN93-KENO-V.a results[a,b]

Pin	Relative pin power	Total capture rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu
1	1.0690	2.5650E+15	0.00570	0.36901	0.41549	0.09838	0.00313	2.1584E+15	0.02474	0.06402	0.89894	0.00072	0.01160
2	1.0690	2.5665E+15	0.00568	0.36915	0.41524	0.09865	0.00313	2.1584E+15	0.02469	0.06398	0.89902	0.00072	0.01159
3	1.0620	2.5578E+15	0.00569	0.37043	0.41441	0.09807	0.00313	2.1443E+15	0.02470	0.06418	0.89882	0.00072	0.01159
4	1.0635	2.5620E+15	0.00569	0.37110	0.41363	0.09844	0.00313	2.1472E+15	0.02478	0.06404	0.89886	0.00072	0.01160
5	1.0360	2.5138E+15	0.00567	0.37328	0.41128	0.09990	0.00309	2.0919E+15	0.02467	0.06547	0.89758	0.00073	0.01155
6	0.9387	2.3464E+15	0.00574	0.38875	0.39704	0.10064	0.00299	1.8953E+15	0.02498	0.07218	0.89046	0.00080	0.01159
7	1.0119	2.4762E+15	0.00572	0.37772	0.40672	0.09965	0.00308	2.0431E+15	0.02489	0.06735	0.89540	0.00076	0.01161
8	1.0147	2.4729E+15	0.00572	0.37611	0.40826	0.09947	0.00308	2.0488E+15	0.02482	0.06737	0.89546	0.00075	0.01159
9	1.0692	2.5719E+15	0.00569	0.36992	0.41505	0.09830	0.00312	2.1589E+15	0.02469	0.06387	0.89914	0.00071	0.01158
10	1.0130	2.4714E+15	0.00572	0.37769	0.40764	0.09865	0.00308	2.0454E+15	0.02485	0.06728	0.89552	0.00075	0.01160
11	1.0127	2.4719E+15	0.00572	0.37745	0.40745	0.09914	0.00308	2.0448E+15	0.02484	0.06734	0.89547	0.00075	0.01160
12	1.0535	2.5468E+15	0.00569	0.37245	0.41230	0.09882	0.00311	2.1273E+15	0.02477	0.06451	0.89839	0.00072	0.01160
13	0.9800	2.4184E+15	0.00573	0.38251	0.40292	0.09968	0.00304	1.9788E+15	0.02488	0.06920	0.89356	0.00078	0.01159
14	0.9315	2.3326E+15	0.00574	0.38915	0.39631	0.10079	0.00298	1.8808E+15	0.02496	0.07262	0.89002	0.00081	0.01158
15	1.0152	2.4859E+15	0.00568	0.37776	0.40655	0.10000	0.00306	2.0499E+15	0.02479	0.06735	0.89553	0.00076	0.01159
16	1.0699	2.5695E+15	0.00569	0.36894	0.41520	0.09885	0.00313	2.1603E+15	0.02473	0.06381	0.89916	0.00071	0.01159
17	1.0160	2.4725E+15	0.00573	0.37594	0.40868	0.09892	0.00309	2.0515E+15	0.02488	0.06712	0.89564	0.00075	0.01161
18	1.0145	2.4726E+15	0.00573	0.37612	0.40818	0.09942	0.00308	2.0484E+15	0.02486	0.06719	0.89559	0.00075	0.01160
19	1.0608	2.5519E+15	0.00569	0.37015	0.41464	0.09861	0.00313	2.1419E+15	0.02470	0.06414	0.89886	0.00072	0.01158
20	0.9796	2.4151E+15	0.00574	0.38156	0.40325	0.10007	0.00304	1.9779E+15	0.02490	0.06914	0.89359	0.00078	0.01159
21	0.9305	2.3275E+15	0.00575	0.38898	0.39682	0.10049	0.00300	1.8788E+15	0.02497	0.07270	0.88992	0.00081	0.01159
22	1.0825	2.5899E+15	0.00570	0.36741	0.41687	0.09837	0.00315	2.1856E+15	0.02473	0.06306	0.89991	0.00070	0.01160
23	1.0828	2.5938E+15	0.00569	0.36863	0.41635	0.09774	0.00314	2.1863E+15	0.02475	0.06297	0.89996	0.00070	0.01161
24	1.0303	2.5026E+15	0.00570	0.37456	0.41071	0.09863	0.00309	2.0804E+15	0.02476	0.06574	0.89719	0.00074	0.01157
25	0.9350	2.3359E+15	0.00576	0.38890	0.39720	0.10013	0.00300	1.8879E+15	0.02500	0.07239	0.89019	0.00081	0.01161
26	1.0594	2.5525E+15	0.00569	0.37025	0.41419	0.09826	0.00313	2.1391E+15	0.02469	0.06440	0.89859	0.00073	0.01159
27	1.1091	2.6406E+15	0.00567	0.36458	0.41977	0.09793	0.00317	2.2395E+15	0.02464	0.06133	0.90176	0.00069	0.01159
28	1.0865	2.6063E+15	0.00567	0.36875	0.41625	0.09812	0.00314	2.1938E+15	0.02470	0.06236	0.90064	0.00070	0.01159
29	0.9755	2.4098E+15	0.00573	0.38398	0.40313	0.09805	0.00304	1.9696E+15	0.02486	0.06927	0.89349	0.00077	0.01160
30	0.9217	2.3178E+15	0.00574	0.39101	0.39478	0.10097	0.00297	1.8610E+15	0.02496	0.07313	0.88950	0.00082	0.01158
31	1.0470	2.5321E+15	0.00570	0.37265	0.41249	0.09864	0.00311	2.1141E+15	0.02476	0.06467	0.89825	0.00073	0.01160
32	0.9384	2.3458E+15	0.00575	0.38896	0.39719	0.10009	0.00299	1.8948E+15	0.02499	0.07188	0.89072	0.00080	0.01160
33	0.9078	2.2996E+15	0.00575	0.39489	0.39171	0.10084	0.00295	1.8329E+15	0.02504	0.07418	0.88834	0.00083	0.01160
34	0.9657	2.3975E+15	0.00569	0.38340	0.40081	0.10135	0.00302	1.9498E+15	0.02485	0.06992	0.89286	0.00078	0.01158
35	0.9160	2.3065E+15	0.00575	0.39252	0.39440	0.10011	0.00297	1.8495E+15	0.02497	0.07350	0.88914	0.00082	0.01157
36	0.8975	2.2780E+15	0.00576	0.39532	0.39092	0.10158	0.00294	1.8121E+15	0.02508	0.07460	0.88788	0.00084	0.01159
37	0.8986	2.2737E+15	0.00576	0.39532	0.39217	0.09997	0.00294	1.8145E+15	0.02503	0.07456	0.88803	0.00084	0.01156
38	0.8867	2.2634E+15	0.00575	0.39757	0.38886	0.10165	0.00292	1.7905E+15	0.02506	0.07539	0.88711	0.00085	0.01159
39	0.8853	2.2567E+15	0.00576	0.39807	0.38887	0.10108	0.00294	1.7875E+15	0.02512	0.07513	0.88732	0.00085	0.01160
Assembly total		6.5097E+17	0.00568	0.37699	0.40365	0.09880	0.00304	5.3304E+17	0.02484	0.06782	0.89499	0.00076	0.01159

[a]Total production/total absorption = 1.27779 ± 0.00020.

[b]Multiplication factor (k_{eff}) = 1.27288 ± 0.00018.

Table 4.21. Case BOL4 ABBN93-KENO-V.a results[a,b]

Pin	Relative pin power	Total capture rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu	Total fission rate (1/s)	^{235}U	^{238}U	^{239}Pu	^{240}Pu	^{241}Pu
1	1.1057	2.6603E+15	0.00571	0.37779	0.40785	0.09914	0.00308	2.1965E+15	0.0248	0.0665	0.8964	0.0007	0.0116
2	1.0400	2.5620E+15	0.00569	0.38747	0.39884	0.10118	0.00299	2.0658E+15	0.0248	0.0700	0.8929	0.0008	0.0116
3	1.0151	2.5238E+15	0.00569	0.39182	0.39538	0.10084	0.00296	2.0164E+15	0.0248	0.0711	0.8917	0.0008	0.0116
4	1.0166	2.5293E+15	0.00569	0.39207	0.39510	0.10131	0.00295	2.0195E+15	0.0248	0.0712	0.8917	0.0008	0.0116
5	1.0056	2.5080E+15	0.00570	0.39401	0.39403	0.10075	0.00294	1.9977E+15	0.0248	0.0720	0.8908	0.0008	0.0116
6	0.9760	2.4406E+15	0.00577	0.39790	0.39042	0.09963	0.00295	1.9389E+15	0.0251	0.0747	0.8877	0.0008	0.0116
7	1.0445	2.5590E+15	0.00574	0.38687	0.39970	0.09942	0.00302	2.0749E+15	0.0250	0.0699	0.8928	0.0008	0.0116
8	1.0200	2.5185E+15	0.00572	0.39027	0.39696	0.10012	0.00299	2.0263E+15	0.0249	0.0714	0.8914	0.0008	0.0116
9	1.0229	2.5379E+15	0.00569	0.39033	0.39631	0.10172	0.00297	2.0320E+15	0.0248	0.0707	0.8922	0.0008	0.0116
10	1.0022	2.4921E+15	0.00573	0.39174	0.39430	0.10178	0.00296	1.9909E+15	0.0249	0.0723	0.8905	0.0008	0.0116
11	0.9989	2.4903E+15	0.00573	0.39315	0.39327	0.10173	0.00296	1.9843E+15	0.0249	0.0726	0.8901	0.0008	0.0116
12	1.0121	2.5219E+15	0.00570	0.39256	0.39440	0.10167	0.00296	2.0105E+15	0.0248	0.0714	0.8914	0.0008	0.0116
13	0.9899	2.4753E+15	0.00573	0.39487	0.39176	0.10165	0.00294	1.9665E+15	0.0250	0.0733	0.8893	0.0008	0.0116
14	0.9766	2.4434E+15	0.00576	0.39708	0.39058	0.10058	0.00294	1.9399E+15	0.0251	0.0746	0.8879	0.0008	0.0116
15	1.0060	2.5025E+15	0.00572	0.39323	0.39406	0.10048	0.00296	1.9985E+15	0.0249	0.0722	0.8905	0.0008	0.0116
16	1.0192	2.5316E+15	0.00571	0.39129	0.39583	0.10117	0.00297	2.0246E+15	0.0248	0.0710	0.8918	0.0008	0.0116
17	1.0009	2.4949E+15	0.00573	0.39273	0.39325	0.10195	0.00296	1.9883E+15	0.0250	0.0723	0.8903	0.0008	0.0116
18	1.0026	2.4955E+15	0.00572	0.39298	0.39438	0.10077	0.00296	1.9918E+15	0.0249	0.0722	0.8905	0.0008	0.0116
19	1.0132	2.5186E+15	0.00570	0.39191	0.39559	0.10097	0.00296	2.0128E+15	0.0248	0.0714	0.8915	0.0008	0.0116
20	0.9938	2.4784E+15	0.00572	0.39424	0.39307	0.10117	0.00295	1.9743E+15	0.0249	0.0732	0.8896	0.0008	0.0116
21	0.9769	2.4438E+15	0.00575	0.39647	0.39094	0.10101	0.00294	1.9406E+15	0.0250	0.0745	0.8880	0.0008	0.0116
22	1.0250	2.5463E+15	0.00569	0.39099	0.39609	0.10155	0.00297	2.0361E+15	0.0248	0.0704	0.8924	0.0008	0.0116
23	1.0255	2.5433E+15	0.00569	0.39074	0.39665	0.10116	0.00297	2.0371E+15	0.0248	0.0702	0.8926	0.0008	0.0116
24	1.0066	2.5144E+15	0.00569	0.39547	0.39343	0.10009	0.00294	1.9996E+15	0.0248	0.0719	0.8909	0.0008	0.0116
25	0.9743	2.4400E+15	0.00577	0.39663	0.39010	0.10141	0.00293	1.9355E+15	0.0251	0.0749	0.8876	0.0008	0.0116
26	1.0161	2.5283E+15	0.00571	0.39202	0.39487	0.10138	0.00296	2.0185E+15	0.0249	0.0707	0.8920	0.0008	0.0116
27	1.0308	2.5616E+15	0.00566	0.39042	0.39634	0.10199	0.00296	2.0476E+15	0.0247	0.0696	0.8934	0.0008	0.0116
28	1.0240	2.5444E+15	0.00568	0.39219	0.39651	0.10001	0.00296	2.0343E+15	0.0247	0.0705	0.8925	0.0008	0.0116
29	0.9875	2.4731E+15	0.00573	0.39599	0.39102	0.10138	0.00294	1.9616E+15	0.0250	0.0735	0.8891	0.0008	0.0116
30	0.9707	2.4375E+15	0.00575	0.39742	0.38915	0.10181	0.00293	1.9281E+15	0.0250	0.0753	0.8873	0.0009	0.0116
31	1.0130	2.5240E+15	0.00569	0.39351	0.39427	0.10095	0.00295	2.0123E+15	0.0248	0.0714	0.8914	0.0008	0.0116
32	0.9762	2.4455E+15	0.00575	0.39671	0.39025	0.10128	0.00293	1.9391E+15	0.0250	0.0746	0.8879	0.0008	0.0116
33	0.9686	2.4328E+15	0.00575	0.39812	0.38904	0.10138	0.00292	1.9241E+15	0.0250	0.0755	0.8870	0.0009	0.0116
34	0.9879	2.4734E+15	0.00573	0.39749	0.39117	0.10002	0.00293	1.9624E+15	0.0249	0.0736	0.8891	0.0008	0.0116
35	0.9715	2.4408E+15	0.00575	0.39881	0.38895	0.10090	0.00293	1.9299E+15	0.0250	0.0752	0.8874	0.0009	0.0116
36	0.9664	2.4285E+15	0.00576	0.39866	0.38885	0.10107	0.00293	1.9198E+15	0.0250	0.0757	0.8868	0.0009	0.0116
37	0.9659	2.4324E+15	0.00573	0.39977	0.38796	0.10137	0.00292	1.9188E+15	0.0250	0.0756	0.8870	0.0009	0.0116
38	0.9623	2.4274E+15	0.00575	0.39982	0.38702	0.10191	0.00291	1.9116E+15	0.0251	0.0760	0.8866	0.0009	0.0116
39	0.9573	2.4170E+15	0.00576	0.40203	0.38705	0.09979	0.00290	1.9016E+15	0.0251	0.0762	0.8862	0.0009	0.0116
Assembly total		7.1876E+17	0.00524	0.36070	0.36013	0.09256	0.00270	5.2443E+17	0.0249	0.0726	0.8901	0.0008	0.0116

[a]Total production/total absorption = 1.20619 ± 0.00021.

[b]Multiplication factor (k_{eff}) = 1.20160 ± 0.00019.

4.2.2.1 Cross section processing

The cross sections used in the TWODANT calculations originated with the WIMS-ABBN 69 neutron group library based on the FOND-2 nuclear data files. No energy condensation was performed for either WIMS or TWODANT calculations. The TWODANT model required cell-weighted cross sections. The cell weighting was performed using the WIMS-D4 code in discrete ordinate transport theory, S8 approximation. A cell calculation was used to obtain the fuel cross sections. A cluster model was used to obtain cross sections for the guide tubes and burnable absorber pins.

The cross sections used in the KENO calculations were processed using the CONSYST2 code and originated with the ABBN-93 (DLC-182) 299 energy group library. This library is based on the FOND-2 nuclear data files. P5 approximation was used.

For BOL1 and BOL2, where the temperature of the materials is 300 K, the ENDF/B-V continuous cross section libraries of MCNP4A were used. Also, the $S(\alpha, \beta)$ treatment was invoked for taking into account the molecular bindings of hydrogen in the water molecule at 300 K. For BOL3 and BOL4, the libraries were used at 600 K for H, O (in water), ^{10}B, and Zr; at 900 K for ^{235}U, ^{238}U, and O (in fuel).

4.2.2.2 TWODANT assembly calculations

The assembly calculations performed with the TWODANT code used an S8 approximation and P0 with diagonal transport correction. The calculations were performed in 2-D 1/4-assembly geometry using a geometric buckling value that uses the height of the fuel. The mesh size was 0.31496 cm (4 mesh spaces per pin for each direction). The value of 210 MeV/fission was used for the power normalization.

4.2.2.3 KENO assembly calculations

In the Monte Carlo calculations, the pellet, gap, and clad, as well as BP rods and guide tubes, are explicitly modeled. The calculations were performed with 5010 batches of 2000 neutrons with the first 10 batches being skipped. This results in multiplication factor uncertainties of 0.0002 and pin reaction rate and power density uncertainties of less than 0.3%.

4.2.2.4 MCNP assembly calculations

For criticality calculation, 510 neutron generations with 10 generations skipped and 2000 histories per generation were used.

4.2.3 Results of PWR Benchmark Verification/Validation Studies

A comparison of multiplication factors for four of the PWR benchmark configurations is shown in Fig. 4.2. The level of agreement among calculations is excellent and serves to verify, in part, that the implementation of numerical algorithms in these programs is accurate for the computation of MOX PWR assembly configurations.

4.3 DESCRIPTION OF THE VVER REACTOR COMPUTATIONAL BENCHMARK

(A. Lazarenko and A. Pavlovichev)

Calculation variants differ by material composition and geometric objects to be calculated. There are two types of materials: fresh fuel and spent fuel; and there are three types of geometry: cell, assembly, and multiassembly.

4.3.1 Materials Specification

The materials specification for variants with fresh fuel is given in Table 4.22. Spent fuel specifications are given in Table 4.23.

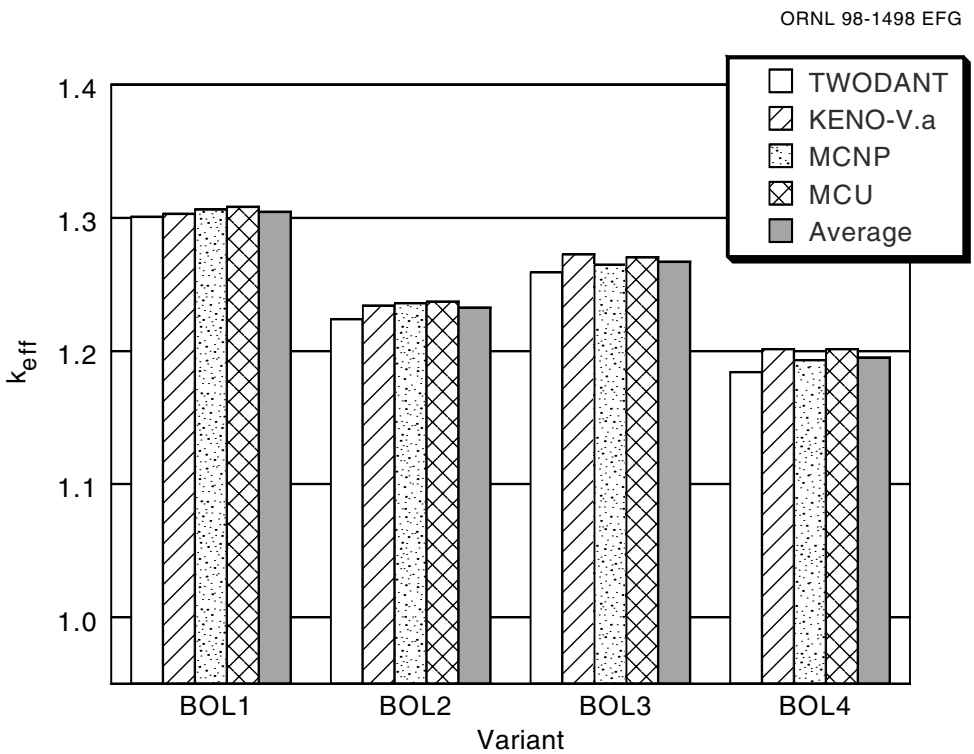

Fig. 4.2. Comparison of k-effectives calculated with various code packages.

Table 4.22. Materials description for fresh fuel

Material	Comment	Isotope	Content (10^{-24} cm^{-3})	Isotope	Content (10^{-24} cm^{-3})
FU1	Fresh uranium fuel	^{235}U	8.7370×10^{-4}	^{16}O	3.9235×10^{-2}
		^{238}U	1.8744×10^{-2}		
FU2	Fresh MOX fuel	^{235}U	3.8393×10^{-5}	^{239}Pu	6.5875×10^{-4}
		^{238}U	1.8917×10^{-2}	^{240}Pu	4.2323×10^{-5}
		^{16}O	4.1707×10^{-2}	^{241}Pu	7.0246×10^{-6}
FU7	MOX fuel with ^{239}Pu only	^{235}U	3.8393×10^{-5}	^{239}Pu	6.5875×10^{-4}
		^{238}U	1.8917×10^{-2}	^{16}O	4.1707×10^{-2}
FU8	MOX fuel with ^{240}Pu only	^{235}U	6.9714×10^{-4}	^{240}Pu	4.2323×10^{-5}
		^{238}U	1.8917×10^{-2}	^{16}O	4.1707×10^{-2}
FU9	MOX fuel with ^{241}Pu only	^{235}U	3.8393×10^{-5}	^{241}Pu	6.6577×10^{-4}
		^{238}U	1.8917×10^{-2}	^{16}O	4.1707×10^{-2}
FU10	Fresh MOX fuel (reactor plutonium)	^{235}U	5.0000×10^{-5}	^{240}Pu	4.9000×10^{-4}
		^{238}U	2.2100×10^{-2}	^{241}Pu	1.9000×10^{-4}
		^{16}O	4.6300×10^{-2}	^{242}Pu	1.0500×10^{-4}
		^{238}Pu	3.0000×10^{-5}	^{241}Am	2.5000×10^{-5}
		^{239}Pu	1.1600×10^{-3}		
CL1	Cladding	Zr	4.230×10^{-2}		
ABS	Absorber pellet	^{10}B	0.01557	^{12}C	0.01966
		^{11}B	0.06306		
MOD1	Hot moderator with boron acid	H	0.04783	^{10}B	4.7344×10^{-6}
		^{16}O	0.02391	^{11}B	1.9177×10^{-5}
MOD2	Hot moderator without boron acid	H	0.04783	^{16}O	0.02391
MOD3	Cold moderator with boron acid	H	0.06694	^{10}B	6.6262×10^{-6}
		^{16}O	0.03347	^{11}B	2.6839×10^{-5}

Table 4.23. Materials specification for variants with spent fuel

Material	Comment	Isotope	Content (10^{-24} cm^{-3})	Isotope	Content (10^{-24} cm^{-3})
FU3	Spent uranium fuel without FPs	^{235}U	3.78430×10^{-4}	^{242}Pu	4.75760×10^{-6}
		^{236}U	8.63650×10^{-5}	^{241}Am	4.94910×10^{-7}
		^{238}U	1.83270×10^{-2}	^{242m}Am	7.91940×10^{-9}
		^{237}Np	2.48230×10^{-5}	^{243}Am	6.69250×10^{-7}
		^{238}Pu	6.72540×10^{-6}	^{242}Cm	1.25820×10^{-7}
		^{239}Np	1.83320×10^{-6}	^{243}Cm	2.06290×10^{-9}
		^{239}Pu	1.31110×10^{-4}	^{244}Cm	1.23870×10^{-7}
		^{240}Pu	3.62330×10^{-5}	^{16}O	3.9235×10^{-2}
		^{241}Pu	2.17010×10^{-5}		
FU4	Spent uranium fuel with FPs	^{235}U	3.78430×10^{-4}	^{242}Pu	4.75760×10^{-6}
		^{236}U	8.63650×10^{-5}	^{241}Am	4.94910×10^{-7}
		^{238}U	1.83270×10^{-2}	^{242m}Am	7.91940×10^{-9}
		^{237}Np	2.48230×10^{-5}	^{243}Am	6.69250×10^{-7}
		^{238}Pu	6.72540×10^{-6}	^{242}Cm	1.25820×10^{-7}
		^{239}Np	1.83320×10^{-6}	^{243}Cm	2.06290×10^{-9}
		^{239}Pu	1.31110×10^{-4}	^{244}Cm	1.23870×10^{-7}
		^{240}Pu	3.62330×10^{-5}	^{16}O	3.9235×10^{-2}
		^{241}Pu	2.17010×10^{-5}		
		^{103}Rh	1.8890×10^{-5}	^{145}Nd	1.9975×10^{-5}
		^{131}Xe	1.4255×10^{-5}	^{153}Eu	2.4801×10^{-6}
		^{143}Nd	2.6692×10^{-5}	^{109}Ag	2.2037×10^{-6}
		^{147}Pm	6.1574×10^{-6}	^{155}Eu	9.6857×10^{-8}
		^{133}Cs	3.5974×10^{-5}	^{95}Mo	3.3720×10^{-5}
		^{99}Tc	3.3320×10^{-5}	^{154}Eu	5.1189×10^{-7}
		^{152}Sm	2.6842×10^{-6}	^{101}Ru	3.1134×10^{-5}
		^{151}Sm	3.0757×10^{-7}		

4.3.2 Geometry Description

There are three types of geometric objects:

- n-zones of elementary cells (C_n),
- an assembly containing 331 elementary cells of 3 types (K331), and
- a multiassembly structure formed by assemblies of two types (MK2).

The n-zones elementary cell C_n is

1st zone—Cyl (r_0,r_1) ;

jth zone—Cyl (r_0, r_j)\Cyl (r_0, r_{j-1}) , j = 1 , . . . n – 1 ;

nth zone—Hex (r_0, h = 1.275 cm)\Cyl (r_0, r_{n-1}) ;

where Cyl (r_0, r_j) is a cylinder of radius r_j with the center at point r_0; Hex (r_0, h = 1.275 cm) is a hexagon with the center at point r_0 and across flats dimension h = 1.275 cm.

4.3.2.1 Assembly K331

This structure is a "container" hexagon (r_0, H = 23. 6 cm) that contains 331 elementary cells C_n, of three types. The principal map of the K331 assembly is given in Fig. 4.3. This map is used to describe the different configurations of assemblies considered (i.e., Variants 11 and 12). These configurations differ by types of cells placed into the lattice. The map reproduces the hexagonal lattice in such a way that the upper number drawn inside each cell represents a lattice position. The lower numbers represent the cell types of the lattice positions. An actual assembly configuration can thus be specified by giving the actual "values" of these position types. As an example, consider two different assembly configurations. The first configuration is a regular lattice. In this case, the lattice positions labeled 1, 2, and 3 could contain cells of same type. In another case, the lattice could contain cells of different types. Then the lattice positions labeled 1 contain the cells of one type, and the positions labeled 2 and 3 contain the cells of other types. The types of cells placed at various lattice positions are described for all the variants (configurations) in Table 4.24.

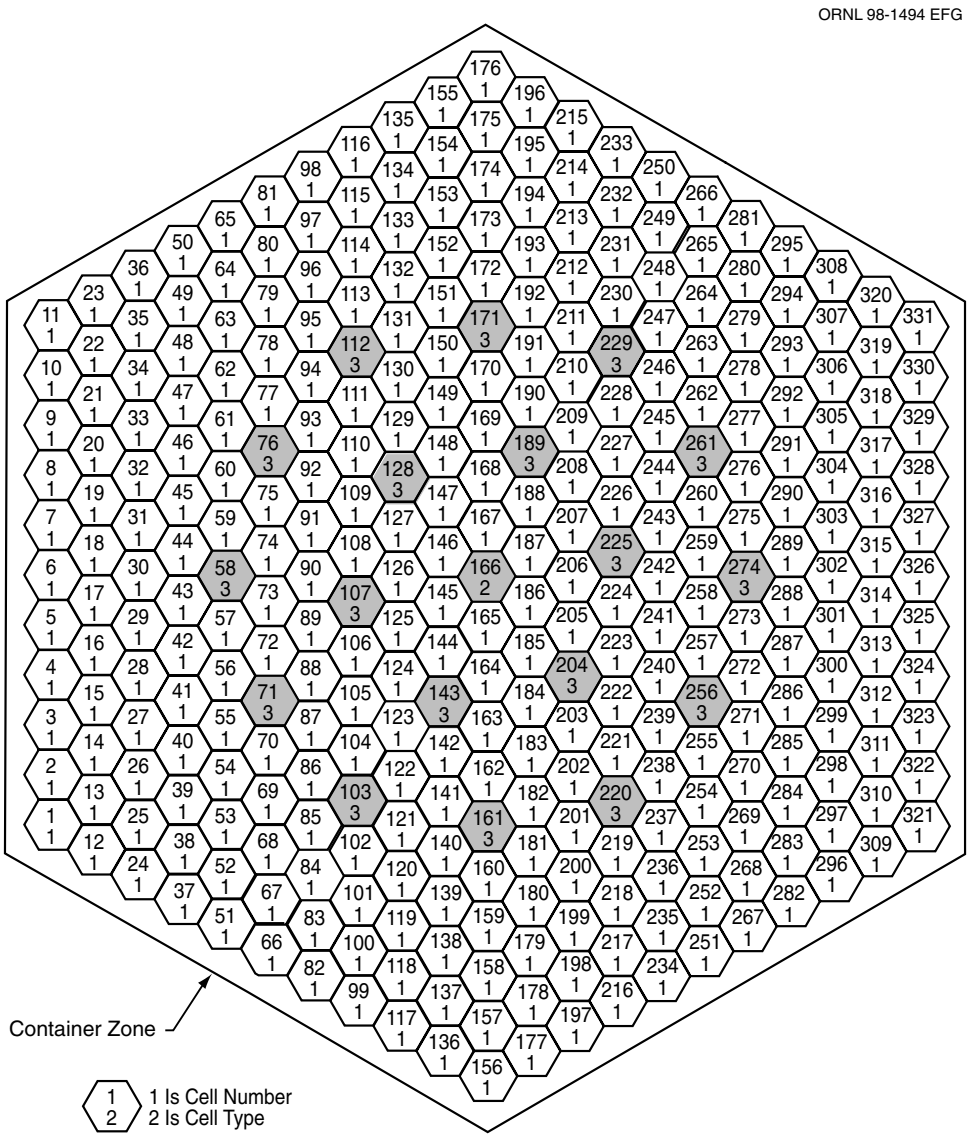

Fig. 4.3. Map of K331 assembly.

Table 4.24. Cell types used in different configurations of K331 assemblies[a]

Cell type	Comment	Number of zones n	Zone radius r_j, j = 1, n – 1 (cm)
G1	Fuel cell	3	$r_1 = 0.386$ $r_2 = 0.4582$
G2	Central tube cell	3	$r_1 = 0.45$ $r_2 = 0.5177$
G3	Absorber cell	5	$r_1 = 0.35$ $r_2 = 0.41$ $r_3 = 0.545$ $r_4 = 0.6323$
G4	Guide tube cell	3	$r_1 = 0.545$ $r_2 = 0.6323$

[a]Cells of all types have the same hexagonal outer dimension h = 1.275 cm.

4.3.2.2 Multiassembly structure MK2

The multiassembly structure is formed by an unlimited number of K331 assemblies of two different types (see Fig. 4.4).

4.3.3 Specification of Calculations to be Performed

Definition of the states to be calculated are given in Table 4.25. Definitions of the cases to be calculated (i.e., variants) are given in Table 4.26. Burnup calculations (with a power density equal to 108 MWt/m^3) should be performed for state S1 only. The nuclide content obtained in this calculation should be used for the calculation of other states. All calculations should be performed with a buckling value, B^2, of 0.003 cm^{-2} and with zero current boundary conditions.

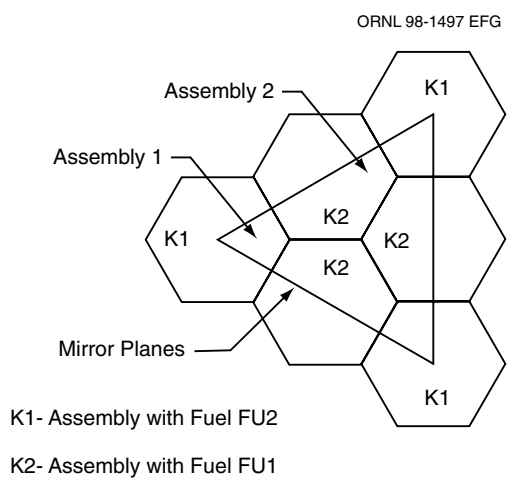

Fig. 4.4. MK2 multiassembly structure.

Table 4.25. State parameters for VVER computational benchmarks

State	Fuel zones temperature (K)	Nonfuel zones temperature (K)	Moderator material	Cell of type 3 (see Fig. 4.3)	^{135}Xe, ^{149}Sm
S1	1027	579	MOD1	G4	$\neq 0^a$
S2	1027	579	MOD1	G3	$\neq 0^a$
S3	1027	579	MOD2	G4	$\neq 0^a$
S4	1027	579	MOD1	G4	0
S5	579	579	MOD1	G4	0
S6	300	300	MOD3	G4	0

[a]At zero burnup $\rho(^{135}Xe)$ = 9.4581E–9, $\rho(^{149}Sm)$ = 7.3667E–8; at nonzero burnup points—equilibrium concentrations.

4.3.4 Parameters to be Calculated

For state S1 the following parameters should be calculated as a function of burnup (burnup step 2 MWd/kgU):

- k_{eff} ;
- k_0 (the ratio of production rate to absorption rate but with buckling applied in the flux calculation);
- M^2 (the migration area);
- concentrations of ^{235}U, ^{236}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{135}Xe, ^{149}Sm and total concentrations of fission products in fuel (for geometry type K331 in cells numbered 1, 29, and 72);
- concentrations of ^{241}Am,^{242m}Am,^{243}Am,^{242}Cm,^{243}Cm, ^{244}Cm in fuel (only for V1, V2, and V10 variants).

In addition, for states S1 and S2, the following results are required at burnups 0, 10, 20, 30, 40, 50, and 60 MWd/kgU:

- pin-by-pin power distribution;
- Φ_{cell}, Φ_{fuel}/Φ_{cell}, Φ_{clad}/Φ_{cell}, Φ_{mod}/Φ_{cell} and sets of one-group constants (Σ_a, Σ_f, and $\nu\Sigma_f$) averaged over cell (in case of geometry type K331 for cells numbered 1, 29, and 72);
- fuel averaged one-group micro cross sections (σ_a and $\nu\sigma_f$) of ^{235}U, ^{236}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{135}Xe, ^{149}Sm, total fission products, and relative reactions rates produced by these nuclides in the cell (in cells 1, 29, and 72 in the case of K331 geometry type).

For remaining states (S3–S6) the following results are required to be obtained at burnups 0, 10, 20, 30, 40, 50 MWd/kgU : k_{eff} , k_0, M^2.

In case of V13 variant the only parameters to be calculated from the list given above are

- k_{eff} and k_0
- pin-by-pin power distribution.

The energy group structure is shown in Table 4.27.

4.4 CALCULATED REACTOR PHYSICS PARAMETERS FOR THE VVER BENCHMARK

The specifications listed in the previous section were used to develop computational models. Four sets of calculations were performed, although not all cases were calculated with all computer programs.

4.4.1 Calculations with the Monte Carlo (MCU) Method (M. Kalugin and L. Maiorov)

The list of calculated variants is presented in Table 4.28. In this table, the letter V denotes the variant number, and the letter S denotes the state number according to the specifications provided in the previous section.

Table 4.26. Set of calculation variants[a]

	Comment	Geometry type	Assembly type	Cell type	Zone number	Zone material	Maximum burnup
V1	UO_2 fuel pin cell	C3		G1	1 2 3	FU1 CL1 MOD	60
V2	MOX pin cell	All is the same as for V1 but FU1 → FU2					60
V3		All is the same as for V1 but FU1 → FU3					0
V4		All is the same as for V1 but FU1 → FU4					0
V7		All is the same as for V1 but FU1 → FU7					0
V8		All is the same as for V1 but FU1 → FU8					0
V9		All is the same as for V1 but FU1 → FU9					0
V10		All is the same as for V1 but FU1 → FU10					60
V11	UO_2 fuel assembly	K331		1 - G1	1 2 3	FU1 CL1 MOD	60
				2 - G2	1 2 3	MOD CL1 MOD	
				3 - G4 (G3)	1 2 3 4	MOD (ABS) CL1 (CL1) MOD (MOD) (CL1)	
					5	(MOD)	
				Container zone		MOD	
V12	MOX fuel assembly	All is the same as for V11 but FU1 → FU2					60
V13	Multiassembly structure (MOX assembly surrounded by UO_2 assemblies)	MK2	1 - K331	1 - G1	1 2 3	FU2 CL1 MOD	0
				2 - The same as for cell type 1			
				3 - The same as for cell type 1			
			2 - K331	The same as for assembly type 1 but FU2 → FU1			

[a]Remarks:
1. Moderator material depends on state number and is given in Table 4.25.
2. Data in parentheses ( ) correspond to state S2.

Table 4.27. Four-group energy boundaries

Group	Energy region (eV)
1	10.5E+06–0.8E+06
2	0.8E+06–4.65E+03
3	4.65E+03–1.0
4	1.0–0.0

Table 4.28. List of variants calculated

Variant	Comments
V1S1	
V1S3	
V1S4	FU1 fresh uranium
V1S5	
V1S6	
V2S1	
V2S3	
V2S4	FU2 fresh MOX
V2S5	
V2S6	
V3S6	FU3 spent uranium fuel without FP
V4S3	
V4S4	FU4 spent uranium fuel with FP
V4S5	
V4S6	
V7S6	FU7 MOX fuel with ^{239}Pu only
V8S6	FU8 MOX fuel with ^{240}Pu only
V9S6	FU9 MOX fuel with ^{241}Pu only
V11S1	
V11S2	FU1 fresh uranium
V11S6	
V12S1	
V12S2	FU2 fresh MOX
V12S6	
V13S6	K1-FU2 and K2-FU1

4.4.1.1 Procedure for analyses

The calculations reported were performed using the MCU-RFFI/A Monte Carlo code and the MCUDAT library.[4] MCU-RFFI/A is a pointwise continuous energy code permitting systems to be modeled with any geometry. The MCU-RFFI/A code is certified by Russian safety authorities (GAN, Passport N61 17.10.96).

As stated previously, an important goal of this work was to verify nuclear data contained in the MCUDAT library, comparing them with results obtained by other participants of the project. Therefore, 4-group and 26-group cross sections were collapsed from the pointwise energy data as a part of the Monte Carlo calculation.

All the calculations reported were performed using the LIPAR section of the MCUDAT library if the isotope cross sections differed from the 1/v law. During the course of these studies, it was discovered that ^{154}Eu and ^{155}Eu data were absent in LIPAR. Therefore, the very inaccurate 1/v law was used for these isotopes. Fortunately, this assumption did not significantly influence the results of the calculations. As a result of this work, the LIPAR library has been updated. During these studies, A. Lasarenko noted and corrected some deficiencies in one of the options of the MCUDAT fission product data.

All the problems were solved using the axial buckling value $B^2 = 0.003\ cm^{-2}$. In other words, the transport equation was solved when the flux F(**r, v**) was represented as:

$$F(\mathbf{r}, \mathbf{v}) = f(x, y, \mathbf{v}) \exp(iBz) \ ,$$

where the f(x, y, **v**) function does not depend on the Z coordinate. The MCU code permits similar problems to be solved using the method described in Ref. 5.

4.4.1.2 Results and output description

Table 4.29 contains the k_{eff}, k_{inf}, and k_0 values obtained. All the calculations were performed with a statistical error less than 0.1% for multiplication coefficients.

The lower boundaries of the four-group library were as follows: 8 keV, 4.65 keV, 1 eV, and 0. The upper boundaries of the 26-group library are given in Table 4.30.

The original description of the VVER computational benchmark did not contain oxygen in the material specification of FU3 and FU4 materials. Therefore, all the results of variants V3 and V4 were calculated without oxygen in fuel. The results given in Table 4.29 differ from the TVS results where authors took into account the oxygen in fuel. Additional MCU results calculated taking into account the presence of oxygen in the fuel are as follows:

Variant V3S6 $k_{eff} = 1.0629$, $k_0 = 1.1989$
Variant V4S6 $k_{eff} = 1.0004$, $k_0 = 1.1284$.

Variants V1S1 and V2S1 were calculated with $\rho(^{135}Xe) = 9.4581E{-9}$, $\rho(^{149}Sm) = 7.3667E{-8}$. The other variants were calculated with zero concentrations of ^{135}Xe and ^{149}Sm.

Various physics parameters are presented in Tables 4.31–4.134. They include the following parameters:

- the one-group constants of cells,
- the 4-group and the 26-group macroscopic cross sections of isotopes calculated by the Monte Carlo code,
- the reaction rates for the regions of cells, and
- the fission rate distribution over the assemblies considered.

All of the results are normalized to one neutron born per fission. That is, for the problem modeled, the volume integral of the product of the flux and the macroscopic fission cross section is normalized to 1.0.

Table 4.29. The k_{eff}, k_{inf}, and k_0 values

Variant	k_{eff}	k_{inf}	k_0
V1S1	1.0639	1.2743	1.269
V1S3	1.1531	1.3841	1.376
V1S4	1.1033	1.3219	1.315
V1S5	1.1161	1.3382	1.332
V1S6	1.2187	1.3739	1.370
V2S1	1.0200	1.2135	1.210
V2S3	1.0614	1.2632	1.258
V2S4	1.0368	1.2331	1.229
V2S5	1.0498	1.2514	1.248
V2S6	1.1786	1.3242	1.321
V3S6	1.0479	1.2096	1.206
V4S3	0.90470	1.1260	1.120
V4S4	0.86828	1.0803	1.076
V4S5	0.88063	1.0956	1.092
V4S6	0.98904	1.1396	1.136
V7S6	1.2501	1.4058	1.403
V8S6	1.0828	1.2196	1.216
V9S6	1.4177[a]	1.6323	1.620
V11S4	1.1172	1.3348	1.329
V11S2	0.86617	1.0327	1.028
V11S6	1.2182	1.3682	1.365
V12S4	1.0600	1.2592	1.256
V12S2	0.86283	1.0242	1.023
V12S6	1.1904	1.3349	1.331
V13S6	1.212	1.3614	1.358

[a]With corrected ^{241}Pu spectrum, k_{eff} = 1.432.

Table 4.30. Upper boundaries of 26 groups

Group	Energy (eV)	Group	Energy (eV)	Group	Energy (eV)	Group	Energy (eV)
26	0.2150E+00	25	0.4650E+00	24	0.1000E+01	23	0.2150E+01
22	0.4650E+01	21	0.1000E+02	20	0.2150E+02	19	0.4650E+02
18	0.1000E+03	17	0.2150E+03	16	0.4650E+03	15	0.1000E+04
14	0.2250E+04	13	0.4650E+04	12	0.1000E+05	11	0.2150E+05
10	0.4650E+05	9	0.1000E+06	8	0.2000E+06	7	0.4000E+06
6	0.8000E+06	5	0.1400E+07	4	0.2500E+07	3	0.4000E+07
2	0.6500E+07	1	0.1000E+19				

Table 4.31. The cell one-group cross section and flux values for Variant V1S1

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2065E–01	0.2621E–01	0.1067E–01	0.4065E+02

Table 4.32. Reaction rates for every region of cell for Variant V1S1

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.7761E+00	0.1066E+01	0.4337E+00	0.1353E+02	0.3329E+00
2	0.9312E–02	0.0000E+00	0.0000E+00	0.5531E+01	0.1361E+00
3	0.5408E–01	0.0000E+00	0.0000E+00	0.2159E+02	0.5310E+00

Table 4.33. Region 1 four-group fluxes (cm) and nuclear data (cm^{-1}) for Variant V1S1

		^{235}U			^{238}U			Absorption[a]		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	O	^{135}Xe	^{149}Sm
1	0.3737E+01	0.11107E–02	0.28523E–02	0.10569E–02	0.80275E–02	0.19461E–01	0.69440E–02	0.52831E–03	0.54239E–11	0.12215E–07
2	0.4946E+01	0.18431E–02	0.35704E–02	0.14595E–02	0.48819E–02	0.15623E–04	0.62587E–05	0.00000E+00	0.32804E–10	0.12790E–06
3	0.3262E+01	0.30423E–01	0.48368E–01	0.19888E–01	0.48219E–01	0.00000E+00	0.00000E+00	0.17948E–06	0.11399E–05	0.10191E–04
4	0.1571E+01	0.24857E+00	0.51463E+00	0.21161E+00	0.24023E–01	0.00000E+00	0.00000E+00	0.49039E–05	0.11843E–01	0.28155E–02

[a] Absorption is reaction 3.
[b] $\nu\Sigma_f$ is reaction 918.
[c] Fission is reaction 18.

Table 4.34. Region 2 absorption reaction rate in Zr for Variant V1S1

Group	Flux $(cm^2 \cdot s)^{-1}$	Absorption $(cm^3 \cdot s)^{-1}$
1	0.1473E+01	0.26821E–03
2	0.1996E+01	0.72193E–03
3	0.1371E+01	0.35471E–02
4	0.6863E+00	0.38232E–02

Table 4.35. Region 3 absorption reaction rates for Variant V1S1

Group	Flux (cm)	H	O	^{10}B	^{11}B
1	0.5623E+01	0.00000E+00	0.32177E–03	0.15055E–05	0.13440E–06
2	0.7696E+01	0.00000E+00	0.00000E+00	0.10708E–04	0.14897E–06
3	0.5428E+01	0.49814E–03	0.10680E–06	0.57766E–03	0.14805E–07
4	0.2807E+01	0.77132E–02	0.31357E–05	0.88214E–02	0.51232E–07

Table 4.36. The cell one-group cross section and flux values for Variant V1S3

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2038E–01	0.2803E–01	0.1142E–01	0.4105E+02

Table 4.37. Reaction rates for every region of cell for Variant V1S3

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.7987E+00	0.1151E+01	0.4687E+00	0.1366E+02	0.3328E+00
2	0.9595E–02	0.0000E+00	0.0000E+00	0.5586E+01	0.1361E+00
3	0.2826E–01	0.0000E+00	0.0000E+00	0.2180E+02	0.5311E+00

Table 4.38. The cell one-group cross section and flux values for Variant V1S4

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2053E–01	0.2700E–01	0.1099E–01	0.4079E+02

Table 4.39. Reaction rates for every region of cell for Variant V1S4

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.7723E+00	0.1101E+01	0.4484E+00	0.1358E+02	0.3329E+00
2	0.9405E–02	0.0000E+00	0.0000E+00	0.5551E+01	0.1361E+00
3	0.5583E–01	0.0000E+00	0.0000E+00	0.2166E+02	0.5310E+00

Table 4.40. The cell one-group cross section and flux values for Variant V1S5

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2045E–01	0.2723E–01	0.1109E–01	0.4100E+02

Table 4.41. Reaction rates for every region of cell for Variant V1S5

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.7721E+00	0.1116E+01	0.4546E+00	0.1365E+02	0.3330E+00
2	0.9523E–02	0.0000E+00	0.0000E+00	0.5577E+01	0.1360E+00
3	0.5670E–01	0.0000E+00	0.0000E+00	0.2177E+02	0.5310E+00

Table 4.42. The cell one-group cross section and flux values for Variant V1S6

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2659E–01	0.3643E–01	0.1486E–01	0.3341E+02

Table 4.43. Reaction rates for every region of cell for Variant V1S6

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.7894E+00	0.1217E+01	0.4967E+00	0.1113E+02	0.3331E+00
2	0.8705E–02	0.0000E+00	0.0000E+00	0.4544E+01	0.1360E+00
3	0.9056E–01	0.0000E+00	0.0000E+00	0.1774E+02	0.5310E+00

Table 4.44. Multigroup cross sections of nuclides (cm^{-1}) for Region 1 for Variant V1S6

	^{235}U			^{238}U		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.14150E–02	0.49320E–02	0.14128E–02	0.17769E–01	0.61808E–01	0.17664E–01
2	0.96422E–03	0.29089E–02	0.95845E–03	0.10946E–01	0.33351E–01	0.10746E–01
3	0.10637E–02	0.28994E–02	0.10415E–02	0.10470E–01	0.28187E–01	0.10084E–01
4	0.11534E–02	0.28893E–02	0.10965E–02	0.96382E–02	0.22967E–01	0.87178E–02
5	0.11213E–02	0.26154E–02	0.10301E–02	0.28510E–02	0.18936E–02	0.74226E–03
6	0.11260E–02	0.24716E–02	0.99340E–03	0.22268E–02	0.51503E–04	0.20618E–04
7	0.13102E–02	0.27124E–02	0.11026E–02	0.23505E–02	0.46290E–05	0.18744E–05
8	0.15762E–02	0.30916E–02	0.12660E–02	0.29724E–02	0.00000E+00	0.00000E+00
9	0.19314E–02	0.36139E–02	0.14897E–02	0.48752E–02	0.00000E+00	0.00000E+00
10	0.23954E–02	0.43815E–02	0.18068E–02	0.82174E–02	0.00000E+00	0.00000E+00
11	0.30606E–02	0.55395E–02	0.22796E–02	0.10724E–01	0.00000E+00	0.00000E+00
12	0.40534E–02	0.72468E–02	0.29798E–02	0.13783E–01	0.00000E+00	0.00000E+00
13	0.58569E–02	0.10576E–01	0.43486E–02	0.17564E–01	0.00000E+00	0.00000E+00
14	0.89902E–02	0.14888E–01	0.61215E–02	0.19637E–01	0.00000E+00	0.00000E+00
15	0.13528E–01	0.23884E–01	0.98208E–02	0.26605E–01	0.00000E+00	0.00000E+00
16	0.19238E–01	0.34580E–01	0.14219E–01	0.27664E–01	0.00000E+00	0.00000E+00
17	0.26444E–01	0.43178E–01	0.17754E–01	0.50434E–01	0.00000E+00	0.00000E+00
18	0.43529E–01	0.72702E–01	0.29894E–01	0.39234E–01	0.00000E+00	0.00000E+00
19	0.55065E–01	0.85478E–01	0.35147E–01	0.80126E–01	0.00000E+00	0.00000E+00
20	0.67393E–01	0.89472E–01	0.36789E–01	0.79667E–01	0.00000E+00	0.00000E+00
21	0.65793E–01	0.93493E–01	0.38443E–01	0.19500E+00	0.00000E+00	0.00000E+00
22	0.20558E–01	0.35145E–01	0.14451E–01	0.11976E–01	0.00000E+00	0.00000E+00
23	0.40814E–01	0.74132E–01	0.30482E–01	0.87968E–02	0.00000E+00	0.00000E+00
24	0.63509E–01	0.13915E+00	0.57218E–01	0.10959E–01	0.00000E+00	0.00000E+00
25	0.16460E+00	0.32837E+00	0.13502E+00	0.15233E–01	0.00000E+00	0.00000E+00
26	0.40014E+00	0.83178E+00	0.34201E+00	0.36136E–01	0.00000E+00	0.00000E+00

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.45. Multigroup cross sections of nuclides (cm^{-1}) for Regions 1 and 2 for Variant V1S6

Group	Absorption	
	Region 1 O	Region 2 Zr
1	0.67820E–02	0.42300E–03
2	0.34600E–02	0.16920E–03
3	0.10755E–03	0.16920E–03
4	0.00000E+00	0.21150E–03
5	0.00000E+00	0.42300E–03
6	0.00000E+00	0.54990E–03
7	0.00000E+00	0.54990E–03
8	0.00000E+00	0.59220E–03
9	0.00000E+00	0.76140E–03
10	0.00000E+00	0.92449E–03
11	0.00000E+00	0.11221E–02
12	0.00000E+00	0.12262E–02
13	0.00000E+00	0.12166E–02
14	0.00000E+00	0.15171E–02
15	0.00000E+00	0.47859E–02
16	0.00000E+00	0.23007E–01
17	0.00000E+00	0.33416E–02
18	0.00000E+00	0.16920E–03
19	0.00000E+00	0.21150E–03
20	0.00000E+00	0.33840E–03
21	0.00000E+00	0.46530E–03
22	0.95454E–06	0.72430E–03
23	0.13999E–05	0.10629E–02
24	0.20578E–05	0.15614E–02
25	0.30413E–05	0.23088E–02
26	0.74853E–05	0.58504E–02

Table 4.46. Multigroup cross sections of nuclides (cm^{-1}) for Region 3 for Variant V1S6

	Absorption		
Group	H	O	^{10}B
1	0.00000E+00	0.57846E–02	0.13252E–05
2	0.00000E+00	0.29459E–02	0.20541E–05
3	0.00000E+00	0.91165E–04	0.21204E–05
4	0.00000E+00	0.00000E+00	0.27167E–05
5	0.00000E+00	0.00000E+00	0.14578E–05
6	0.00000E+00	0.00000E+00	0.40420E–05
7	0.00000E+00	0.00000E+00	0.72888E–05
8	0.00000E+00	0.00000E+00	0.11066E–04
9	0.00000E+00	0.00000E+00	0.15572E–04
10	0.00000E+00	0.00000E+00	0.22264E–04
11	0.00000E+00	0.00000E+00	0.32468E–04
12	0.00000E+00	0.00000E+00	0.47642E–04
13	0.66940E–04	0.00000E+00	0.70238E–04
14	0.66940E–04	0.00000E+00	0.10210E–03
15	0.13388E–03	0.00000E+00	0.15373E–03
16	0.20082E–03	0.00000E+00	0.22595E–03
17	0.26776E–03	0.00000E+00	0.33330E–03
18	0.40164E–03	0.00000E+00	0.49034E–03
19	0.60246E–03	0.00000E+00	0.72226E–03
20	0.93716E–03	0.00000E+00	0.10602E–02
21	0.13388E–02	0.00000E+00	0.15572E–02
22	0.20026E–02	0.81429E–06	0.22904E–02
23	0.29400E–02	0.11955E–05	0.33625E–02
24	0.43196E–02	0.17564E–05	0.49404E–02
25	0.63882E–02	0.25976E–05	0.73063E–02
26	0.16586E–01	0.67444E–05	0.18970E–01

Table 4.47. The cell one-group cross section and flux values for Variant V2S1

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2205E–01	0.2668E–01	0.9362E–02	0.3825E+02

Table 4.48. Reaction rates for every region of cell for Variant V2S1

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.8052E+00	0.1021E+01	0.3581E+00	0.1272E+02	0.3325E+00
2	0.7943E–02	0.0000E+00	0.0000E+00	0.5209E+01	0.1362E+00
3	0.3031E–01	0.0000E+00	0.0000E+00	0.2032E+02	0.5313E+00

Table 4.49. Four-group cross sections (cm^{-1}) and fluxes (cm) of cell regions for Region 1, Variant V2S1

		^{235}U			^{238}U			^{239}Pu		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.3795E+01	0.48800E–04	0.12569E–03	0.46469E–04	0.81851E–02	0.19977E–01	0.71077E–02	0.12440E–02	0.39402E–02	0.12271E–02
2	0.4930E+01	0.80946E–04	0.15682E–03	0.64103E–04	0.49260E–02	0.15791E–04	0.63259E–05	0.13221E–02	0.30897E–02	0.10627E–02
3	0.3244E+01	0.13868E–02	0.21815E–02	0.89702E–03	0.49201E–01	0.00000E+00	0.00000E+00	0.25018E–01	0.42604E–01	0.14823E–01
4	0.7273E+00	0.99058E–02	0.20624E–01	0.84805E–02	0.22842E–01	0.00000E+00	0.00000E+00	0.55067E+00	0.10186E+01	0.35674E+00

		^{240}Pu			^{241}Pu			Absorption[a]		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	O	^{135}Xe	^{149}Sm
1	0.3795E+01	0.72096E–04	0.22255E–03	0.68380E–04	0.11614E–04	0.36517E–04	0.11240E–04	0.60145E–03	0.54966E–11	0.12036E–07
2	0.4930E+01	0.29303E–04	0.32171E–04	0.10534E–04	0.17602E–04	0.45049E–04	0.15270E–04	0.00000E+00	0.32763E–10	0.12776E–06
3	0.3244E+01	0.11066E–01	0.19319E–04	0.67203E–05	0.49154E–03	0.10550E–02	0.35864E–03	0.17763E–06	0.92425E–06	0.10031E–04
4	0.7273E+00	0.21656E–01	0.12651E–04	0.43517E–05	0.51921E–02	0.11082E–01	0.37628E–02	0.48859E–05	0.10714E–01	0.25499E–02

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.50. Four-group cross sections (cm^{-1}) and fluxes (cm) of cell region for Region 2 for Variant V2S1

Group	Flux	Zr Absorption
1	0.1499E+01	0.26696E–03
2	0.1988E+01	0.72199E–03
3	0.1366E+01	0.35752E–02
4	0.3468E+00	0.35437E–02

Table 4.51. Four-group cross sections (cm^{-1}) and fluxes (cm) of cell regions for Region 3 for Variant V2S1

		Absorption			
Group	Flux	H	O	^{10}B	^{11}B
1	0.5717E+01	0.00000E+00	0.34409E–03	0.15061E–05	0.13284E–06
2	0.7672E+01	0.00000E+00	0.00000E+00	0.10698E–04	0.14909E–06
3	0.5416E+01	0.48904E–03	0.10290E–06	0.56731E–03	0.14796E–07
4	0.1480E+01	0.71082E–02	0.28898E–05	0.81296E–02	0.47214E–07

Table 4.52. The cell one-group cross section and flux values for Variant V2S3

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2200E–01	0.2768E–01	0.9713E–02	0.3835E+02

Table 4.53. Reaction rates for every region of cell for Variant V2S3

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.8197E+00	0.1062E+01	0.3724E+00	0.1275E+02	0.3325E+00
2	0.8095E–02	0.0000E+00	0.0000E+00	0.5222E+01	0.1362E+00
3	0.1579E–01	0.0000E+00	0.0000E+00	0.2037E+02	0.5313E+00

Table 4.54. The cell one-group cross section and flux values for Variant V2S4

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2204E–01	0.2709E–01	0.9506E–02	0.3828E+02

Table 4.55. Reaction rates for every region of cell for Variant V2S4

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.8049E+00	0.1037E+01	0.3639E+00	0.1273E+02	0.3325E+00
2	0.7989E–02	0.0000E+00	0.0000E+00	0.5214E+01	0.1362E+00
3	0.3086E–01	0.0000E+00	0.0000E+00	0.2034E+02	0.5313E+00

Table 4.56. The cell one-group cross section and flux values for Variant V2S5

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2196E–01	0.2740E–01	0.9615E–02	0.3841E+02

Table 4.57. Reaction rates for every region of cell for Variant V2S5

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.8042E+00	0.1053E+01	0.3693E+00	0.1278E+02	0.3326E+00
2	0.7995E–02	0.0000E+00	0.0000E+00	0.5231E+01	0.1362E+00
3	0.3136E–01	0.0000E+00	0.0000E+00	0.2041E+02	0.5312E+00

Table 4.58. The cell one-group cross section and flux values for Variant V2S6

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2837E–01	0.3748E–01	0.1315E–01	0.3144E+02

Table 4.59. Reaction rates for every region of cell for Variant V2S6

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.8287E+00	0.1179E+01	0.4134E+00	0.1046E+02	0.3325E+00
2	0.7340E–02	0.0000E+00	0.0000E+00	0.4281E+01	0.1361E+00
3	0.5603E–01	0.0000E+00	0.0000E+00	0.1671E+02	0.5313E+00

Table 4.60. Multigroup cross sections of nuclides (cm^{-1}) for Region 1 for Variant V2S6

	^{235}U			^{238}U		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.62177E–04	0.21673E–03	0.62082E–04	0.17933E–01	0.62378E–01	0.17827E–01
2	0.42371E–04	0.12783E–03	0.42117E–04	0.11048E–01	0.33659E–01	0.10845E–01
3	0.46744E–04	0.12741E–03	0.45764E–04	0.10567E–01	0.28447E–01	0.10177E–01
4	0.50683E–04	0.12696E–03	0.48183E–04	0.97271E–02	0.23179E–01	0.87983E–02
5	0.49274E–04	0.11493E–03	0.45265E–04	0.28773E–02	0.19111E–02	0.74911E–03
6	0.49481E–04	0.10861E–03	0.43653E–04	0.22473E–02	0.51978E–04	0.20809E–04
7	0.57574E–04	0.11919E–03	0.48452E–04	0.23722E–02	0.46717E–05	0.18917E–05
8	0.69261E–04	0.13585E–03	0.55632E–04	0.30004E–02	0.00000E+00	0.00000E+00
9	0.84871E–04	0.15881E–03	0.65460E–04	0.49198E–02	0.00000E+00	0.00000E+00
10	0.10526E–03	0.19254E–03	0.79397E–04	0.82990E–02	0.00000E+00	0.00000E+00
11	0.13429E–03	0.24304E–03	0.10002E–03	0.10842E–01	0.00000E+00	0.00000E+00
12	0.17846E–03	0.31905E–03	0.13119E–03	0.13875E–01	0.00000E+00	0.00000E+00
13	0.25773E–03	0.46538E–03	0.19136E–03	0.17703E–01	0.00000E+00	0.00000E+00
14	0.39587E–03	0.65557E–03	0.26956E–03	0.19735E–01	0.00000E+00	0.00000E+00
15	0.59629E–03	0.10527E–02	0.43287E–03	0.26587E–01	0.00000E+00	0.00000E+00
16	0.85020E–03	0.15281E–02	0.62832E–03	0.27615E–01	0.00000E+00	0.00000E+00
17	0.11784E–02	0.19233E–02	0.79081E–03	0.50425E–01	0.00000E+00	0.00000E+00
18	0.19571E–02	0.32655E–02	0.13427E–02	0.38760E–01	0.00000E+00	0.00000E+00
19	0.25757E–02	0.39767E–02	0.16352E–02	0.79311E–01	0.00000E+00	0.00000E+00
20	0.34810E–02	0.45655E–02	0.18773E–02	0.84149E–01	0.00000E+00	0.00000E+00
21	0.32889E–02	0.47575E–02	0.19562E–02	0.19603E+00	0.00000E+00	0.00000E+00
22	0.91553E–03	0.15656E–02	0.64375E–03	0.12065E–01	0.00000E+00	0.00000E+00
23	0.15680E–02	0.27457E–02	0.11290E–02	0.88162E–02	0.00000E+00	0.00000E+00
24	0.27794E–02	0.60923E–02	0.25051E–02	0.11060E–01	0.00000E+00	0.00000E+00
25	0.65291E–02	0.13202E–01	0.54285E–02	0.14865E–01	0.00000E+00	0.00000E+00
26	0.17857E–01	0.37124E–01	0.15265E–01	0.36955E–01	0.00000E+00	0.00000E+00

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.61. Multigroup cross sections of nuclides (cm^{-1}) for Regions 1 and 2 for Variant V2S6

Group	Region 1					
	^{239}Pu			^{240}Pu		
	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.14084E–02	0.56313E–02	0.14064E–02	0.90444E–04	0.35663E–03	0.90148E–04
2	0.11443E–02	0.40768E–02	0.11429E–02	0.68309E–04	0.24121E–03	0.67717E–04
3	0.12282E–02	0.40591E–02	0.12259E–02	0.71949E–04	0.23352E–03	0.70679E–04
4	0.13046E–02	0.40532E–02	0.12925E–02	0.73557E–04	0.21948E–03	0.70256E–04
5	0.12062E–02	0.35384E–02	0.11666E–02	0.70383E–04	0.20104E–03	0.63061E–04
6	0.11501E–02	0.31464E–02	0.10659E–02	0.32589E–04	0.80166E–04	0.25563E–04
7	0.11300E–02	0.29273E–02	0.10053E–02	0.13713E–04	0.16384E–04	0.56713E–05
8	0.11519E–02	0.28852E–02	0.99801E–03	0.16125E–04	0.98354E–05	0.34282E–05
9	0.12307E–02	0.29522E–02	0.10244E–02	0.23320E–04	0.97943E–05	0.34282E–05
10	0.13956E–02	0.30572E–02	0.10619E–02	0.34578E–04	0.14123E–04	0.49518E–05
11	0.16133E–02	0.30331E–02	0.10543E–02	0.45511E–04	0.14094E–04	0.49451E–05
12	0.24349E–02	0.39379E–02	0.13688E–02	0.63367E–04	0.11694E–04	0.41060E–05
13	0.37972E–02	0.57000E–02	0.19812E–02	0.91849E–04	0.18255E–04	0.64121E–05
14	0.55163E–02	0.85089E–02	0.29585E–02	0.14398E–03	0.33562E–04	0.11789E–04
15	0.95829E–02	0.14832E–01	0.51570E–02	0.23450E–03	0.31424E–04	0.11037E–04
16	0.15327E–01	0.23880E–01	0.83033E–02	0.34015E–03	0.66986E–05	0.23529E–05
17	0.21982E–01	0.36633E–01	0.12737E–01	0.10181E–02	0.62875E–08	0.21629E–08
18	0.56909E–01	0.10532E+00	0.36640E–01	0.95493E–03	0.16647E–07	0.57265E–08
19	0.30425E–01	0.34889E–01	0.12141E–01	0.27735E–02	0.16844E–04	0.57941E–05
20	0.91785E–01	0.16028E+00	0.55785E–01	0.11055E–02	0.22646E–04	0.77902E–05
21	0.35514E–01	0.62729E–01	0.21833E–01	0.38366E–04	0.70358E–07	0.24203E–07
22	0.82974E–02	0.20287E–01	0.70612E–02	0.38132E–03	0.27082E–06	0.93161E–07
23	0.17306E–01	0.40882E–01	0.14230E–01	0.15425E+00	0.88839E–04	0.30560E–04
24	0.93586E–01	0.18675E+00	0.65399E–01	0.46730E–01	0.26983E–04	0.92821E–05
25	0.14001E+01	0.23970E+01	0.84290E+00	0.70547E–02	0.41813E–05	0.14383E–05
26	0.60101E+00	0.11890E+01	0.41484E+00	0.93562E–02	0.56882E–05	0.19567E–05

Group	Region 1				Region 2
	^{241}Pu			O	Zr
	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	Absorption[a]
1	0.13487E–04	0.53982E–04	0.13445E–04	0.71926E–02	0.42300E–03
2	0.10017E–04	0.35944E–04	0.99679E–05	0.36836E–02	0.16920E–03
3	0.10670E–04	0.35572E–04	0.10593E–04	0.11423E–03	0.16920E–03
4	0.12286E–04	0.37821E–04	0.11879E–04	0.00000E+00	0.21150E–03
5	0.11907E–04	0.34440E–04	0.11218E–04	0.00000E+00	0.42300E–03
6	0.11289E–04	0.31864E–04	0.10614E–04	0.00000E+00	0.54990E–03
7	0.12996E–04	0.36091E–04	0.12181E–04	0.00000E+00	0.54990E–03
8	0.15693E–04	0.41547E–04	0.14112E–04	0.00000E+00	0.59220E–03
9	0.18664E–04	0.46600E–04	0.15883E–04	0.00000E+00	0.76140E–03
10	0.22542E–04	0.54503E–04	0.18608E–04	0.00000E+00	0.92504E–03
11	0.27340E–04	0.62710E–04	0.21432E–04	0.00000E+00	0.11220E–02
12	0.36746E–04	0.87459E–04	0.29911E–04	0.00000E+00	0.12258E–02
13	0.57651E–04	0.12969E–03	0.44353E–04	0.00000E+00	0.12125E–02
14	0.85498E–04	0.18816E–03	0.64350E–04	0.00000E+00	0.15093E–02
15	0.11585E–03	0.25913E–03	0.88622E–04	0.00000E+00	0.48102E–02

Table 4.61. (continued)

Group	Region 1				Region 2
	^{241}Pu			O	Zr
	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	Absorption[a]
16	0.21360E–03	0.46313E–03	0.15839E–03	0.00000E+00	0.22713E–01
17	0.23427E–03	0.53124E–03	0.18168E–03	0.00000E+00	0.34645E–02
18	0.38768E–03	0.87599E–03	0.29745E–03	0.00000E+00	0.16920E–03
19	0.56409E–03	0.13666E–02	0.46406E–03	0.00000E+00	0.21150E–03
20	0.15044E–02	0.28553E–02	0.96954E–03	0.00000E+00	0.33840E–03
21	0.18591E–02	0.46670E–02	0.15847E–02	0.00000E+00	0.46530E–03
22	0.12316E–02	0.21893E–02	0.74340E–03	0.10149E–05	0.72427E–03
23	0.12169E–03	0.23514E–03	0.79845E–04	0.14596E–05	0.10496E–02
24	0.41950E–03	0.76970E–03	0.26136E–03	0.21879E–05	0.15614E–02
25	0.69746E–02	0.13976E–01	0.47456E–02	0.31138E–05	0.22599E–02
26	0.80256E–02	0.17472E–01	0.59327E–02	0.80647E–05	0.58692E–02

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.62. Multigroup cross sections of nuclides (cm^{-1}) for Region 3 for Variant V2S6

Group	Absorption[a]		
	H	O	^{10}B
1	0.00000E+00	0.57678E–02	0.13252E–05
2	0.00000E+00	0.29502E–02	0.20541E–05
3	0.00000E+00	0.91212E–04	0.21204E–05
4	0.00000E+00	0.00000E+00	0.27167E–05
5	0.00000E+00	0.00000E+00	0.14578E–05
6	0.00000E+00	0.00000E+00	0.40420E–05
7	0.00000E+00	0.00000E+00	0.72888E–05
8	0.00000E+00	0.00000E+00	0.11066E–04
9	0.00000E+00	0.00000E+00	0.15572E–04
10	0.00000E+00	0.00000E+00	0.22264E–04
11	0.00000E+00	0.00000E+00	0.32468E–04
12	0.00000E+00	0.00000E+00	0.47642E–04
13	0.66940E–04	0.00000E+00	0.70238E–04
14	0.66940E–04	0.00000E+00	0.10209E–03
15	0.13388E–03	0.00000E+00	0.15373E–03
16	0.20082E–03	0.00000E+00	0.22595E–03
17	0.26776E–03	0.00000E+00	0.33330E–03
18	0.40164E–03	0.00000E+00	0.49034E–03
19	0.60246E–03	0.00000E+00	0.72226E–03
20	0.93716E–03	0.00000E+00	0.10602E–02
21	0.13388E–02	0.00000E+00	0.15572E–02
22	0.20027E–02	0.81434E–06	0.22905E–02
23	0.29135E–02	0.11847E–05	0.33323E–02
24	0.43180E–02	0.17558E–05	0.49386E–02
25	0.62799E–02	0.25536E–05	0.71824E–02
26	0.16570E–01	0.67379E–05	0.18952E–01

[a]Absorption is reaction 3.

Table 4.63. The cell one-group cross section and flux values for Variant V3S6

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2582E–01	0.3113E–01	0.1177E–01	0.3361E+02

Table 4.64. Reaction rates $(cm^3 \cdot s)^{-1}$ for every region of cell for Variant V3S6

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.7705E+00	0.1046E+01	0.3957E+00	0.1119E+02	0.3331E+00
2	0.8515E–02	0.0000E+00	0.0000E+00	0.4571E+01	0.1360E+00
3	0.8881E–01	0.0000E+00	0.0000E+00	0.1785E+02	0.5310E+00

Table 4.65. Multigroup cross sections of nuclides (cm^{-1}) for Region 1 for Variant V3S6

	^{235}U			^{236}U		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.61287E–03	0.21362E–02	0.61192E–03	0.13041E–03	0.44305E–03	0.12955E–03
2	0.41764E–03	0.12599E–02	0.41514E–03	0.81183E–04	0.24155E–03	0.79456E–04
3	0.46074E–03	0.12558E–02	0.45109E–03	0.82047E–04	0.21997E–03	0.77728E–04
4	0.49957E–03	0.12514E–02	0.47493E–03	0.74274E–04	0.17490E–03	0.66501E–04
5	0.48568E–03	0.11328E–02	0.44617E–03	0.64774E–04	0.92134E–04	0.36273E–04
6	0.48772E–03	0.10705E–02	0.43027E–03	0.28500E–04	0.63737E–05	0.25909E–05
7	0.56749E–03	0.11748E–02	0.47758E–03	0.28500E–04	0.00000E+00	0.00000E+00
8	0.68269E–03	0.13391E–02	0.54835E–03	0.34546E–04	0.00000E+00	0.00000E+00
9	0.83656E–03	0.15653E–02	0.64522E–03	0.51819E–04	0.00000E+00	0.00000E+00
10	0.10375E–02	0.18978E–02	0.78259E–03	0.69092E–04	0.00000E+00	0.00000E+00
11	0.13255E–02	0.23990E–02	0.98726E–03	0.94604E–04	0.00000E+00	0.00000E+00
12	0.17576E–02	0.31424E–02	0.12921E–02	0.13661E–03	0.00000E+00	0.00000E+00
13	0.25364E–02	0.45799E–02	0.18832E–02	0.20891E–03	0.00000E+00	0.00000E+00
14	0.38899E–02	0.64414E–02	0.26486E–02	0.19353E–03	0.33097E–10	0.13942E–10
15	0.58820E–02	0.10384E–01	0.42699E–02	0.41832E–03	0.61834E–09	0.26046E–09
16	0.83887E–02	0.15077E–01	0.61993E–02	0.48528E–03	0.13918E–04	0.58628E–05
17	0.11527E–01	0.18817E–01	0.77374E–02	0.10766E–02	0.42211E–04	0.17780E–04
18	0.19148E–01	0.31996E–01	0.13156E–01	0.15888E–02	0.48576E–04	0.20462E–04
19	0.24682E–01	0.38194E–01	0.15705E–01	0.30761E–02	0.11815E–03	0.49766E–04
20	0.31433E–01	0.41454E–01	0.17045E–01	0.92705E–05	0.23999E–06	0.10109E–06
21	0.30284E–01	0.43253E–01	0.17785E–01	0.23075E–01	0.64076E–03	0.26991E–03
22	0.90770E–02	0.15525E–01	0.63836E–02	0.22670E–03	0.60916E–05	0.25660E–05
23	0.15516E–01	0.27231E–01	0.11197E–01	0.88434E–04	0.20630E–05	0.86901E–06
24	0.27491E–01	0.60249E–01	0.24773E–01	0.10130E–03	0.21185E–05	0.89236E–06
25	0.69313E–01	0.13880E+00	0.57073E–01	0.13678E–03	0.27050E–05	0.11394E–05
26	0.18006E+00	0.37437E+00	0.15393E+00	0.33513E–03	0.63408E–05	0.26709E–05

Table 4.65. (continued)

	^{238}U			^{237}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.17374E–01	0.60432E–01	0.17271E–01	0.53975E–04	0.20490E–03	0.53767E–04
2	0.10703E–01	0.32609E–01	0.10507E–01	0.38764E–04	0.13109E–03	0.38376E–04
3	0.10237E–01	0.27559E–01	0.98599E–02	0.41601E–04	0.12911E–03	0.40883E–04
4	0.94237E–02	0.22456E–01	0.85239E–02	0.42490E–04	0.12208E–03	0.41008E–04
5	0.27875E–02	0.18515E–02	0.72575E–03	0.39771E–04	0.10439E–03	0.36539E–04
6	0.21772E–02	0.50357E–04	0.20160E–04	0.24873E–04	0.48009E–04	0.17245E–04
7	0.22982E–02	0.45260E–05	0.18327E–05	0.17806E–04	0.61735E–05	0.22514E–05
8	0.29066E–02	0.00000E+00	0.00000E+00	0.24150E–04	0.21952E–05	0.80675E–06
9	0.47685E–02	0.00000E+00	0.00000E+00	0.32717E–04	0.12109E–05	0.44681E–06
10	0.80233E–02	0.00000E+00	0.00000E+00	0.44493E–04	0.69832E–06	0.25816E–06
11	0.10475E–01	0.00000E+00	0.00000E+00	0.64083E–04	0.64389E–06	0.23830E–06
12	0.13369E–01	0.00000E+00	0.00000E+00	0.97103E–04	0.72411E–06	0.26809E–06
13	0.16983E–01	0.00000E+00	0.00000E+00	0.15144E–03	0.58979E–06	0.21844E–06
14	0.18554E–01	0.00000E+00	0.00000E+00	0.23296E–03	0.14685E–05	0.54388E–06
15	0.24835E–01	0.00000E+00	0.00000E+00	0.36984E–03	0.19298E–05	0.71739E–06
16	0.25935E–01	0.00000E+00	0.00000E+00	0.56842E–03	0.25782E–05	0.96562E–06
17	0.47305E–01	0.00000E+00	0.00000E+00	0.82048E–03	0.54796E–05	0.20678E–05
18	0.34855E–01	0.00000E+00	0.00000E+00	0.14568E–02	0.32451E–05	0.12312E–05
19	0.73973E–01	0.00000E+00	0.00000E+00	0.20593E–02	0.32743E–04	0.12422E–04
20	0.74327E–01	0.00000E+00	0.00000E+00	0.22568E–02	0.19534E–05	0.74111E–06
21	0.18330E+00	0.00000E+00	0.00000E+00	0.24344E–02	0.26465E–05	0.10041E–05
22	0.11727E–01	0.00000E+00	0.00000E+00	0.12273E–02	0.66220E–06	0.25123E–06
23	0.85440E–02	0.00000E+00	0.00000E+00	0.66770E–02	0.68626E–06	0.26036E–06
24	0.10729E–01	0.00000E+00	0.00000E+00	0.81818E–02	0.56321E–06	0.21368E–06
25	0.14778E–01	0.00000E+00	0.00000E+00	0.38596E–02	0.39529E–06	0.14997E–06
26	0.36502E–01	0.00000E+00	0.00000E+00	0.32220E–02	0.82604E–06	0.31339E–06

	^{238}Pu			^{239}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.18412E–04	0.73827E–04	0.18360E–04	0.36022E–05	0.13405E–04	0.35949E–05
2	0.14213E–04	0.50994E–04	0.14083E–04	0.27564E–05	0.91994E–05	0.27241E–05
3	0.14930E–04	0.49541E–04	0.14749E–04	0.29777E–05	0.91931E–05	0.29203E–05
4	0.15257E–04	0.47654E–04	0.15004E–04	0.32952E–05	0.94621E–05	0.31678E–05
5	0.14269E–04	0.42332E–04	0.13861E–04	0.32778E–05	0.86081E–05	0.29899E–05
6	0.11604E–04	0.31766E–04	0.10660E–04	0.27712E–05	0.60429E–05	0.21467E–05
7	0.78768E–05	0.18736E–04	0.63770E–05	0.19566E–05	0.18378E–05	0.66178E–06
8	0.67644E–05	0.13359E–04	0.45813E–05	0.22999E–05	0.37225E–06	0.13492E–06
9	0.76891E–05	0.12389E–04	0.42646E–05	0.31403E–05	0.21166E–06	0.76994E–07
10	0.95682E–05	0.14948E–04	0.51456E–05	0.46780E–05	0.59358E–07	0.21632E–07
11	0.12342E–04	0.15282E–04	0.52606E–05	0.69295E–05	0.00000E+00	0.00000E+00
12	0.14964E–04	0.20221E–04	0.69608E–05	0.98076E–05	0.00000E+00	0.00000E+00
13	0.23983E–04	0.22644E–04	0.77947E–05	0.14336E–04	0.00000E+00	0.00000E+00
14	0.26152E–04	0.25187E–04	0.86701E–05	0.20664E–04	0.00000E+00	0.00000E+00
15	0.47690E–04	0.44855E–04	0.15441E–04	0.30944E–04	0.00000E+00	0.00000E+00
16	0.12014E–03	0.14574E–03	0.50167E–04	0.45445E–04	0.00000E+00	0.00000E+00
17	0.22994E–03	0.11207E–03	0.38579E–04	0.66655E–04	0.00000E+00	0.00000E+00
18	0.11603E–03	0.30893E–04	0.10634E–04	0.97746E–04	0.00000E+00	0.00000E+00
19	0.33121E–05	0.12595E–05	0.43356E–06	0.14341E–03	0.00000E+00	0.00000E+00
20	0.38628E–03	0.46493E–04	0.16004E–04	0.21063E–03	0.00000E+00	0.00000E+00
21	0.66002E–04	0.26955E–04	0.92790E–05	0.30871E–03	0.00000E+00	0.00000E+00

Table 4.65. (continued)

	^{238}Pu			^{239}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
22	0.33122E–03	0.23063E–04	0.79392E–05	0.12714E–04	0.00000E+00	0.00000E+00
23	0.34528E–04	0.47366E–05	0.16305E–05	0.18314E–04	0.00000E+00	0.00000E+00
24	0.12993E–03	0.14005E–04	0.48211E–05	0.27473E–04	0.00000E+00	0.00000E+00
25	0.40035E–03	0.38430E–04	0.13229E–04	0.40170E–04	0.00000E+00	0.00000E+00
26	0.24665E–02	0.22053E–03	0.75912E–04	0.10310E–03	0.00000E+00	0.00000E+00

	^{239}Pu			^{240}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.28031E–03	0.11208E–02	0.27992E–03	0.77430E–04	0.30531E–03	0.77176E–04
2	0.22775E–03	0.81141E–03	0.22748E–03	0.58480E–04	0.20650E–03	0.57973E–04
3	0.24444E–03	0.80787E–03	0.24400E–03	0.61596E–04	0.19992E–03	0.60509E–04
4	0.25965E–03	0.80670E–03	0.25724E–03	0.62973E–04	0.18790E–03	0.60147E–04
5	0.24008E–03	0.70425E–03	0.23220E–03	0.60256E–04	0.17211E–03	0.53987E–04
6	0.22890E–03	0.62623E–03	0.21214E–03	0.27899E–04	0.68630E–04	0.21885E–04
7	0.22489E–03	0.58261E–03	0.20007E–03	0.11739E–04	0.14027E–04	0.48552E–05
8	0.22926E–03	0.57424E–03	0.19863E–03	0.13805E–04	0.84201E–05	0.29349E–05
9	0.24494E–03	0.58757E–03	0.20388E–03	0.19964E–04	0.83849E–05	0.29349E–05
10	0.27777E–03	0.60847E–03	0.21135E–03	0.29602E–04	0.12090E–04	0.42393E–05
11	0.32137E–03	0.60416E–03	0.21000E–03	0.39021E–04	0.12081E–04	0.42391E–05
12	0.48520E–03	0.78467E–03	0.27274E–03	0.54091E–04	0.99826E–05	0.35051E–05
13	0.75619E–03	0.11351E–02	0.39454E–03	0.79629E–04	0.15815E–04	0.55548E–05
14	0.11010E–02	0.16981E–02	0.59044E–03	0.12371E–03	0.28841E–04	0.10130E–04
15	0.19419E–02	0.29935E–02	0.10409E–02	0.20202E–03	0.27172E–04	0.95442E–05
16	0.31633E–02	0.49044E–02	0.17053E–02	0.29713E–03	0.58511E–05	0.20552E–05
17	0.45303E–02	0.74651E–02	0.25957E–02	0.87618E–03	0.53848E–08	0.18523E–08
18	0.12562E–01	0.22724E–01	0.79057E–02	0.80718E–03	0.14248E–07	0.49014E–08
19	0.70656E–02	0.78900E–02	0.27457E–02	0.24453E–02	0.14057E–04	0.48357E–05
20	0.21504E–01	0.37110E–01	0.12916E–01	0.89055E–03	0.18234E–04	0.62725E–05
21	0.85250E–02	0.14800E–01	0.51510E–02	0.32703E–04	0.60156E–07	0.20693E–07
22	0.16503E–02	0.40352E–02	0.14045E–02	0.32547E–03	0.23127E–06	0.79558E–07
23	0.34540E–02	0.81576E–02	0.28394E–02	0.13681E+00	0.78791E–04	0.27104E–04
24	0.18869E–01	0.37603E–01	0.13169E–01	0.39817E–01	0.22992E–04	0.79090E–05
25	0.33377E+00	0.56999E+00	0.20045E+00	0.58761E–02	0.34883E–05	0.12000E–05
26	0.12067E+00	0.23942E+00	0.83519E–01	0.81357E–02	0.49472E–05	0.17018E–05

	^{241}Pu			^{242}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.41666E–04	0.16677E–03	0.41536E–04	0.76122E–05	0.29611E–04	0.76122E–05
2	0.30946E–04	0.11104E–03	0.30794E–04	0.58994E–05	0.20599E–04	0.58518E–05
3	0.32964E–04	0.10989E–03	0.32725E–04	0.59946E–05	0.19311E–04	0.58519E–05
4	0.37955E–04	0.11684E–03	0.36696E–04	0.63276E–05	0.18731E–04	0.60422E–05
5	0.36783E–04	0.10640E–03	0.34656E–04	0.66131E–05	0.18126E–04	0.60422E–05
6	0.34874E–04	0.98436E–04	0.32790E–04	0.22361E–05	0.44607E–05	0.15224E–05
7	0.40147E–04	0.11150E–03	0.37630E–04	0.10942E–05	0.82497E–06	0.28546E–06
8	0.48480E–04	0.12835E–03	0.43597E–04	0.13321E–05	0.40963E–06	0.14273E–06
9	0.57660E–04	0.14396E–03	0.49066E–04	0.19982E–05	0.27213E–06	0.95152E–07
10	0.69638E–04	0.16838E–03	0.57486E–04	0.24740E–05	0.27118E–06	0.95152E–07
11	0.84460E–04	0.19373E–03	0.66210E–04	0.33779E–05	0.13559E–06	0.47576E–07

Table 4.65. (continued)

	^{241}Pu			^{242}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
12	0.11352E–03	0.27019E–03	0.92403E–04	0.48052E–05	0.13559E–06	0.47576E–07
13	0.17810E–03	0.40065E–03	0.13702E–03	0.76122E–05	0.00000E+00	0.00000E+00
14	0.26421E–03	0.58145E–03	0.19885E–03	0.12997E–04	0.00000E+00	0.00000E+00
15	0.35789E–03	0.80053E–03	0.27378E–03	0.21409E–04	0.00000E+00	0.00000E+00
16	0.65986E–03	0.14308E–02	0.48931E–03	0.42818E–04	0.00000E+00	0.00000E+00
17	0.72373E–03	0.16412E–02	0.56128E–03	0.51271E–04	0.68677E–06	0.24919E–06
18	0.11989E–02	0.27118E–02	0.92083E–03	0.16252E–03	0.53327E–06	0.19350E–06
19	0.17345E–02	0.42036E–02	0.14274E–02	0.22303E–04	0.12203E–08	0.44279E–09
20	0.48320E–02	0.92321E–02	0.31348E–02	0.76461E–05	0.63558E–09	0.23062E–09
21	0.56501E–02	0.14222E–01	0.48292E–02	0.34203E–05	0.14144E–08	0.51322E–09
22	0.38312E–02	0.68104E–02	0.23125E–02	0.60990E–02	0.13455E–05	0.48821E–06
23	0.37641E–03	0.72701E–03	0.24686E–03	0.77382E–04	0.18311E–07	0.66441E–08
24	0.13081E–02	0.24003E–02	0.81505E–03	0.30257E–04	0.85138E–08	0.30892E–08
25	0.26353E–01	0.52939E–01	0.17976E–01	0.31631E–04	0.96476E–08	0.35006E–08
26	0.25108E–01	0.54644E–01	0.18555E–01	0.66180E–04	0.21414E–07	0.77700E–08

	^{241}Am			^{242m}Am		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.12036E–05	0.53315E–05	0.11927E–05	0.19430E–07	0.88636E–07	0.19387E–07
2	0.96260E–06	0.38294E–05	0.95023E–06	0.16186E–07	0.66318E–07	0.16148E–07
3	0.10116E–05	0.36920E–05	0.98982E–06	0.18035E–07	0.68475E–07	0.18001E–07
4	0.10264E–05	0.34417E–05	0.97497E–06	0.15337E–07	0.54871E–07	0.15284E–07
5	0.83541E–06	0.24327E–05	0.71762E–06	0.18866E–07	0.64715E–07	0.18769E–07
6	0.48798E–06	0.72079E–06	0.21776E–06	0.17957E–07	0.59711E–07	0.17755E–07
7	0.46917E–06	0.11294E–06	0.34644E–07	0.19695E–07	0.63723E–07	0.19228E–07
8	0.65972E–06	0.95914E–07	0.29695E–07	0.23499E–07	0.74103E–07	0.22531E–07
9	0.80571E–06	0.44621E–07	0.13857E–07	0.29142E–07	0.89584E–07	0.27346E–07
10	0.10715E–05	0.47808E–07	0.14847E–07	0.34004E–07	0.98329E–07	0.30070E–07
11	0.14451E–05	0.79433E–07	0.24746E–07	0.45636E–07	0.12683E–06	0.38821E–07
12	0.20687E–05	0.12709E–06	0.39593E–07	0.76684E–07	0.21536E–06	0.65961E–07
13	0.30783E–05	0.19064E–06	0.59389E–07	0.11727E–06	0.32864E–06	0.10066E–06
14	0.46001E–05	0.28054E–06	0.87397E–07	0.17417E–06	0.48702E–06	0.14921E–06
15	0.71514E–05	0.39717E–06	0.12373E–06	0.26641E–06	0.74367E–06	0.22784E–06
16	0.10913E–04	0.71490E–06	0.22271E–06	0.39759E–06	0.11084E–05	0.33958E–06
17	0.16431E–04	0.95320E–06	0.29695E–06	0.59110E–06	0.16463E–05	0.50439E–06
18	0.23632E–04	0.11915E–05	0.37118E–06	0.87383E–06	0.24319E–05	0.74506E–06
19	0.34788E–04	0.16929E–05	0.52739E–06	0.12909E–05	0.35930E–05	0.11008E–05
20	0.39643E–04	0.28280E–05	0.88100E–06	0.19086E–05	0.52990E–05	0.16235E–05
21	0.61084E–04	0.45925E–05	0.14307E–05	0.25263E–05	0.77547E–05	0.23758E–05
22	0.66611E–04	0.25234E–05	0.78611E–06	0.29030E–05	0.82747E–05	0.25351E–05
23	0.32426E–03	0.11595E–04	0.36120E–05	0.34647E–05	0.10263E–04	0.31442E–05
24	0.38245E–03	0.11316E–04	0.35251E–05	0.86999E–05	0.24167E–04	0.74040E–05
25	0.68698E–03	0.30127E–04	0.93855E–05	0.24204E–04	0.65612E–04	0.20102E–04
26	0.29690E–03	0.99072E–05	0.30863E–05	0.58884E–04	0.15919E–03	0.48773E–04

	^{243}Am			^{242}Cm		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.16493E–05	0.77232E–05	0.16457E–05	0.32691E–06	0.15958E–05	0.32688E–06
2	0.11175E–05	0.46600E–05	0.11130E–05	0.25447E–06	0.11095E–05	0.25441E–06
3	0.10557E–05	0.40397E–05	0.10474E–05	0.25510E–06	0.10273E–05	0.25491E–06

Table 4.65. (continued)

	^{243}Am			^{242}Cm		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
4	0.10800E–05	0.38477E–05	0.10614E–05	0.26568E–06	0.10068E–05	0.26523E–06
5	0.83368E–06	0.27612E–05	0.79574E–06	0.27527E–06	0.99685E–06	0.27378E–06
6	0.18578E–06	0.34793E–06	0.10300E–06	0.17733E–06	0.60399E–06	0.17023E–06
7	0.17414E–06	0.51165E–07	0.15393E–07	0.85671E–07	0.23350E–06	0.66810E–07
8	0.31917E–06	0.27361E–07	0.82987E–08	0.59224E–07	0.10862E–06	0.31329E–07
9	0.61176E–06	0.30980E–07	0.94364E–08	0.78600E–07	0.10344E–06	0.29958E–07
10	0.94451E–06	0.33545E–07	0.10240E–07	0.12176E–06	0.12061E–06	0.34991E–07
11	0.12628E–05	0.43590E–07	0.13318E–07	0.17855E–06	0.14603E–06	0.42414E–07
12	0.19761E–05	0.34369E–07	0.10507E–07	0.24756E–06	0.19249E–06	0.55940E–07
13	0.32666E–05	0.10946E–07	0.33463E–08	0.34749E–06	0.24799E–06	0.72070E–07
14	0.51455E–05	0.39244E–08	0.12001E–08	0.50900E–06	0.27936E–06	0.81207E–07
15	0.82923E–05	0.10942E–08	0.33463E–09	0.84248E–06	0.40594E–06	0.11801E–06
16	0.12638E–04	0.21866E–09	0.66868E–10	0.16881E–05	0.63928E–06	0.18584E–06
17	0.21493E–04	0.00000E+00	0.00000E+00	0.12637E–05	0.39993E–06	0.11626E–06
18	0.23188E–04	0.00000E+00	0.00000E+00	0.38977E–05	0.67105E–06	0.19507E–06
19	0.38210E–04	0.00000E+00	0.00000E+00	0.40057E–05	0.14852E–05	0.43174E–06
20	0.73150E–04	0.00000E+00	0.00000E+00	0.72660E–05	0.10614E–05	0.30855E–06
21	0.83937E–04	0.00000E+00	0.00000E+00	0.57829E–07	0.64534E–07	0.18760E–07
22	0.50066E–04	0.00000E+00	0.00000E+00	0.10736E–06	0.11041E–06	0.32097E–07
23	0.12100E–02	0.00000E+00	0.00000E+00	0.21571E–06	0.19897E–06	0.57839E–07
24	0.50417E–04	0.00000E+00	0.00000E+00	0.40873E–06	0.34487E–06	0.10025E–06
25	0.29619E–04	0.00000E+00	0.00000E+00	0.66516E–06	0.51982E–06	0.15111E–06
26	0.41022E–04	0.00000E+00	0.00000E+00	0.16873E–05	0.77195E–06	0.22440E–06

	^{243}Cm			^{244}Cm		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.41547E–08	0.19856E–07	0.41506E–08	0.31624E–06	0.15351E–05	0.31587E–06
2	0.36617E–08	0.15738E–07	0.36575E–08	0.24724E–06	0.10747E–05	0.24650E–06
3	0.41039E–08	0.16347E–07	0.40990E–08	0.24254E–06	0.96844E–06	0.24031E–06
4	0.48408E–08	0.18204E–07	0.48313E–08	0.23585E–06	0.87310E–06	0.22916E–06
5	0.46834E–08	0.16889E–07	0.46642E–08	0.25517E–06	0.87046E–06	0.23783E–06
6	0.38756E–08	0.13542E–07	0.38329E–08	0.12511E–06	0.35169E–06	0.96618E–07
7	0.33755E–08	0.11382E–07	0.32697E–08	0.60696E–07	0.52174E–07	0.14864E–07
8	0.39488E–08	0.12769E–07	0.36947E–08	0.73083E–07	0.21615E–07	0.61935E–08
9	0.47799E–08	0.14833E–07	0.43094E–08	0.11768E–06	0.25790E–07	0.74322E–08
10	0.55422E–08	0.16856E–07	0.49056E–08	0.15855E–06	0.30088E–07	0.86709E–08
11	0.67952E–08	0.20700E–07	0.60299E–08	0.20810E–06	0.42859E–07	0.12387E–07
12	0.10950E–07	0.32636E–07	0.95120E–08	0.24650E–06	0.55717E–07	0.16103E–07
13	0.17500E–07	0.51979E–07	0.15150E–07	0.32949E–06	0.72860E–07	0.21058E–07
14	0.26938E–07	0.79768E–07	0.23256E–07	0.46736E–06	0.10116E–06	0.29236E–07
15	0.42597E–07	0.12574E–06	0.36658E–07	0.91416E–06	0.18001E–06	0.52025E–07
16	0.65111E–07	0.19175E–06	0.55905E–07	0.16094E–05	0.25588E–06	0.73954E–07
17	0.98584E–07	0.28975E–06	0.84476E–07	0.13204E–05	0.27463E–06	0.79371E–07
18	0.14793E–06	0.43410E–06	0.12656E–06	0.20420E–05	0.32239E–06	0.93177E–07
19	0.13099E–06	0.35379E–06	0.10314E–06	0.27136E–05	0.70222E–06	0.20295E–06
20	0.30160E–06	0.90570E–06	0.26405E–06	0.47278E–05	0.62101E–06	0.17948E–06
21	0.71211E–06	0.22642E–05	0.66013E–06	0.10196E–03	0.61061E–05	0.17648E–05
22	0.13657E–06	0.38622E–06	0.11260E–06	0.34765E–06	0.36263E–07	0.10481E–07
23	0.19672E–06	0.55632E–06	0.16219E–06	0.28996E–06	0.48350E–07	0.13974E–07
24	0.29510E–06	0.83454E–06	0.24331E–06	0.37594E–06	0.79513E–07	0.22981E–07

Table 4.65. (continued)

Group	^{243}Cm			^{244}Cm		
	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
25	0.43148E–06	0.12202E–05	0.35575E–06	0.52840E–06	0.12331E–06	0.35638E–07
26	0.11074E–05	0.31317E–05	0.91305E–06	0.13293E–05	0.33261E–06	0.96132E–07

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.66. Multigroup cross sections of nuclides (cm^{-1}) for Regions 2 and 3 for Variant V3S6

Group	Absorption[a]				
	Region 2	Region 3			
	Zr	H	O	^{10}B	^{11}B
1	0.31302E–03	0.00000E+00	0.57806E–02	0.13252E–05	0.78907E–07
2	0.13113E–03	0.00000E+00	0.29724E–02	0.20541E–05	0.67098E–08
3	0.23688E–03	0.00000E+00	0.94383E–04	0.21204E–05	0.72465E–07
4	0.54567E–03	0.00000E+00	0.00000E+00	0.27167E–05	0.23538E–06
5	0.53721E–03	0.00000E+00	0.00000E+00	0.14578E–05	0.27966E–06
6	0.57528E–03	0.00000E+00	0.00000E+00	0.40420E–05	0.39641E–06
7	0.54144E–03	0.00000E+00	0.00000E+00	0.72888E–05	0.36072E–06
8	0.57951E–03	0.00000E+00	0.00000E+00	0.11066E–04	0.12802E–06
9	0.73981E–03	0.00000E+00	0.00000E+00	0.15572E–04	0.48310E–07
10	0.12732E–02	0.00000E+00	0.00000E+00	0.22264E–04	0.24155E–07
11	0.16811E–02	0.00000E+00	0.00000E+00	0.32468E–04	0.21471E–07
12	0.36020E–02	0.00000E+00	0.00000E+00	0.47642E–04	0.21471E–07
13	0.51551E–02	0.66940E–04	0.00000E+00	0.70238E–04	0.21471E–07
14	0.25182E–02	0.66940E–04	0.00000E+00	0.10211E–03	0.21471E–07
15	0.26781E–02	0.13388E–03	0.00000E+00	0.15373E–03	0.21471E–07
16	0.12855E–01	0.20082E–03	0.00000E+00	0.22595E–03	0.21471E–07
17	0.36255E–02	0.26776E–03	0.00000E+00	0.33330E–03	0.21471E–07
18	0.13536E–03	0.40164E–03	0.00000E+00	0.49034E–03	0.21471E–07
19	0.20727E–03	0.60246E–03	0.00000E+00	0.72225E–03	0.21471E–07
20	0.32148E–03	0.93716E–03	0.00000E+00	0.10602E–02	0.21471E–07
21	0.48645E–03	0.13388E–02	0.00000E+00	0.15572E–02	0.21471E–07
22	0.73534E–03	0.20021E–02	0.81412E–06	0.22899E–02	0.13298E–07
23	0.10669E–02	0.29150E–02	0.11853E–05	0.33340E–02	0.19362E–07
24	0.15886E–02	0.43241E–02	0.17583E–05	0.49455E–02	0.28721E–07
25	0.23318E–02	0.63585E–02	0.25856E–05	0.72724E–02	0.42234E–07
26	0.60832E–02	0.16918E–01	0.68791E–05	0.19349E–01	0.11237E–06

[a]Absorption is reaction 3.

Table 4.67. The cell one-group cross section and flux values for Variant V4S3

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2008E–01	0.2249E–01	0.8440E–02	0.4014E+02

Table 4.68. Reaction rates for every region of cell for Variant V4S3

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.7733E+00	0.9027E+00	0.3388E+00	0.1336E+02	0.3328E+00
2	0.8876E–02	0.0000E+00	0.0000E+00	0.5463E+01	0.1361E+00
3	0.2392E–01	0.0000E+00	0.0000E+00	0.2131E+02	0.5311E+00

Table 4.69. Multigroup cross sections of nuclides (cm^{-1}) for Region 1 for Variant V4S3

	^{235}U			^{236}U		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.61287E–03	0.21362E–02	0.61192E–03	0.13041E–03	0.44305E–03	0.12955E–03
2	0.41764E–03	0.12599E–02	0.41514E–03	0.81183E–04	0.24155E–03	0.79456E–04
3	0.46074E–03	0.12558E–02	0.45109E–03	0.82047E–04	0.21997E–03	0.77728E–04
4	0.49957E–03	0.12514E–02	0.47493E–03	0.74274E–04	0.17490E–03	0.66501E–04
5	0.48568E–03	0.11328E–02	0.44617E–03	0.64774E–04	0.92134E–04	0.36273E–04
6	0.48772E–03	0.10705E–02	0.43027E–03	0.28500E–04	0.63737E–05	0.25910E–05
7	0.56749E–03	0.11748E–02	0.47758E–03	0.28501E–04	0.00000E+00	0.00000E+00
8	0.68269E–03	0.13391E–02	0.54835E–03	0.34546E–04	0.00000E+00	0.00000E+00
9	0.83656E–03	0.15653E–02	0.64522E–03	0.51819E–04	0.00000E+00	0.00000E+00
10	0.10375E–02	0.18978E–02	0.78259E–03	0.69092E–04	0.00000E+00	0.00000E+00
11	0.13241E–02	0.23965E–02	0.98622E–03	0.94544E–04	0.00000E+00	0.00000E+00
12	0.17551E–02	0.31379E–02	0.12902E–02	0.13700E–03	0.00000E+00	0.00000E+00
13	0.25416E–02	0.45893E–02	0.18871E–02	0.20966E–03	0.00000E+00	0.00000E+00
14	0.38881E–02	0.64385E–02	0.26474E–02	0.19161E–03	0.33058E–10	0.13925E–10
15	0.58821E–02	0.10385E–01	0.42700E–02	0.41711E–03	0.61655E–09	0.25971E–09
16	0.83547E–02	0.15017E–01	0.61746E–02	0.47554E–03	0.12899E–04	0.54336E–05
17	0.11516E–01	0.18800E–01	0.77304E–02	0.11185E–02	0.44060E–04	0.18560E–04
18	0.19204E–01	0.32074E–01	0.13189E–01	0.16898E–02	0.51681E–04	0.21770E–04
19	0.25092E–01	0.38769E–01	0.15941E–01	0.30804E–02	0.11777E–03	0.49607E–04
20	0.31903E–01	0.42032E–01	0.17283E–01	0.93012E–05	0.24075E–06	0.10141E–06
21	0.31264E–01	0.45693E–01	0.18788E–01	0.23445E–01	0.65104E–03	0.27424E–03
22	0.91392E–02	0.15589E–01	0.64098E–02	0.22618E–03	0.60770E–05	0.25598E–05
23	0.14816E–01	0.25820E–01	0.10617E–01	0.88478E–04	0.20680E–05	0.87109E–06
24	0.27800E–01	0.60883E–01	0.25034E–01	0.10171E–03	0.21245E–05	0.89489E–06
25	0.68492E–01	0.13740E+00	0.56496E–01	0.13585E–03	0.26887E–05	0.11325E–05
26	0.14734E+00	0.30606E+00	0.12585E+00	0.28338E–03	0.53807E–05	0.22665E–05

Table 4.69. (continued)

	^{238}U			^{237}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.17374E–01	0.60433E–01	0.17271E–01	0.53975E–04	0.20490E–03	0.53767E–04
2	0.10703E–01	0.32609E–01	0.10507E–01	0.38764E–04	0.13109E–03	0.38376E–04
3	0.10237E–01	0.27559E–01	0.98599E–02	0.41601E–04	0.12911E–03	0.40883E–04
4	0.94237E–02	0.22456E–01	0.85239E–02	0.42490E–04	0.12208E–03	0.41008E–04
5	0.27875E–02	0.18515E–02	0.72575E–03	0.39771E–04	0.10439E–03	0.36539E–04
6	0.21772E–02	0.50357E–04	0.20160E–04	0.24873E–04	0.48009E–04	0.17245E–04
7	0.22982E–02	0.45260E–05	0.18327E–05	0.17806E–04	0.61735E–05	0.22514E–05
8	0.29061E–02	0.00000E+00	0.00000E+00	0.24150E–04	0.21952E–05	0.80675E–06
9	0.47599E–02	0.00000E+00	0.00000E+00	0.32717E–04	0.12109E–05	0.44681E–06
10	0.80076E–02	0.00000E+00	0.00000E+00	0.44493E–04	0.69832E–06	0.25816E–06
11	0.10409E–01	0.00000E+00	0.00000E+00	0.64083E–04	0.64389E–06	0.23830E–06
12	0.13248E–01	0.00000E+00	0.00000E+00	0.97103E–04	0.72411E–06	0.26809E–06
13	0.16795E–01	0.00000E+00	0.00000E+00	0.15144E–03	0.58980E–06	0.21844E–06
14	0.21196E–01	0.00000E+00	0.00000E+00	0.23296E–03	0.14685E–05	0.54389E–06
15	0.30280E–01	0.00000E+00	0.00000E+00	0.36984E–03	0.19298E–05	0.71739E–06
16	0.31948E–01	0.00000E+00	0.00000E+00	0.56842E–03	0.25782E–05	0.96561E–06
17	0.54369E–01	0.00000E+00	0.00000E+00	0.82048E–03	0.54796E–05	0.20678E–05
18	0.41528E–01	0.00000E+00	0.00000E+00	0.14523E–02	0.32467E–05	0.12318E–05
19	0.74256E–01	0.00000E+00	0.00000E+00	0.20551E–02	0.32848E–04	0.12462E–04
20	0.77915E–01	0.00000E+00	0.00000E+00	0.22470E–02	0.19526E–05	0.74079E–06
21	0.18854E+00	0.00000E+00	0.00000E+00	0.24287E–02	0.26351E–05	0.99974E–06
22	0.11686E–01	0.00000E+00	0.00000E+00	0.12545E–02	0.66890E–06	0.25378E–06
23	0.85277E–02	0.00000E+00	0.00000E+00	0.67713E–02	0.68178E–06	0.25866E–06
24	0.10779E–01	0.00000E+00	0.00000E+00	0.84641E–02	0.58079E–06	0.22035E–06
25	0.14674E–01	0.00000E+00	0.00000E+00	0.44177E–02	0.42583E–06	0.16156E–06
26	0.30851E–01	0.00000E+00	0.00000E+00	0.26856E–02	0.67689E–06	0.25681E–06

	^{238}Pu			^{239}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.18412E–04	0.73827E–04	0.18360E–04	0.36022E–05	0.13405E–04	0.35949E–05
2	0.14213E–04	0.50994E–04	0.14083E–04	0.27564E–05	0.91994E–05	0.27241E–05
3	0.14930E–04	0.49541E–04	0.14749E–04	0.29777E–05	0.91931E–05	0.29203E–05
4	0.15257E–04	0.47654E–04	0.15004E–04	0.32952E–05	0.94621E–05	0.31678E–05
5	0.14269E–04	0.42332E–04	0.13861E–04	0.32778E–05	0.86081E–05	0.29900E–05
6	0.11604E–04	0.31766E–04	0.10660E–04	0.27712E–05	0.60429E–05	0.21467E–05
7	0.78768E–05	0.18736E–04	0.63770E–05	0.19566E–05	0.18378E–05	0.66179E–06
8	0.67644E–05	0.13359E–04	0.45813E–05	0.22999E–05	0.37225E–06	0.13492E–06
9	0.76891E–05	0.12389E–04	0.42646E–05	0.31403E–05	0.21166E–06	0.76994E–07
10	0.95682E–05	0.14948E–04	0.51456E–05	0.46780E–05	0.59358E–07	0.21632E–07
11	0.12342E–04	0.15282E–04	0.52606E–05	0.69295E–05	0.00000E+00	0.00000E+00
12	0.14964E–04	0.20221E–04	0.69608E–05	0.98076E–05	0.00000E+00	0.00000E+00
13	0.23983E–04	0.22644E–04	0.77947E–05	0.14336E–04	0.00000E+00	0.00000E+00
14	0.26152E–04	0.25187E–04	0.86701E–05	0.20664E–04	0.00000E+00	0.00000E+00
15	0.47679E–04	0.44847E–04	0.15438E–04	0.30944E–04	0.00000E+00	0.00000E+00
16	0.12016E–03	0.14574E–03	0.50169E–04	0.45445E–04	0.00000E+00	0.00000E+00
17	0.23046E–03	0.11239E–03	0.38687E–04	0.66655E–04	0.00000E+00	0.00000E+00
18	0.11376E–03	0.30603E–04	0.10535E–04	0.97746E–04	0.00000E+00	0.00000E+00
19	0.33033E–05	0.12577E–05	0.43294E–06	0.14341E–03	0.00000E+00	0.00000E+00

Table 4.69. (continued)

	^{238}Pu			^{239}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
20	0.39907E–03	0.49450E–04	0.17022E–04	0.21063E–03	0.00000E+00	0.00000E+00
21	0.66228E–04	0.27055E–04	0.93134E–05	0.30871E–03	0.00000E+00	0.00000E+00
22	0.32673E–03	0.22770E–04	0.78382E–05	0.12720E–04	0.00000E+00	0.00000E+00
23	0.33923E–04	0.46695E–05	0.16074E–05	0.18203E–04	0.00000E+00	0.00000E+00
24	0.13262E–03	0.14254E–04	0.49066E–05	0.27639E–04	0.00000E+00	0.00000E+00
25	0.39257E–03	0.37734E–04	0.12989E–04	0.39857E–04	0.00000E+00	0.00000E+00
26	0.19228E–02	0.17266E–03	0.59435E–04	0.86890E–04	0.00000E+00	0.00000E+00

	^{239}Pu			^{240}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.28031E–03	0.11208E–02	0.27992E–03	0.77430E–04	0.30531E–03	0.77176E–04
2	0.22775E–03	0.81141E–03	0.22748E–03	0.58480E–04	0.20650E–03	0.57973E–04
3	0.24444E–03	0.80787E–03	0.24400E–03	0.61596E–04	0.19992E–03	0.60509E–04
4	0.25965E–03	0.80670E–03	0.25724E–03	0.62973E–04	0.18790E–03	0.60147E–04
5	0.24008E–03	0.70425E–03	0.23220E–03	0.60256E–04	0.17211E–03	0.53987E–04
6	0.22890E–03	0.62623E–03	0.21214E–03	0.27899E–04	0.68631E–04	0.21885E–04
7	0.22489E–03	0.58262E–03	0.20007E–03	0.11739E–04	0.14027E–04	0.48552E–05
8	0.22926E–03	0.57424E–03	0.19863E–03	0.13805E–04	0.84202E–05	0.29349E–05
9	0.24494E–03	0.58757E–03	0.20388E–03	0.19964E–04	0.83849E–05	0.29349E–05
10	0.27777E–03	0.60847E–03	0.21135E–03	0.29602E–04	0.12090E–04	0.42393E–05
11	0.32159E–03	0.60456E–03	0.21013E–03	0.38952E–04	0.12063E–04	0.42326E–05
12	0.48602E–03	0.78595E–03	0.27318E–03	0.54280E–04	0.10017E–04	0.35171E–05
13	0.75828E–03	0.11382E–02	0.39561E–03	0.79918E–04	0.15868E–04	0.55737E–05
14	0.11030E–02	0.17012E–02	0.59152E–03	0.12373E–03	0.28843E–04	0.10131E–04
15	0.19334E–02	0.29799E–02	0.10361E–02	0.20585E–03	0.27841E–04	0.97789E–05
16	0.31439E–02	0.48762E–02	0.16955E–02	0.29502E–03	0.58097E–05	0.20406E–05
17	0.45002E–02	0.74997E–02	0.26077E–02	0.87308E–03	0.53790E–08	0.18504E–08
18	0.12332E–01	0.22226E–01	0.77325E–02	0.84417E–03	0.14223E–07	0.48926E–08
19	0.73284E–02	0.80878E–02	0.28146E–02	0.26632E–02	0.14555E–04	0.50070E–05
20	0.21775E–01	0.37526E–01	0.13060E–01	0.82140E–03	0.16808E–04	0.57820E–05
21	0.90400E–02	0.15610E–01	0.54329E–02	0.32071E–04	0.59894E–07	0.20603E–07
22	0.16509E–02	0.40362E–02	0.14049E–02	0.32690E–03	0.23211E–06	0.79845E–07
23	0.33946E–02	0.80261E–02	0.27936E–02	0.13484E+00	0.77658E–04	0.26714E–04
24	0.19567E–01	0.38865E–01	0.13613E–01	0.43433E–01	0.25073E–04	0.86251E–05
25	0.32787E+00	0.56016E+00	0.19699E+00	0.59149E–02	0.35099E–05	0.12074E–05
26	0.11584E+00	0.22319E+00	0.77976E–01	0.71468E–02	0.43369E–05	0.14919E–05

	^{241}Pu			^{242}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.41666E–04	0.16677E–03	0.41536E–04	0.76122E–05	0.29611E–04	0.76122E–05
2	0.30946E–04	0.11104E–03	0.30794E–04	0.58994E–05	0.20599E–04	0.58518E–05
3	0.32964E–04	0.10989E–03	0.32725E–04	0.59946E–05	0.19311E–04	0.58518E–05
4	0.37955E–04	0.11684E–03	0.36696E–04	0.63276E–05	0.18731E–04	0.60422E–05
5	0.36783E–04	0.10640E–03	0.34656E–04	0.66131E–05	0.18126E–04	0.60422E–05
6	0.34874E–04	0.98436E–04	0.32790E–04	0.22361E–05	0.44607E–05	0.15224E–05
7	0.40147E–04	0.11150E–03	0.37630E–04	0.10942E–05	0.82497E–06	0.28546E–06
8	0.48480E–04	0.12835E–03	0.43597E–04	0.13321E–05	0.40963E–06	0.14273E–06
9	0.57660E–04	0.14396E–03	0.49066E–04	0.19982E–05	0.27213E–06	0.95152E–07

Table 4.69. (continued)

	^{241}Pu			^{242}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
10	0.69638E–04	0.16838E–03	0.57486E–04	0.24740E–05	0.27118E–06	0.95152E–07
11	0.84460E–04	0.19373E–03	0.66210E–04	0.33779E–05	0.13559E–06	0.47576E–07
12	0.11352E–03	0.27019E–03	0.92403E–04	0.48052E–05	0.13559E–06	0.47576E–07
13	0.17810E–03	0.40065E–03	0.13702E–03	0.76122E–05	0.00000E+00	0.00000E+00
14	0.26421E–03	0.58146E–03	0.19886E–03	0.12997E–04	0.00000E+00	0.00000E+00
15	0.35789E–03	0.80053E–03	0.27378E–03	0.21409E–04	0.00000E+00	0.00000E+00
16	0.65986E–03	0.14308E–02	0.48931E–03	0.42818E–04	0.00000E+00	0.00000E+00
17	0.72373E–03	0.16412E–02	0.56127E–03	0.53050E–04	0.75036E–06	0.27226E–06
18	0.11692E–02	0.26434E–02	0.89759E–03	0.16093E–03	0.52765E–06	0.19146E–06
19	0.17742E–02	0.43057E–02	0.14620E–02	0.21918E–04	0.12164E–08	0.44137E–09
20	0.49027E–02	0.93567E–02	0.31772E–02	0.76358E–05	0.63569E–09	0.23066E–09
21	0.55666E–02	0.13962E–01	0.47409E–02	0.33409E–05	0.13944E–08	0.50595E–09
22	0.37321E–02	0.66268E–02	0.22502E–02	0.63173E–02	0.13936E–05	0.50567E–06
23	0.37389E–03	0.72461E–03	0.24605E–03	0.79489E–04	0.18768E–07	0.68100E–08
24	0.13510E–02	0.24796E–02	0.84195E–03	0.30196E–04	0.85110E–08	0.30882E–08
25	0.24839E–01	0.49801E–01	0.16910E–01	0.31512E–04	0.96007E–08	0.34836E–08
26	0.23334E–01	0.50800E–01	0.17249E–01	0.56623E–04	0.18237E–07	0.66172E–08

	^{241}Am			^{242m}Am		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.12036E–05	0.53315E–05	0.11927E–05	0.19430E–07	0.88636E–07	0.19387E–07
2	0.96260E–06	0.38294E–05	0.95023E–06	0.16186E–07	0.66318E–07	0.16148E–07
3	0.10116E–05	0.36920E–05	0.98982E–06	0.18035E–07	0.68475E–07	0.18001E–07
4	0.10264E–05	0.34417E–05	0.97497E–06	0.15337E–07	0.54871E–07	0.15284E–07
5	0.83541E–06	0.24327E–05	0.71762E–06	0.18866E–07	0.64715E–07	0.18769E–07
6	0.48798E–06	0.72079E–06	0.21776E–06	0.17957E–07	0.59711E–07	0.17755E–07
7	0.46917E–06	0.11294E–06	0.34644E–07	0.19695E–07	0.63723E–07	0.19228E–07
8	0.65971E–06	0.95913E–07	0.29695E–07	0.23499E–07	0.74103E–07	0.22531E–07
9	0.80571E–06	0.44621E–07	0.13857E–07	0.29142E–07	0.89584E–07	0.27346E–07
10	0.10715E–05	0.47808E–07	0.14847E–07	0.34004E–07	0.98329E–07	0.30070E–07
11	0.14451E–05	0.79433E–07	0.24745E–07	0.45636E–07	0.12683E–06	0.38821E–07
12	0.20687E–05	0.12709E–06	0.39593E–07	0.76684E–07	0.21536E–06	0.65961E–07
13	0.30783E–05	0.19064E–06	0.59389E–07	0.11727E–06	0.32864E–06	0.10066E–06
14	0.46001E–05	0.28055E–06	0.87398E–07	0.17417E–06	0.48702E–06	0.14921E–06
15	0.71515E–05	0.39717E–06	0.12373E–06	0.26641E–06	0.74367E–06	0.22784E–06
16	0.10913E–04	0.71490E–06	0.22271E–06	0.39759E–06	0.11084E–05	0.33958E–06
17	0.16431E–04	0.95320E–06	0.29695E–06	0.59110E–06	0.16463E–05	0.50439E–06
18	0.23632E–04	0.11915E–05	0.37118E–06	0.87383E–06	0.24319E–05	0.74506E–06
19	0.35574E–04	0.17041E–05	0.53087E–06	0.12909E–05	0.35930E–05	0.11008E–05
20	0.40453E–04	0.28558E–05	0.88964E–06	0.19086E–05	0.52990E–05	0.16235E–05
21	0.60723E–04	0.45787E–05	0.14264E–05	0.25263E–05	0.77547E–05	0.23758E–05
22	0.66894E–04	0.25265E–05	0.78708E–06	0.29074E–05	0.82870E–05	0.25389E–05
23	0.30934E–03	0.11187E–04	0.34850E–05	0.34353E–05	0.10165E–04	0.31143E–05
24	0.39355E–03	0.11432E–04	0.35614E–05	0.88223E–05	0.24483E–04	0.75008E–05
25	0.68751E–03	0.30105E–04	0.93786E–05	0.23499E–04	0.63719E–04	0.19522E–04
26	0.25170E–03	0.80813E–05	0.25175E–05	0.55803E–04	0.15076E–03	0.46188E–04

Table 4.69. (continued)

	^{243}Am			^{242}Cm		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.16493E–05	0.77232E–05	0.16457E–05	0.32691E–06	0.15958E–05	0.32688E–06
2	0.11175E–05	0.46600E–05	0.11130E–05	0.25447E–06	0.11095E–05	0.25441E–06
3	0.10557E–05	0.40397E–05	0.10474E–05	0.25510E–06	0.10273E–05	0.25491E–06
4	0.10800E–05	0.38477E–05	0.10614E–05	0.26568E–06	0.10068E–05	0.26523E–06
5	0.83368E–06	0.27612E–05	0.79574E–06	0.27527E–06	0.99685E–06	0.27378E–06
6	0.18578E–06	0.34793E–06	0.10300E–06	0.17733E–06	0.60399E–06	0.17023E–06
7	0.17414E–06	0.51165E–07	0.15393E–07	0.85671E–07	0.23350E–06	0.66810E–07
8	0.31917E–06	0.27361E–07	0.82987E–08	0.59223E–07	0.10862E–06	0.31329E–07
9	0.61176E–06	0.30980E–07	0.94364E–08	0.78600E–07	0.10344E–06	0.29958E–07
10	0.94451E–06	0.33545E–07	0.10240E–07	0.12176E–06	0.12061E–06	0.34991E–07
11	0.12628E–05	0.43590E–07	0.13318E–07	0.17855E–06	0.14603E–06	0.42414E–07
12	0.19761E–05	0.34369E–07	0.10507E–07	0.24756E–06	0.19249E–06	0.55940E–07
13	0.32666E–05	0.10946E–07	0.33463E–08	0.34749E–06	0.24799E–06	0.72070E–07
14	0.51456E–05	0.39242E–08	0.12000E–08	0.50901E–06	0.27936E–06	0.81208E–07
15	0.82923E–05	0.10942E–08	0.33463E–09	0.84248E–06	0.40594E–06	0.11801E–06
16	0.12655E–04	0.21892E–09	0.66949E–10	0.16881E–05	0.63928E–06	0.18584E–06
17	0.21636E–04	0.00000E+00	0.00000E+00	0.12637E–05	0.39993E–06	0.11626E–06
18	0.23561E–04	0.00000E+00	0.00000E+00	0.39074E–05	0.67105E–06	0.19507E–06
19	0.38409E–04	0.00000E+00	0.00000E+00	0.38718E–05	0.14852E–05	0.43174E–06
20	0.72993E–04	0.00000E+00	0.00000E+00	0.72156E–05	0.10614E–05	0.30855E–06
21	0.84230E–04	0.00000E+00	0.00000E+00	0.57871E–07	0.64534E–07	0.18760E–07
22	0.50790E–04	0.00000E+00	0.00000E+00	0.10743E–06	0.11041E–06	0.32097E–07
23	0.11974E–02	0.00000E+00	0.00000E+00	0.21392E–06	0.19897E–06	0.57839E–07
24	0.47726E–04	0.00000E+00	0.00000E+00	0.41147E–06	0.34487E–06	0.10025E–06
25	0.30039E–04	0.00000E+00	0.00000E+00	0.66019E–06	0.51982E–06	0.15111E–06
26	0.35256E–04	0.00000E+00	0.00000E+00	0.14180E–05	0.67125E–06	0.19513E–06

	^{243}Cm			^{244}Cm		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.41547E–08	0.19856E–07	0.41506E–08	0.31624E–06	0.15351E–05	0.31587E–06
2	0.36616E–08	0.15738E–07	0.36575E–08	0.24724E–06	0.10747E–05	0.24650E–06
3	0.41039E–08	0.16347E–07	0.40990E–08	0.24254E–06	0.96844E–06	0.24031E–06
4	0.48408E–08	0.18204E–07	0.48313E–08	0.23585E–06	0.87310E–06	0.22916E–06
5	0.46834E–08	0.16889E–07	0.46642E–08	0.25517E–06	0.87046E–06	0.23783E–06
6	0.38756E–08	0.13542E–07	0.38329E–08	0.12511E–06	0.35169E–06	0.96619E–07
7	0.33755E–08	0.11382E–07	0.32697E–08	0.60696E–07	0.52174E–07	0.14864E–07
8	0.39488E–08	0.12769E–07	0.36947E–08	0.73083E–07	0.21615E–07	0.61935E–08
9	0.47799E–08	0.14833E–07	0.43094E–08	0.11768E–06	0.25790E–07	0.74322E–08
10	0.55422E–08	0.16856E–07	0.49056E–08	0.15855E–06	0.30088E–07	0.86709E–08
11	0.67952E–08	0.20701E–07	0.60299E–08	0.20810E–06	0.42859E–07	0.12387E–07
12	0.10950E–07	0.32636E–07	0.95120E–08	0.24650E–06	0.55717E–07	0.16103E–07
13	0.17500E–07	0.51980E–07	0.15150E–07	0.32949E–06	0.72860E–07	0.21058E–07
14	0.26938E–07	0.79769E–07	0.23256E–07	0.46736E–06	0.10116E–06	0.29236E–07
15	0.42597E–07	0.12574E–06	0.36658E–07	0.91416E–06	0.18001E–06	0.52025E–07
16	0.65111E–07	0.19175E–06	0.55905E–07	0.16542E–05	0.25999E–06	0.75141E–07
17	0.98584E–07	0.28975E–06	0.84476E–07	0.13164E–05	0.27801E–06	0.80349E–07
18	0.14793E–06	0.43410E–06	0.12656E–06	0.20532E–05	0.32398E–06	0.93635E–07
19	0.13099E–06	0.35379E–06	0.10314E–06	0.27116E–05	0.69849E–06	0.20187E–06

Table 4.69. (continued)

Group	^{243}Cm Absorption[a]	^{243}Cm $\nu\Sigma_f$[b]	^{243}Cm Fission[c]	^{244}Cm Absorption[a]	^{244}Cm $\nu\Sigma_f$[b]	^{244}Cm Fission[c]
20	0.30160E–06	0.90570E–06	0.26405E–06	0.47516E–05	0.62405E–06	0.18036E–06
21	0.71211E–06	0.22642E–05	0.66013E–06	0.10718E–03	0.64185E–05	0.18551E–05
22	0.13664E–06	0.38640E–06	0.11265E–06	0.34729E–06	0.36256E–07	0.10479E–07
23	0.19552E–06	0.55294E–06	0.16121E–06	0.28925E–06	0.47989E–07	0.13870E–07
24	0.29688E–06	0.83958E–06	0.24478E–06	0.37782E–06	0.80090E–07	0.23147E–07
25	0.42812E–06	0.12107E–05	0.35299E–06	0.52451E–06	0.12224E–06	0.35329E–07
26	0.93333E–06	0.26395E–05	0.76952E–06	0.11218E–05	0.27921E–06	0.80696E–07

Group	Absorption[a] ^{103}Rh	^{131}Xe	^{143}Nd	^{147}Pm	^{133}Cs
1	0.62337E–07	0.19957E–07	0.80076E–07	0.20319E–07	0.28779E–07
2	0.16623E–06	0.12829E–07	0.24824E–06	0.58495E–07	0.18706E–06
3	0.38536E–06	0.57020E–07	0.65929E–06	0.19704E–06	0.54680E–06
4	0.80471E–06	0.17106E–06	0.10437E–05	0.51168E–06	0.11763E–05
5	0.14092E–05	0.34355E–06	0.11264E–05	0.12592E–05	0.20937E–05
6	0.23650E–05	0.64005E–06	0.13052E–05	0.21569E–05	0.40543E–05
7	0.49095E–05	0.11347E–05	0.16949E–05	0.29063E–05	0.52702E–05
8	0.74200E–05	0.16963E–05	0.24530E–05	0.33545E–05	0.74574E–05
9	0.11522E–04	0.30206E–05	0.38890E–05	0.44715E–05	0.11882E–04
10	0.17529E–04	0.48353E–05	0.75298E–05	0.64529E–05	0.18336E–04
11	0.24225E–04	0.74682E–05	0.12396E–04	0.10480E–04	0.27984E–04
12	0.31341E–04	0.11348E–04	0.20326E–04	0.18509E–04	0.43780E–04
13	0.41207E–04	0.18047E–04	0.28201E–04	0.33915E–04	0.73351E–04
14	0.50752E–04	0.30282E–04	0.52549E–04	0.60526E–04	0.92894E–04
15	0.80740E–04	0.39144E–04	0.79080E–04	0.11206E–03	0.18799E–03
16	0.18146E–03	0.71603E–04	0.24821E–03	0.17185E–03	0.46854E–03
17	0.30292E–03	0.17234E–03	0.93625E–03	0.27585E–03	0.58003E–03
18	0.38342E–04	0.12117E–03	0.65742E–03	0.41578E–03	0.99161E–03
19	0.74662E–05	0.30705E–03	0.11505E–04	0.52997E–03	0.11570E–02
20	0.15572E–05	0.15025E–01	0.38845E–04	0.27270E–03	0.45949E–04
21	0.10479E–04	0.25830E–03	0.12579E–03	0.11945E–01	0.15153E–01
22	0.16153E–03	0.10913E–03	0.35268E–03	0.42015E–03	0.37635E–03
23	0.20669E–01	0.15616E–03	0.72211E–03	0.15297E–03	0.20001E–03
24	0.30164E–02	0.23711E–03	0.13791E–02	0.19576E–03	0.23487E–03
25	0.13763E–02	0.34193E–03	0.21981E–02	0.29089E–03	0.31310E–03
26	0.18607E–02	0.74542E–03	0.51639E–02	0.68048E–03	0.64997E–03

Group	Absorption[a] ^{99}Tc	^{152}Sm	^{151}Sm	^{145}Nd	^{153}Eu
1	0.96628E–07	0.88579E–08	0.19992E–08	0.51935E–07	0.16121E–07
2	0.24324E–06	0.30063E–07	0.12118E–07	0.14382E–06	0.71675E–07
3	0.72638E–06	0.11676E–06	0.40630E–07	0.41947E–06	0.19270E–06
4	0.15694E–05	0.23353E–06	0.75170E–07	0.94282E–06	0.33903E–06
5	0.25890E–05	0.37659E–06	0.87873E–07	0.13923E–05	0.53645E–06
6	0.45915E–05	0.42947E–06	0.87565E–07	0.16240E–05	0.90821E–06
7	0.62542E–05	0.45041E–06	0.13841E–06	0.18956E–05	0.14610E–05
8	0.10156E–04	0.74272E–06	0.24849E–06	0.27705E–05	0.26735E–05

Table 4.69. (continued)

Group	Absorption[a]				
	^{99}Tc	^{152}Sm	^{151}Sm	^{145}Nd	^{153}Eu
9	0.16777E–04	0.11392E–05	0.39307E–06	0.49618E–05	0.43055E–05
10	0.27436E–04	0.15198E–05	0.72248E–06	0.87351E–05	0.60043E–05
11	0.41017E–04	0.21331E–05	0.12595E–05	0.14004E–04	0.91044E–05
12	0.56011E–04	0.30036E–05	0.22603E–05	0.23950E–04	0.14729E–04
13	0.75203E–04	0.38089E–05	0.40599E–05	0.44464E–04	0.24875E–04
14	0.10899E–03	0.60738E–05	0.67115E–05	0.67960E–04	0.41133E–04
15	0.13278E–03	0.15251E–04	0.11371E–04	0.14077E–03	0.69567E–04
16	0.29445E–03	0.26255E–04	0.18414E–04	0.20550E–03	0.11163E–03
17	0.52512E–03	0.44139E–04	0.29191E–04	0.19874E–03	0.17584E–03
18	0.13335E–03	0.12091E–03	0.42463E–04	0.13189E–03	0.32043E–03
19	0.10749E–03	0.25565E–05	0.41967E–04	0.13050E–02	0.21834E–03
20	0.15027E–02	0.81213E–04	0.22160E–03	0.20508E–04	0.58065E–03
21	0.95229E–02	0.11277E–01	0.76858E–04	0.11504E–03	0.48576E–03
22	0.57410E–04	0.13967E–03	0.75692E–04	0.31743E–02	0.23734E–02
23	0.82154E–04	0.10628E–03	0.49123E–03	0.11172E–03	0.27495E–03
24	0.12474E–03	0.12512E–03	0.19385E–03	0.16296E–03	0.87276E–04
25	0.17989E–03	0.16459E–03	0.26968E–03	0.23502E–03	0.14776E–03
26	0.39216E–03	0.33719E–03	0.19687E–02	0.51406E–03	0.43898E–03

Group	Absorption[a]				
	^{109}Ag	^{155}Eu	^{95}Mo	^{154}Eu	^{101}Ru
1	0.14324E–07	0.14625E–08	0.31697E–06	0.53237E–08	0.17435E–06
2	0.21376E–07	0.87074E–08	0.41813E–06	0.24571E–08	0.40786E–06
3	0.60822E–07	0.36031E–07	0.87672E–06	0.10596E–07	0.77212E–06
4	0.11371E–06	0.94067E–07	0.11802E–05	0.29894E–07	0.11115E–05
5	0.17255E–06	0.13298E–06	0.18816E–05	0.70487E–07	0.16345E–05
6	0.29287E–06	0.65611E–07	0.27246E–05	0.19477E–06	0.35026E–05
7	0.53440E–06	0.51276E–07	0.31663E–05	0.48118E–06	0.77150E–05
8	0.76446E–06	0.76120E–07	0.46770E–05	0.70231E–06	0.12180E–04
9	0.11409E–05	0.11933E–06	0.76747E–05	0.99460E–06	0.19474E–04
10	0.17013E–05	0.20437E–06	0.13279E–04	0.14799E–05	0.31003E–04
11	0.23646E–05	0.36525E–06	0.21652E–04	0.23701E–05	0.45020E–04
12	0.31711E–05	0.65291E–06	0.32027E–04	0.39308E–05	0.60649E–04
13	0.44625E–05	0.11671E–05	0.44713E–04	0.64652E–05	0.82443E–04
14	0.67406E–05	0.20341E–05	0.65641E–04	0.10236E–04	0.11827E–03
15	0.14494E–04	0.37290E–05	0.82074E–04	0.16642E–04	0.11744E–03
16	0.14906E–04	0.63209E–05	0.89358E–04	0.26009E–04	0.35181E–03
17	0.39895E–04	0.74289E–05	0.58167E–04	0.40076E–04	0.27868E–03
18	0.75663E–04	0.84576E–05	0.13296E–03	0.61529E–04	0.76745E–03
19	0.10088E–03	0.15642E–04	0.44005E–02	0.81749E–04	0.77275E–03
20	0.40113E–05	0.13492E–04	0.21749E–04	0.40260E–04	0.17918E–02
21	0.37331E–02	0.13667E–05	0.25809E–04	0.13596E–03	0.17170E–04
22	0.21481E–03	0.32818E–04	0.42541E–04	0.62366E–04	0.95392E–05
23	0.52218E–04	0.46963E–04	0.60877E–04	0.89246E–04	0.13650E–04
24	0.50996E–04	0.71308E–04	0.92434E–04	0.13551E–03	0.20727E–04
25	0.63433E–04	0.10283E–03	0.13330E–03	0.19542E–03	0.29890E–04
26	0.12548E–03	0.22418E–03	0.29059E–03	0.42601E–03	0.65160E–04

[a] Absorption is reaction 3.
[b] $\nu\Sigma_f$ is reaction 918.
[c] Fission is reaction 18.

Table 4.70. Multigroup cross sections of nuclides (cm^{-1}) for Regions 2 and 3 for Variant V4S3

Group	Absorption[a]		
	Region 2	Region 3	
	Zr	H	O
1	0.31302E–03	0.00000E+00	0.41336E–02
2	0.13113E–03	0.00000E+00	0.21335E–02
3	0.23688E–03	0.00000E+00	0.68263E–04
4	0.54567E–03	0.00000E+00	0.00000E+00
5	0.53721E–03	0.00000E+00	0.00000E+00
6	0.57528E–03	0.00000E+00	0.00000E+00
7	0.54144E–03	0.00000E+00	0.00000E+00
8	0.57951E–03	0.00000E+00	0.00000E+00
9	0.73529E–03	0.00000E+00	0.00000E+00
10	0.12553E–02	0.00000E+00	0.00000E+00
11	0.16466E–02	0.00000E+00	0.00000E+00
12	0.34921E–02	0.00000E+00	0.00000E+00
13	0.50034E–02	0.47830E–04	0.00000E+00
14	0.24843E–02	0.47830E–04	0.00000E+00
15	0.26416E–02	0.95660E–04	0.00000E+00
16	0.12305E–01	0.14349E–03	0.00000E+00
17	0.36304E–02	0.19132E–03	0.00000E+00
18	0.13536E–03	0.28698E–03	0.00000E+00
19	0.20727E–03	0.43047E–03	0.00000E+00
20	0.32148E–03	0.66962E–03	0.00000E+00
21	0.48645E–03	0.95660E–03	0.00000E+00
22	0.73551E–03	0.14304E–02	0.58152E–06
23	0.10612E–02	0.20723E–02	0.84247E–06
24	0.15973E–02	0.31052E–02	0.12624E–05
25	0.23143E–02	0.45090E–02	0.18331E–05
26	0.51029E–02	0.10071E–01	0.40944E–05

[a] Absorption is reaction 3.

Table 4.71. The cell one-group cross section and flux values for Variant V4S4

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2023E–01	0.2177E–01	0.8166E–02	0.3990E+02

Table 4.72. Reaction rates for every region of cell for Variant V4S4

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.7521E+00	0.8685E+00	0.3258E+00	0.1328E+02	0.3328E+00
2	0.8755E–02	0.0000E+00	0.0000E+00	0.5432E+01	0.1361E+00
3	0.4640E–01	0.0000E+00	0.0000E+00	0.2119E+02	0.5310E+00

Table 4.73. Multigroup cross sections of nuclides (s^{-1}) for Region 1 for Variant V4S4

	^{235}U			^{236}U		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.61287E–03	0.21362E–02	0.61192E–03	0.13041E–03	0.44305E–03	0.12955E–03
2	0.41763E–03	0.12599E–02	0.41514E–03	0.81183E–04	0.24155E–03	0.79456E–04
3	0.46074E–03	0.12558E–02	0.45109E–03	0.82047E–04	0.21997E–03	0.77728E–04
4	0.49957E–03	0.12514E–02	0.47493E–03	0.74274E–04	0.17490E–03	0.66501E–04
5	0.48568E–03	0.11328E–02	0.44617E–03	0.64774E–04	0.92134E–04	0.36273E–04
6	0.48772E–03	0.10705E–02	0.43028E–03	0.28500E–04	0.63737E–05	0.25910E–05
7	0.56749E–03	0.11748E–02	0.47758E–03	0.28500E–04	0.00000E+00	0.00000E+00
8	0.68269E–03	0.13391E–02	0.54835E–03	0.34546E–04	0.00000E+00	0.00000E+00
9	0.83656E–03	0.15653E–02	0.64522E–03	0.51819E–04	0.00000E+00	0.00000E+00
10	0.10375E–02	0.18978E–02	0.78259E–03	0.69092E–04	0.00000E+00	0.00000E+00
11	0.13232E–02	0.23948E–02	0.98552E–03	0.94412E–04	0.00000E+00	0.00000E+00
12	0.17567E–02	0.31408E–02	0.12914E–02	0.13687E–03	0.00000E+00	0.00000E+00
13	0.25404E–02	0.45872E–02	0.18862E–02	0.20858E–03	0.00000E+00	0.00000E+00
14	0.38930E–02	0.64470E–02	0.26509E–02	0.19030E–03	0.33113E–10	0.13948E–10
15	0.58590E–02	0.10344E–01	0.42535E–02	0.41555E–03	0.61689E–09	0.25985E–09
16	0.83547E–02	0.15017E–01	0.61747E–02	0.47851E–03	0.12962E–04	0.54598E–05
17	0.11520E–01	0.18807E–01	0.77332E–02	0.11238E–02	0.44830E–04	0.18884E–04
18	0.19243E–01	0.32144E–01	0.13217E–01	0.16863E–02	0.51546E–04	0.21713E–04
19	0.24922E–01	0.38533E–01	0.15844E–01	0.31052E–02	0.11921E–03	0.50214E–04
20	0.32069E–01	0.42258E–01	0.17376E–01	0.93052E–05	0.24084E–06	0.10145E–06
21	0.31186E–01	0.45413E–01	0.18673E–01	0.23653E–01	0.65681E–03	0.27667E–03
22	0.91465E–02	0.15602E–01	0.64151E–02	0.22539E–03	0.60549E–05	0.25505E–05
23	0.14827E–01	0.25830E–01	0.10621E–01	0.88488E–04	0.20684E–05	0.87127E–06
24	0.27780E–01	0.60841E–01	0.25017E–01	0.10168E–03	0.21240E–05	0.89471E–06
25	0.68462E–01	0.13734E+00	0.56472E–01	0.13579E–03	0.26877E–05	0.11322E–05
26	0.14668E+00	0.30467E+00	0.12528E+00	0.28233E–03	0.53612E–05	0.22583E–05

	^{238}U			^{237}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.17374E–01	0.60433E–01	0.17271E–01	0.53975E–04	0.20490E–03	0.53767E–04
2	0.10703E–01	0.32609E–01	0.10507E–01	0.38764E–04	0.13109E–03	0.38376E–04
3	0.10237E–01	0.27559E–01	0.98599E–02	0.41601E–04	0.12911E–03	0.40883E–04
4	0.94238E–02	0.22456E–01	0.85239E–02	0.42490E–04	0.12208E–03	0.41008E–04
5	0.27875E–02	0.18515E–02	0.72575E–03	0.39771E–04	0.10439E–03	0.36539E–04
6	0.21773E–02	0.50357E–04	0.20160E–04	0.24873E–04	0.48009E–04	0.17245E–04
7	0.22982E–02	0.45260E–05	0.18327E–05	0.17806E–04	0.61735E–05	0.22515E–05
8	0.29054E–02	0.00000E+00	0.00000E+00	0.24150E–04	0.21952E–05	0.80675E–06
9	0.47618E–02	0.00000E+00	0.00000E+00	0.32717E–04	0.12109E–05	0.44681E–06
10	0.80002E–02	0.00000E+00	0.00000E+00	0.44493E–04	0.69832E–06	0.25816E–06
11	0.10408E–01	0.00000E+00	0.00000E+00	0.64083E–04	0.64389E–06	0.23830E–06
12	0.13193E–01	0.00000E+00	0.00000E+00	0.97103E–04	0.72411E–06	0.26809E–06
13	0.16800E–01	0.00000E+00	0.00000E+00	0.15144E–03	0.58979E–06	0.21844E–06
14	0.21097E–01	0.00000E+00	0.00000E+00	0.23291E–03	0.14679E–05	0.54368E–06
15	0.30458E–01	0.00000E+00	0.00000E+00	0.36984E–03	0.19298E–05	0.71738E–06
16	0.31870E–01	0.00000E+00	0.00000E+00	0.56842E–03	0.25782E–05	0.96561E–06
17	0.54191E–01	0.00000E+00	0.00000E+00	0.82048E–03	0.54796E–05	0.20678E–05
18	0.41799E–01	0.00000E+00	0.00000E+00	0.14623E–02	0.32584E–05	0.12362E–05
19	0.76178E–01	0.00000E+00	0.00000E+00	0.20718E–02	0.32835E–04	0.12457E–04

Table 4.73. (continued)

	^{238}U			^{237}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
20	0.76902E–01	0.00000E+00	0.00000E+00	0.22532E–02	0.19528E–05	0.74087E–06
21	0.18690E+00	0.00000E+00	0.00000E+00	0.24124E–02	0.26302E–05	0.99786E–06
22	0.11654E–01	0.00000E+00	0.00000E+00	0.12436E–02	0.66634E–06	0.25280E–06
23	0.85276E–02	0.00000E+00	0.00000E+00	0.67404E–02	0.67890E–06	0.25757E–06
24	0.10775E–01	0.00000E+00	0.00000E+00	0.84477E–02	0.57976E–06	0.21996E–06
25	0.14668E–01	0.00000E+00	0.00000E+00	0.44368E–02	0.42682E–06	0.16193E–06
26	0.30736E–01	0.00000E+00	0.00000E+00	0.26749E–02	0.67384E–06	0.25565E–06

	^{238}Pu			^{239}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.18412E–04	0.73827E–04	0.18360E–04	0.36022E–05	0.13405E–04	0.35949E–05
2	0.14213E–04	0.50994E–04	0.14083E–04	0.27564E–05	0.91994E–05	0.27241E–05
3	0.14930E–04	0.49541E–04	0.14749E–04	0.29777E–05	0.91931E–05	0.29203E–05
4	0.15257E–04	0.47654E–04	0.15004E–04	0.32952E–05	0.94621E–05	0.31678E–05
5	0.14269E–04	0.42332E–04	0.13861E–04	0.32778E–05	0.86081E–05	0.29900E–05
6	0.11604E–04	0.31766E–04	0.10660E–04	0.27713E–05	0.60429E–05	0.21467E–05
7	0.78768E–05	0.18736E–04	0.63770E–05	0.19566E–05	0.18378E–05	0.66179E–06
8	0.67644E–05	0.13359E–04	0.45813E–05	0.22999E–05	0.37225E–06	0.13492E–06
9	0.76891E–05	0.12389E–04	0.42646E–05	0.31403E–05	0.21166E–06	0.76994E–07
10	0.95682E–05	0.14948E–04	0.51456E–05	0.46780E–05	0.59358E–07	0.21632E–07
11	0.12342E–04	0.15282E–04	0.52606E–05	0.69295E–05	0.00000E+00	0.00000E+00
12	0.14964E–04	0.20221E–04	0.69608E–05	0.98076E–05	0.00000E+00	0.00000E+00
13	0.23983E–04	0.22644E–04	0.77947E–05	0.14336E–04	0.00000E+00	0.00000E+00
14	0.26151E–04	0.25185E–04	0.86696E–05	0.20660E–04	0.00000E+00	0.00000E+00
15	0.47682E–04	0.44850E–04	0.15439E–04	0.30944E–04	0.00000E+00	0.00000E+00
16	0.12010E–03	0.14572E–03	0.50162E–04	0.45445E–04	0.00000E+00	0.00000E+00
17	0.23123E–03	0.11204E–03	0.38568E–04	0.66655E–04	0.00000E+00	0.00000E+00
18	0.11446E–03	0.30749E–04	0.10585E–04	0.97746E–04	0.00000E+00	0.00000E+00
19	0.32493E–05	0.12381E–05	0.42619E–06	0.14341E–03	0.00000E+00	0.00000E+00
20	0.39675E–03	0.49087E–04	0.16897E–04	0.21063E–03	0.00000E+00	0.00000E+00
21	0.64059E–04	0.26159E–04	0.90049E–05	0.30871E–03	0.00000E+00	0.00000E+00
22	0.33282E–03	0.23171E–04	0.79761E–05	0.12727E–04	0.00000E+00	0.00000E+00
23	0.33913E–04	0.46680E–05	0.16069E–05	0.18199E–04	0.00000E+00	0.00000E+00
24	0.13244E–03	0.14237E–04	0.49010E–05	0.27627E–04	0.00000E+00	0.00000E+00
25	0.39210E–03	0.37692E–04	0.12975E–04	0.39839E–04	0.00000E+00	0.00000E+00
26	0.19116E–02	0.17168E–03	0.59097E–04	0.86559E–04	0.00000E+00	0.00000E+00

	^{239}Pu			^{240}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.28031E–03	0.11208E–02	0.27992E–03	0.77430E–04	0.30531E–03	0.77176E–04
2	0.22775E–03	0.81141E–03	0.22748E–03	0.58480E–04	0.20650E–03	0.57973E–04
3	0.24444E–03	0.80787E–03	0.24400E–03	0.61596E–04	0.19992E–03	0.60509E–04
4	0.25965E–03	0.80670E–03	0.25724E–03	0.62973E–04	0.18790E–03	0.60147E–04
5	0.24008E–03	0.70425E–03	0.23220E–03	0.60255E–04	0.17211E–03	0.53987E–04
6	0.22891E–03	0.62623E–03	0.21214E–03	0.27899E–04	0.68631E–04	0.21885E–04
7	0.22489E–03	0.58261E–03	0.20007E–03	0.11739E–04	0.14027E–04	0.48552E–05
8	0.22926E–03	0.57424E–03	0.19863E–03	0.13805E–04	0.84202E–05	0.29349E–05
9	0.24494E–03	0.58757E–03	0.20388E–03	0.19964E–04	0.83849E–05	0.29349E–05

Table 4.73. (continued)

	^{239}Pu			^{240}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
10	0.27777E–03	0.60847E–03	0.21135E–03	0.29602E–04	0.12090E–04	0.42393E–05
11	0.32093E–03	0.60338E–03	0.20972E–03	0.38967E–04	0.12067E–04	0.42339E–05
12	0.48557E–03	0.78524E–03	0.27294E–03	0.54176E–04	0.99980E–05	0.35105E–05
13	0.75907E–03	0.11393E–02	0.39601E–03	0.79845E–04	0.15855E–04	0.55690E–05
14	0.11061E–02	0.17058E–02	0.59309E–03	0.12348E–03	0.28791E–04	0.10113E–04
15	0.19410E–02	0.29869E–02	0.10386E–02	0.20430E–03	0.27608E–04	0.96971E–05
16	0.31638E–02	0.49042E–02	0.17052E–02	0.30257E–03	0.59582E–05	0.20928E–05
17	0.44907E–02	0.74692E–02	0.25971E–02	0.87106E–03	0.53789E–08	0.18503E–08
18	0.12289E–01	0.22143E–01	0.77037E–02	0.83622E–03	0.14233E–07	0.48962E–08
19	0.72861E–02	0.80023E–02	0.27848E–02	0.26364E–02	0.14438E–04	0.49667E–05
20	0.21659E–01	0.37383E–01	0.13011E–01	0.79485E–03	0.16261E–04	0.55937E–05
21	0.90959E–02	0.15698E–01	0.54639E–02	0.32193E–04	0.59948E–07	0.20622E–07
22	0.16517E–02	0.40379E–02	0.14054E–02	0.32782E–03	0.23265E–06	0.80030E–07
23	0.33933E–02	0.80230E–02	0.27925E–02	0.13549E+00	0.78032E–04	0.26843E–04
24	0.19526E–01	0.38789E–01	0.13586E–01	0.43358E–01	0.25030E–04	0.86103E–05
25	0.32793E+00	0.56028E+00	0.19703E+00	0.59169E–02	0.35110E–05	0.12078E–05
26	0.11595E+00	0.22322E+00	0.77989E–01	0.71280E–02	0.43252E–05	0.14879E–05

	^{241}Pu			^{242}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.41666E–04	0.16677E–03	0.41536E–04	0.76122E–05	0.29611E–04	0.76122E–05
2	0.30946E–04	0.11104E–03	0.30794E–04	0.58994E–05	0.20598E–04	0.58518E–05
3	0.32964E–04	0.10989E–03	0.32725E–04	0.59946E–05	0.19311E–04	0.58518E–05
4	0.37955E–04	0.11684E–03	0.36696E–04	0.63276E–05	0.18731E–04	0.60422E–05
5	0.36783E–04	0.10640E–03	0.34656E–04	0.66131E–05	0.18126E–04	0.60422E–05
6	0.34874E–04	0.98436E–04	0.32790E–04	0.22361E–05	0.44607E–05	0.15224E–05
7	0.40147E–04	0.11150E–03	0.37630E–04	0.10942E–05	0.82497E–06	0.28546E–06
8	0.48480E–04	0.12835E–03	0.43597E–04	0.13321E–05	0.40963E–06	0.14273E–06
9	0.57659E–04	0.14396E–03	0.49066E–04	0.19982E–05	0.27213E–06	0.95152E–07
10	0.69639E–04	0.16838E–03	0.57486E–04	0.24740E–05	0.27118E–06	0.95152E–07
11	0.84460E–04	0.19373E–03	0.66210E–04	0.33779E–05	0.13559E–06	0.47576E–07
12	0.11352E–03	0.27019E–03	0.92403E–04	0.48052E–05	0.13559E–06	0.47576E–07
13	0.17810E–03	0.40065E–03	0.13702E–03	0.76122E–05	0.00000E+00	0.00000E+00
14	0.26416E–03	0.58134E–03	0.19882E–03	0.12994E–04	0.00000E+00	0.00000E+00
15	0.35789E–03	0.80053E–03	0.27378E–03	0.21409E–04	0.00000E+00	0.00000E+00
16	0.65986E–03	0.14308E–02	0.48931E–03	0.42818E–04	0.00000E+00	0.00000E+00
17	0.72373E–03	0.16412E–02	0.56128E–03	0.53507E–04	0.76301E–06	0.27686E–06
18	0.11626E–02	0.26290E–02	0.89271E–03	0.16023E–03	0.52550E–06	0.19067E–06
19	0.17635E–02	0.42785E–02	0.14528E–02	0.21719E–04	0.12241E–08	0.44417E–09
20	0.48733E–02	0.93303E–02	0.31682E–02	0.76630E–05	0.63572E–09	0.23067E–09
21	0.55694E–02	0.13964E–01	0.47416E–02	0.33611E–05	0.13992E–08	0.50771E–09
22	0.37097E–02	0.65861E–02	0.22364E–02	0.62932E–02	0.13883E–05	0.50374E–06
23	0.37395E–03	0.72487E–03	0.24613E–03	0.79652E–04	0.18804E–07	0.68230E–08
24	0.13487E–02	0.24753E–02	0.84052E–03	0.30200E–04	0.85112E–08	0.30883E–08
25	0.24803E–01	0.49724E–01	0.16884E–01	0.31505E–04	0.95981E–08	0.34826E–08
26	0.23338E–01	0.50803E–01	0.17250E–01	0.56431E–04	0.18173E–07	0.65939E–08

Table 4.73. (continued)

	^{241}Am			^{242m}Am		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.12036E–05	0.53315E–05	0.11927E–05	0.19430E–07	0.88636E–07	0.19387E–07
2	0.96260E–06	0.38294E–05	0.95023E–06	0.16186E–07	0.66318E–07	0.16148E–07
3	0.10116E–05	0.36920E–05	0.98982E–06	0.18035E–07	0.68475E–07	0.18001E–07
4	0.10264E–05	0.34417E–05	0.97497E–06	0.15337E–07	0.54871E–07	0.15284E–07
5	0.83541E–06	0.24327E–05	0.71762E–06	0.18866E–07	0.64715E–07	0.18769E–07
6	0.48798E–06	0.72079E–06	0.21776E–06	0.17957E–07	0.59711E–07	0.17755E–07
7	0.46917E–06	0.11294E–06	0.34644E–07	0.19695E–07	0.63723E–07	0.19228E–07
8	0.65972E–06	0.95914E–07	0.29695E–07	0.23499E–07	0.74103E–07	0.22531E–07
9	0.80571E–06	0.44621E–07	0.13857E–07	0.29142E–07	0.89584E–07	0.27346E–07
10	0.10715E–05	0.47808E–07	0.14847E–07	0.34004E–07	0.98329E–07	0.30070E–07
11	0.14451E–05	0.79433E–07	0.24746E–07	0.45636E–07	0.12683E–06	0.38821E–07
12	0.20687E–05	0.12709E–06	0.39593E–07	0.76684E–07	0.21536E–06	0.65961E–07
13	0.30783E–05	0.19064E–06	0.59389E–07	0.11727E–06	0.32864E–06	0.10066E–06
14	0.45991E–05	0.28049E–06	0.87379E–07	0.17414E–06	0.48692E–06	0.14918E–06
15	0.71514E–05	0.39716E–06	0.12373E–06	0.26641E–06	0.74367E–06	0.22784E–06
16	0.10913E–04	0.71490E–06	0.22271E–06	0.39759E–06	0.11084E–05	0.33958E–06
17	0.16431E–04	0.95320E–06	0.29695E–06	0.59110E–06	0.16463E–05	0.50439E–06
18	0.23632E–04	0.11915E–05	0.37118E–06	0.87383E–06	0.24319E–05	0.74506E–06
19	0.35432E–04	0.17009E–05	0.52988E–06	0.12909E–05	0.35930E–05	0.11008E–05
20	0.40633E–04	0.28565E–05	0.88988E–06	0.19086E–05	0.52990E–05	0.16235E–05
21	0.60752E–04	0.45808E–05	0.14270E–05	0.25263E–05	0.77547E–05	0.23758E–05
22	0.66793E–04	0.25264E–05	0.78705E–06	0.29024E–05	0.82737E–05	0.25348E–05
23	0.30930E–03	0.11186E–04	0.34848E–05	0.34362E–05	0.10167E–04	0.31148E–05
24	0.39125E–03	0.11410E–04	0.35544E–05	0.88090E–05	0.24448E–04	0.74903E–05
25	0.68801E–03	0.30114E–04	0.93812E–05	0.23459E–04	0.63612E–04	0.19489E–04
26	0.25097E–03	0.80478E–05	0.25071E–05	0.55744E–04	0.15059E–03	0.46138E–04

	^{243}Am			^{242}Cm		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.16493E–05	0.77232E–05	0.16457E–05	0.32691E–06	0.15958E–05	0.32688E–06
2	0.11175E–05	0.46600E–05	0.11130E–05	0.25447E–06	0.11095E–05	0.25441E–06
3	0.10557E–05	0.40397E–05	0.10474E–05	0.25510E–06	0.10273E–05	0.25491E–06
4	0.10800E–05	0.38477E–05	0.10614E–05	0.26568E–06	0.10068E–05	0.26523E–06
5	0.83368E–06	0.27612E–05	0.79574E–06	0.27527E–06	0.99685E–06	0.27378E–06
6	0.18578E–06	0.34793E–06	0.10300E–06	0.17733E–06	0.60399E–06	0.17023E–06
7	0.17414E–06	0.51165E–07	0.15393E–07	0.85671E–07	0.23350E–06	0.66810E–07
8	0.31917E–06	0.27361E–07	0.82987E–08	0.59223E–07	0.10862E–06	0.31329E–07
9	0.61176E–06	0.30980E–07	0.94364E–08	0.78600E–07	0.10344E–06	0.29958E–07
10	0.94451E–06	0.33545E–07	0.10240E–07	0.12176E–06	0.12061E–06	0.34991E–07
11	0.12628E–05	0.43590E–07	0.13318E–07	0.17855E–06	0.14603E–06	0.42414E–07
12	0.19761E–05	0.34369E–07	0.10507E–07	0.24756E–06	0.19249E–06	0.55940E–07
13	0.32666E–05	0.10946E–07	0.33463E–08	0.34749E–06	0.24799E–06	0.72070E–07
14	0.51444E–05	0.39288E–08	0.12014E–08	0.50890E–06	0.27934E–06	0.81202E–07
15	0.82923E–05	0.10942E–08	0.33462E–09	0.84248E–06	0.40594E–06	0.11801E–06
16	0.12635E–04	0.21861E–09	0.66853E–10	0.16881E–05	0.63928E–06	0.18584E–06
17	0.21414E–04	0.00000E+00	0.00000E+00	0.12637E–05	0.39993E–06	0.11626E–06
18	0.23309E–04	0.00000E+00	0.00000E+00	0.39235E–05	0.67105E–06	0.19507E–06
19	0.38190E–04	0.00000E+00	0.00000E+00	0.39549E–05	0.14852E–05	0.43174E–06

Table 4.73. (continued)

	^{243}Am			^{242}Cm		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
20	0.72981E–04	0.00000E+00	0.00000E+00	0.71816E–05	0.10614E–05	0.30855E–06
21	0.84302E–04	0.00000E+00	0.00000E+00	0.57866E–07	0.64534E–07	0.18760E–07
22	0.50897E–04	0.00000E+00	0.00000E+00	0.10751E–06	0.11041E–06	0.32097E–07
23	0.11881E–02	0.00000E+00	0.00000E+00	0.21386E–06	0.19897E–06	0.57839E–07
24	0.47743E–04	0.00000E+00	0.00000E+00	0.41128E–06	0.34487E–06	0.10025E–06
25	0.30066E–04	0.00000E+00	0.00000E+00	0.65991E–06	0.51982E–06	0.15111E–06
26	0.35141E–04	0.00000E+00	0.00000E+00	0.14126E–05	0.66956E–06	0.19464E–06

	^{243}Cm			^{244}Cm		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.41547E–08	0.19856E–07	0.41506E–08	0.31624E–06	0.15351E–05	0.31587E–06
2	0.36616E–08	0.15738E–07	0.36575E–08	0.24724E–06	0.10747E–05	0.24650E–06
3	0.41039E–08	0.16347E–07	0.40990E–08	0.24254E–06	0.96844E–06	0.24031E–06
4	0.48408E–08	0.18204E–07	0.48313E–08	0.23585E–06	0.87310E–06	0.22916E–06
5	0.46834E–08	0.16889E–07	0.46642E–08	0.25517E–06	0.87046E–06	0.23783E–06
6	0.38756E–08	0.13542E–07	0.38329E–08	0.12511E–06	0.35169E–06	0.96619E–07
7	0.33755E–08	0.11382E–07	0.32697E–08	0.60696E–07	0.52174E–07	0.14864E–07
8	0.39488E–08	0.12769E–07	0.36947E–08	0.73083E–07	0.21615E–07	0.61935E–08
9	0.47799E–08	0.14833E–07	0.43094E–08	0.11768E–06	0.25790E–07	0.74322E–08
10	0.55422E–08	0.16856E–07	0.49056E–08	0.15855E–06	0.30088E–07	0.86709E–08
11	0.67952E–08	0.20701E–07	0.60299E–08	0.20810E–06	0.42859E–07	0.12387E–07
12	0.10950E–07	0.32636E–07	0.95120E–08	0.24650E–06	0.55717E–07	0.16103E–07
13	0.17500E–07	0.51979E–07	0.15150E–07	0.32949E–06	0.72860E–07	0.21058E–07
14	0.26932E–07	0.79751E–07	0.23251E–07	0.46727E–06	0.10114E–06	0.29231E–07
15	0.42597E–07	0.12574E–06	0.36658E–07	0.91416E–06	0.18001E–06	0.52025E–07
16	0.65111E–07	0.19175E–06	0.55905E–07	0.16162E–05	0.25680E–06	0.74220E–07
17	0.98584E–07	0.28975E–06	0.84476E–07	0.13102E–05	0.27738E–06	0.80167E–07
18	0.14793E–06	0.43410E–06	0.12656E–06	0.20264E–05	0.32124E–06	0.92843E–07
19	0.13099E–06	0.35379E–06	0.10315E–06	0.27043E–05	0.69581E–06	0.20110E–06
20	0.30160E–06	0.90570E–06	0.26405E–06	0.48386E–05	0.63560E–06	0.18370E–06
21	0.71211E–06	0.22642E–05	0.66013E–06	0.10987E–03	0.65797E–05	0.19016E–05
22	0.13671E–06	0.38661E–06	0.11271E–06	0.34692E–06	0.36252E–07	0.10477E–07
23	0.19548E–06	0.55283E–06	0.16117E–06	0.28924E–06	0.47977E–07	0.13866E–07
24	0.29675E–06	0.83922E–06	0.24467E–06	0.37768E–06	0.80049E–07	0.23136E–07
25	0.42793E–06	0.12102E–05	0.35283E–06	0.52429E–06	0.12218E–06	0.35312E–07
26	0.92977E–06	0.26294E–05	0.76659E–06	0.11176E–05	0.27811E–06	0.80379E–07

	Absorption[a]				
Group	^{103}Rh	^{131}Xe	^{143}Nd	^{147}Pm	^{133}Cs
1	0.62337E–07	0.19957E–07	0.80076E–07	0.20319E–07	0.28779E–07
2	0.16623E–06	0.12830E–07	0.24824E–06	0.58495E–07	0.18706E–06
3	0.38536E–06	0.57020E–07	0.65929E–06	0.19704E–06	0.54680E–06
4	0.80471E–06	0.17106E–06	0.10437E–05	0.51168E–06	0.11764E–05
5	0.14092E–05	0.34355E–06	0.11264E–05	0.12592E–05	0.20937E–05
6	0.23650E–05	0.64005E–06	0.13052E–05	0.21569E–05	0.40543E–05
7	0.49095E–05	0.11347E–05	0.16949E–05	0.29063E–05	0.52702E–05
8	0.74200E–05	0.16963E–05	0.24530E–05	0.33546E–05	0.74574E–05
9	0.11524E–04	0.30206E–05	0.38890E–05	0.44715E–05	0.11882E–04

Table 4.73. (continued)

Group	Absorption[a]				
	^{103}Rh	^{131}Xe	^{143}Nd	^{147}Pm	^{133}Cs
10	0.17524E–04	0.48353E–05	0.75298E–05	0.64530E–05	0.18336E–04
11	0.24258E–04	0.74682E–05	0.12396E–04	0.10480E–04	0.27984E–04
12	0.31250E–04	0.11348E–04	0.20326E–04	0.18509E–04	0.43780E–04
13	0.41314E–04	0.18047E–04	0.28159E–04	0.33915E–04	0.73351E–04
14	0.50349E–04	0.30274E–04	0.52307E–04	0.60509E–04	0.94412E–04
15	0.80210E–04	0.39144E–04	0.79194E–04	0.11206E–03	0.18693E–03
16	0.18065E–03	0.71603E–04	0.24759E–03	0.17185E–03	0.46524E–03
17	0.30243E–03	0.17234E–03	0.93873E–03	0.27585E–03	0.57791E–03
18	0.38239E–04	0.12117E–03	0.64118E–03	0.41728E–03	0.99089E–03
19	0.76908E–05	0.30705E–03	0.11511E–04	0.53179E–03	0.11419E–02
20	0.15579E–05	0.15025E–01	0.38863E–04	0.27215E–03	0.45920E–04
21	0.10528E–04	0.25830E–03	0.12612E–03	0.12008E–01	0.15078E–01
22	0.16202E–03	0.10918E–03	0.35310E–03	0.41859E–03	0.37540E–03
23	0.20622E–01	0.15613E–03	0.72185E–03	0.15299E–03	0.20003E–03
24	0.30207E–02	0.23701E–03	0.13783E–02	0.19568E–03	0.23481E–03
25	0.13765E–02	0.34178E–03	0.21970E–02	0.29074E–03	0.31297E–03
26	0.18554E–02	0.74258E–03	0.51433E–02	0.67775E–03	0.64756E–03

Group	Absorption[a]				
	^{99}Tc	^{152}Sm	^{151}Sm	^{145}Nd	^{153}Eu
1	0.96628E–07	0.88579E–08	0.19992E–08	0.51935E–07	0.16121E–07
2	0.24324E–06	0.30063E–07	0.12118E–07	0.14382E–06	0.71675E–07
3	0.72638E–06	0.11676E–06	0.40630E–07	0.41947E–06	0.19270E–06
4	0.15694E–05	0.23353E–06	0.75170E–07	0.94282E–06	0.33903E–06
5	0.25890E–05	0.37659E–06	0.87873E–07	0.13923E–05	0.53645E–06
6	0.45915E–05	0.42947E–06	0.87565E–07	0.16240E–05	0.90821E–06
7	0.62542E–05	0.45041E–06	0.13841E–06	0.18956E–05	0.14610E–05
8	0.10156E–04	0.74272E–06	0.24849E–06	0.27705E–05	0.26735E–05
9	0.16777E–04	0.11392E–05	0.39307E–06	0.49618E–05	0.43055E–05
10	0.27436E–04	0.15198E–05	0.72248E–06	0.87351E–05	0.60043E–05
11	0.41017E–04	0.21331E–05	0.12595E–05	0.14005E–04	0.91045E–05
12	0.56011E–04	0.30036E–05	0.22603E–05	0.23950E–04	0.14729E–04
13	0.75203E–04	0.38089E–05	0.40599E–05	0.44464E–04	0.24875E–04
14	0.10897E–03	0.60167E–05	0.67098E–05	0.68126E–04	0.41123E–04
15	0.13278E–03	0.15297E–04	0.11371E–04	0.14131E–03	0.69567E–04
16	0.29445E–03	0.25634E–04	0.18414E–04	0.20706E–03	0.11163E–03
17	0.52512E–03	0.44465E–04	0.29191E–04	0.19677E–03	0.17584E–03
18	0.13335E–03	0.11981E–03	0.42598E–04	0.12846E–03	0.32043E–03
19	0.10749E–03	0.25561E–05	0.41926E–04	0.12955E–02	0.21762E–03
20	0.15027E–02	0.81258E–04	0.22206E–03	0.20512E–04	0.57700E–03
21	0.95229E–02	0.11103E–01	0.77310E–04	0.11659E–03	0.48196E–03
22	0.57441E–04	0.13952E–03	0.75615E–04	0.31155E–02	0.23648E–02
23	0.82137E–04	0.10628E–03	0.49252E–03	0.11170E–03	0.27599E–03
24	0.12469E–03	0.12508E–03	0.19378E–03	0.16289E–03	0.87236E–04
25	0.17981E–03	0.16453E–03	0.26959E–03	0.23492E–03	0.14765E–03
26	0.39067E–03	0.33595E–03	0.19533E–02	0.51210E–03	0.43694E–03

Table 4.73. (continued)

Group	Absorption[a]				
	^{109}Ag	^{155}Eu	^{95}Mo	^{154}Eu	^{101}Ru
1	0.14324E–07	0.14625E–08	0.31697E–06	0.53237E–08	0.17435E–06
2	0.21376E–07	0.87074E–08	0.41813E–06	0.24571E–08	0.40786E–06
3	0.60822E–07	0.36031E–07	0.87672E–06	0.10596E–07	0.77212E–06
4	0.11371E–06	0.94068E–07	0.11802E–05	0.29894E–07	0.11115E–05
5	0.17255E–06	0.13298E–06	0.18816E–05	0.70487E–07	0.16345E–05
6	0.29287E–06	0.65611E–07	0.27246E–05	0.19477E–06	0.35026E–05
7	0.53440E–06	0.51276E–07	0.31663E–05	0.48118E–06	0.77150E–05
8	0.76446E–06	0.76120E–07	0.46770E–05	0.70231E–06	0.12180E–04
9	0.11409E–05	0.11933E–06	0.76747E–05	0.99460E–06	0.19474E–04
10	0.17013E–05	0.20437E–06	0.13279E–04	0.14799E–05	0.31003E–04
11	0.23646E–05	0.36525E–06	0.21652E–04	0.23701E–05	0.45020E–04
12	0.31711E–05	0.65291E–06	0.32027E–04	0.39308E–05	0.60649E–04
13	0.44625E–05	0.11671E–05	0.44713E–04	0.64652E–05	0.82443E–04
14	0.67391E–05	0.20335E–05	0.65627E–04	0.10234E–04	0.11825E–03
15	0.14354E–04	0.37290E–05	0.82074E–04	0.16642E–04	0.11744E–03
16	0.15072E–04	0.63209E–05	0.89358E–04	0.26009E–04	0.35181E–03
17	0.39652E–04	0.74289E–05	0.58167E–04	0.40076E–04	0.27868E–03
18	0.77121E–04	0.84575E–05	0.13296E–03	0.61529E–04	0.76745E–03
19	0.10214E–03	0.15642E–04	0.44005E–02	0.81749E–04	0.77275E–03
20	0.40134E–05	0.13492E–04	0.21749E–04	0.40260E–04	0.17918E–02
21	0.37176E–02	0.13667E–05	0.25809E–04	0.13596E–03	0.17170E–04
22	0.21388E–03	0.32836E–04	0.42564E–04	0.62399E–04	0.95442E–05
23	0.52231E–04	0.46953E–04	0.60864E–04	0.89227E–04	0.13648E–04
24	0.50988E–04	0.71277E–04	0.92394E–04	0.13545E–03	0.20718E–04
25	0.63412E–04	0.10278E–03	0.13324E–03	0.19533E–03	0.29876E–04
26	0.12503E–03	0.22332E–03	0.28949E–03	0.42439E–03	0.64912E–04

Group	Absorption[a]				
	Region 2	Region 3			
	Zr	H	O	^{10}B	^{11}B
1	0.31302E–03	0.00000E+00	0.41285E–02	0.94688E–06	0.56380E–07
2	0.13113E–03	0.00000E+00	0.21353E–02	0.14677E–05	0.47942E–08
3	0.23688E–03	0.00000E+00	0.68203E–04	0.15150E–05	0.51778E–07
4	0.54567E–03	0.00000E+00	0.00000E+00	0.19411E–05	0.16818E–06
5	0.53721E–03	0.00000E+00	0.00000E+00	0.10416E–05	0.19982E–06
6	0.57528E–03	0.00000E+00	0.00000E+00	0.28880E–05	0.28324E–06
7	0.54144E–03	0.00000E+00	0.00000E+00	0.52078E–05	0.25774E–06
8	0.57951E–03	0.00000E+00	0.00000E+00	0.79065E–05	0.91474E–07
9	0.73450E–03	0.00000E+00	0.00000E+00	0.11126E–04	0.34519E–07
10	0.12580E–02	0.00000E+00	0.00000E+00	0.15908E–04	0.17259E–07
11	0.16422E–02	0.00000E+00	0.00000E+00	0.23199E–04	0.15342E–07
12	0.35016E–02	0.00000E+00	0.00000E+00	0.34040E–04	0.15342E–07
13	0.50262E–02	0.47830E–04	0.00000E+00	0.50185E–04	0.15342E–07
14	0.24994E–02	0.47830E–04	0.00000E+00	0.72941E–04	0.15342E–07
15	0.26178E–02	0.95660E–04	0.00000E+00	0.10984E–03	0.15342E–07
16	0.12248E–01	0.14349E–03	0.00000E+00	0.16144E–03	0.15342E–07
17	0.37507E–02	0.19132E–03	0.00000E+00	0.23814E–03	0.15342E–07

Table 4.73. (continued)

Group	Absorption[a]				
	Region 2	Region 3			
	Zr	H	O	^{10}B	^{11}B
18	0.13536E–03	0.28698E–03	0.00000E+00	0.35035E–03	0.15342E–07
19	0.20727E–03	0.43047E–03	0.00000E+00	0.51605E–03	0.15342E–07
20	0.32148E–03	0.66962E–03	0.00000E+00	0.75750E–03	0.15342E–07
21	0.48645E–03	0.95660E–03	0.00000E+00	0.11126E–02	0.15342E–07
22	0.73564E–03	0.14307E–02	0.58166E–06	0.16363E–02	0.95031E–08
23	0.10610E–02	0.20719E–02	0.84233E–06	0.23697E–02	0.13762E–07
24	0.15966E–02	0.31035E–02	0.12617E–05	0.35494E–02	0.20613E–07
25	0.23128E–02	0.45071E–02	0.18323E–05	0.51546E–02	0.29936E–07
26	0.50839E–02	0.10028E–01	0.40769E–05	0.11469E–01	0.66608E–07

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.74. The cell one-group cross section and flux values for Variant V4S5

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2015E–01	0.2200E–01	0.8254E–02	0.4006E+02

Table 4.75. Reaction rates for every region of cell for Variant V4S5

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.7512E+00	0.8814E+00	0.3307E+00	0.1334E+02	0.3330E+00
2	0.8808E–02	0.0000E+00	0.0000E+00	0.5453E+01	0.1361E+00
3	0.4722E–01	0.0000E+00	0.0000E+00	0.2127E+02	0.5309E+00

Table 4.76. Multigroup cross sections of nuclides (cm^{-1}) for Region 1 for Variant V4S5

	^{235}U			^{236}U		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.61287E–03	0.21362E–02	0.61192E–03	0.13041E–03	0.44305E–03	0.12955E–03
2	0.41764E–03	0.12599E–02	0.41514E–03	0.81183E–04	0.24155E–03	0.79456E–04
3	0.46074E–03	0.12558E–02	0.45109E–03	0.82047E–04	0.21997E–03	0.77729E–04
4	0.49957E–03	0.12514E–02	0.47493E–03	0.74274E–04	0.17490E–03	0.66501E–04
5	0.48568E–03	0.11328E–02	0.44617E–03	0.64774E–04	0.92134E–04	0.36273E–04
6	0.48772E–03	0.10705E–02	0.43028E–03	0.28500E–04	0.63737E–05	0.25910E–05
7	0.56749E–03	0.11748E–02	0.47758E–03	0.28500E–04	0.00000E+00	0.00000E+00
8	0.68269E–03	0.13391E–02	0.54835E–03	0.34546E–04	0.00000E+00	0.00000E+00
9	0.83656E–03	0.15653E–02	0.64522E–03	0.51819E–04	0.00000E+00	0.00000E+00
10	0.10375E–02	0.18978E–02	0.78259E–03	0.69092E–04	0.00000E+00	0.00000E+00
11	0.13265E–02	0.24010E–02	0.98808E–03	0.94257E–04	0.00000E+00	0.00000E+00
12	0.17571E–02	0.31415E–02	0.12917E–02	0.13704E–03	0.00000E+00	0.00000E+00
13	0.25371E–02	0.45811E–02	0.18837E–02	0.20948E–03	0.00000E+00	0.00000E+00
14	0.38962E–02	0.64515E–02	0.26527E–02	0.19182E–03	0.33081E–10	0.13935E–10
15	0.58626E–02	0.10351E–01	0.42560E–02	0.41492E–03	0.61757E–09	0.26014E–09
16	0.83472E–02	0.15004E–01	0.61692E–02	0.48913E–03	0.13671E–04	0.57586E–05
17	0.11530E–01	0.18823E–01	0.77397E–02	0.11069E–02	0.43545E–04	0.18343E–04
18	0.19172E–01	0.32053E–01	0.13180E–01	0.16735E–02	0.51176E–04	0.21557E–04
19	0.24865E–01	0.38469E–01	0.15818E–01	0.30482E–02	0.11561E–03	0.48698E–04
20	0.31694E–01	0.41668E–01	0.17133E–01	0.92904E–05	0.24049E–06	0.10130E–06
21	0.31244E–01	0.45218E–01	0.18593E–01	0.22130E–01	0.61451E–03	0.25885E–03
22	0.91482E–02	0.15635E–01	0.64288E–02	0.22507E–03	0.60461E–05	0.25468E–05
23	0.14973E–01	0.26082E–01	0.10724E–01	0.88480E–04	0.20676E–05	0.87094E–06
24	0.27724E–01	0.60731E–01	0.24971E–01	0.10165E–03	0.21236E–05	0.89451E–06
25	0.68461E–01	0.13734E+00	0.56472E–01	0.13577E–03	0.26874E–05	0.11320E–05
26	0.14679E+00	0.30492E+00	0.12538E+00	0.28256E–03	0.53655E–05	0.22601E–05

	^{238}U			^{237}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.17374E–01	0.60432E–01	0.17271E–01	0.53975E–04	0.20490E–03	0.53767E–04
2	0.10703E–01	0.32609E–01	0.10507E–01	0.38764E–04	0.13109E–03	0.38376E–04
3	0.10237E–01	0.27560E–01	0.98599E–02	0.41601E–04	0.12911E–03	0.40883E–04
4	0.94237E–02	0.22456E–01	0.85239E–02	0.42489E–04	0.12208E–03	0.41008E–04
5	0.27875E–02	0.18515E–02	0.72575E–03	0.39771E–04	0.10439E–03	0.36539E–04
6	0.21772E–02	0.50357E–04	0.20160E–04	0.24873E–04	0.48009E–04	0.17245E–04
7	0.22982E–02	0.45260E–05	0.18327E–05	0.17806E–04	0.61735E–05	0.22514E–05
8	0.29056E–02	0.00000E+00	0.00000E+00	0.24150E–04	0.21952E–05	0.80675E–06
9	0.47623E–02	0.00000E+00	0.00000E+00	0.32717E–04	0.12109E–05	0.44681E–06
10	0.80046E–02	0.00000E+00	0.00000E+00	0.44493E–04	0.69832E–06	0.25816E–06
11	0.10400E–01	0.00000E+00	0.00000E+00	0.64083E–04	0.64389E–06	0.23830E–06
12	0.13179E–01	0.00000E+00	0.00000E+00	0.97103E–04	0.72411E–06	0.26809E–06
13	0.16806E–01	0.00000E+00	0.00000E+00	0.15144E–03	0.58979E–06	0.21844E–06
14	0.19709E–01	0.00000E+00	0.00000E+00	0.23301E–03	0.14691E–05	0.54409E–06
15	0.27090E–01	0.00000E+00	0.00000E+00	0.36984E–03	0.19298E–05	0.71739E–06
16	0.28378E–01	0.00000E+00	0.00000E+00	0.56842E–03	0.25782E–05	0.96562E–06
17	0.48499E–01	0.00000E+00	0.00000E+00	0.82048E–03	0.54796E–05	0.20678E–05
18	0.37153E–01	0.00000E+00	0.00000E+00	0.14539E–02	0.32464E–05	0.12316E–05
19	0.72403E–01	0.00000E+00	0.00000E+00	0.20818E–02	0.32881E–04	0.12475E–04

Table 4.76. (continued)

	^{238}U			^{237}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
20	0.74037E–01	0.00000E+00	0.00000E+00	0.22546E–02	0.19527E–05	0.74084E–06
21	0.17732E+00	0.00000E+00	0.00000E+00	0.24441E–02	0.26395E–05	0.10014E–05
22	0.11670E–01	0.00000E+00	0.00000E+00	0.12506E–02	0.66837E–06	0.25358E–06
23	0.85300E–02	0.00000E+00	0.00000E+00	0.67225E–02	0.67836E–06	0.25736E–06
24	0.10771E–01	0.00000E+00	0.00000E+00	0.86420E–02	0.59109E–06	0.22425E–06
25	0.14665E–01	0.00000E+00	0.00000E+00	0.41594E–02	0.41040E–06	0.15570E–06
26	0.30761E–01	0.00000E+00	0.00000E+00	0.26772E–02	0.67450E–06	0.25590E–06

	^{238}Pu			^{239}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.18412E–04	0.73827E–04	0.18360E–04	0.36022E–05	0.13405E–04	0.35949E–05
2	0.14213E–04	0.50994E–04	0.14083E–04	0.27564E–05	0.91994E–05	0.27241E–05
3	0.14930E–04	0.49541E–04	0.14749E–04	0.29777E–05	0.91931E–05	0.29203E–05
4	0.15257E–04	0.47654E–04	0.15004E–04	0.32952E–05	0.94621E–05	0.31678E–05
5	0.14269E–04	0.42332E–04	0.13861E–04	0.32778E–05	0.86081E–05	0.29899E–05
6	0.11604E–04	0.31766E–04	0.10660E–04	0.27712E–05	0.60429E–05	0.21467E–05
7	0.78768E–05	0.18736E–04	0.63770E–05	0.19566E–05	0.18378E–05	0.66178E–06
8	0.67644E–05	0.13359E–04	0.45814E–05	0.22999E–05	0.37225E–06	0.13492E–06
9	0.76892E–05	0.12389E–04	0.42646E–05	0.31403E–05	0.21166E–06	0.76995E–07
10	0.95682E–05	0.14948E–04	0.51456E–05	0.46780E–05	0.59358E–07	0.21632E–07
11	0.12342E–04	0.15282E–04	0.52606E–05	0.69295E–05	0.00000E+00	0.00000E+00
12	0.14964E–04	0.20221E–04	0.69608E–05	0.98076E–05	0.00000E+00	0.00000E+00
13	0.23983E–04	0.22644E–04	0.77947E–05	0.14336E–04	0.00000E+00	0.00000E+00
14	0.26154E–04	0.25188E–04	0.86707E–05	0.20668E–04	0.00000E+00	0.00000E+00
15	0.47711E–04	0.44869E–04	0.15445E–04	0.30944E–04	0.00000E+00	0.00000E+00
16	0.12014E–03	0.14574E–03	0.50167E–04	0.45445E–04	0.00000E+00	0.00000E+00
17	0.23014E–03	0.11175E–03	0.38470E–04	0.66655E–04	0.00000E+00	0.00000E+00
18	0.11643E–03	0.31251E–04	0.10757E–04	0.97746E–04	0.00000E+00	0.00000E+00
19	0.32503E–05	0.12392E–05	0.42658E–06	0.14341E–03	0.00000E+00	0.00000E+00
20	0.39899E–03	0.48844E–04	0.16814E–04	0.21063E–03	0.00000E+00	0.00000E+00
21	0.67986E–04	0.27779E–04	0.95624E–05	0.30871E–03	0.00000E+00	0.00000E+00
22	0.33162E–03	0.23091E–04	0.79486E–05	0.12722E–04	0.00000E+00	0.00000E+00
23	0.33990E–04	0.46770E–05	0.16100E–05	0.18215E–04	0.00000E+00	0.00000E+00
24	0.13217E–03	0.14213E–04	0.48924E–05	0.27613E–04	0.00000E+00	0.00000E+00
25	0.39167E–03	0.37655E–04	0.12962E–04	0.39832E–04	0.00000E+00	0.00000E+00
26	0.19134E–02	0.17183E–03	0.59151E–04	0.86632E–04	0.00000E+00	0.00000E+00

	^{239}Pu			^{240}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.28031E–03	0.11208E–02	0.27992E–03	0.77430E–04	0.30531E–03	0.77176E–04
2	0.22775E–03	0.81141E–03	0.22748E–03	0.58480E–04	0.20650E–03	0.57973E–04
3	0.24444E–03	0.80787E–03	0.24400E–03	0.61596E–04	0.19992E–03	0.60509E–04
4	0.25965E–03	0.80670E–03	0.25724E–03	0.62973E–04	0.18790E–03	0.60147E–04
5	0.24008E–03	0.70425E–03	0.23220E–03	0.60256E–04	0.17211E–03	0.53987E–04
6	0.22890E–03	0.62623E–03	0.21214E–03	0.27899E–04	0.68631E–04	0.21885E–04
7	0.22489E–03	0.58261E–03	0.20007E–03	0.11739E–04	0.14027E–04	0.48552E–05
8	0.22926E–03	0.57424E–03	0.19863E–03	0.13805E–04	0.84202E–05	0.29349E–05
9	0.24494E–03	0.58757E–03	0.20388E–03	0.19964E–04	0.83849E–05	0.29349E–05

Table 4.76. (continued)

	^{239}Pu			^{240}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
10	0.27777E–03	0.60847E–03	0.21135E–03	0.29602E–04	0.12090E–04	0.42393E–05
11	0.32100E–03	0.60349E–03	0.20976E–03	0.38958E–04	0.12064E–04	0.42331E–05
12	0.48493E–03	0.78424E–03	0.27259E–03	0.54144E–04	0.99921E–05	0.35085E–05
13	0.75602E–03	0.11348E–02	0.39445E–03	0.79330E–04	0.15759E–04	0.55352E–05
14	0.11017E–02	0.16993E–02	0.59086E–03	0.12236E–03	0.28526E–04	0.10020E–04
15	0.19480E–02	0.30019E–02	0.10438E–02	0.20749E–03	0.28095E–04	0.98683E–05
16	0.31376E–02	0.48696E–02	0.16932E–02	0.29556E–03	0.58205E–05	0.20444E–05
17	0.45552E–02	0.75424E–02	0.26225E–02	0.85925E–03	0.53813E–08	0.18511E–08
18	0.12384E–01	0.22229E–01	0.77337E–02	0.81800E–03	0.14216E–07	0.48904E–08
19	0.72867E–02	0.80027E–02	0.27849E–02	0.26091E–02	0.14085E–04	0.48453E–05
20	0.21444E–01	0.37057E–01	0.12897E–01	0.86183E–03	0.17642E–04	0.60687E–05
21	0.88753E–02	0.15349E–01	0.53424E–02	0.32222E–04	0.59958E–07	0.20626E–07
22	0.16508E–02	0.40359E–02	0.14047E–02	0.32659E–03	0.23193E–06	0.79784E–07
23	0.34020E–02	0.80422E–02	0.27992E–02	0.12973E+00	0.74716E–04	0.25702E–04
24	0.19475E–01	0.38697E–01	0.13554E–01	0.39844E–01	0.23008E–04	0.79146E–05
25	0.32757E+00	0.55965E+00	0.19681E+00	0.59123E–02	0.35083E–05	0.12068E–05
26	0.11587E+00	0.22311E+00	0.77950E–01	0.71315E–02	0.43275E–05	0.14886E–05

	^{241}Pu			^{242}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.41666E–04	0.16677E–03	0.41536E–04	0.76122E–05	0.29611E–04	0.76122E–05
2	0.30946E–04	0.11104E–03	0.30794E–04	0.58994E–05	0.20599E–04	0.58518E–05
3	0.32964E–04	0.10989E–03	0.32725E–04	0.59946E–05	0.19311E–04	0.58519E–05
4	0.37955E–04	0.11684E–03	0.36696E–04	0.63276E–05	0.18731E–04	0.60422E–05
5	0.36783E–04	0.10640E–03	0.34656E–04	0.66131E–05	0.18126E–04	0.60421E–05
6	0.34873E–04	0.98436E–04	0.32790E–04	0.22361E–05	0.44607E–05	0.15224E–05
7	0.40147E–04	0.11150E–03	0.37630E–04	0.10942E–05	0.82497E–06	0.28546E–06
8	0.48480E–04	0.12835E–03	0.43597E–04	0.13321E–05	0.40963E–06	0.14273E–06
9	0.57660E–04	0.14396E–03	0.49066E–04	0.19982E–05	0.27213E–06	0.95152E–07
10	0.69638E–04	0.16838E–03	0.57486E–04	0.24740E–05	0.27118E–06	0.95152E–07
11	0.84460E–04	0.19373E–03	0.66210E–04	0.33779E–05	0.13559E–06	0.47576E–07
12	0.11352E–03	0.27019E–03	0.92403E–04	0.48052E–05	0.13559E–06	0.47576E–07
13	0.17810E–03	0.40065E–03	0.13702E–03	0.76122E–05	0.00000E+00	0.00000E+00
14	0.26427E–03	0.58157E–03	0.19889E–03	0.13000E–04	0.00000E+00	0.00000E+00
15	0.35789E–03	0.80053E–03	0.27378E–03	0.21409E–04	0.00000E+00	0.00000E+00
16	0.65986E–03	0.14308E–02	0.48932E–03	0.42818E–04	0.00000E+00	0.00000E+00
17	0.72373E–03	0.16412E–02	0.56127E–03	0.52282E–04	0.74946E–06	0.27194E–06
18	0.11772E–02	0.26603E–02	0.90334E–03	0.15409E–03	0.50550E–06	0.18342E–06
19	0.17528E–02	0.42530E–02	0.14441E–02	0.21643E–04	0.12239E–08	0.44410E–09
20	0.48369E–02	0.92383E–02	0.31370E–02	0.77000E–05	0.63567E–09	0.23065E–09
21	0.55830E–02	0.14012E–01	0.47578E–02	0.33615E–05	0.13995E–08	0.50781E–09
22	0.37067E–02	0.66120E–02	0.22451E–02	0.61509E–02	0.13569E–05	0.49236E–06
23	0.37427E–03	0.72514E–03	0.24623E–03	0.79185E–04	0.18702E–07	0.67860E–08
24	0.13420E–02	0.24631E–02	0.83637E–03	0.30201E–04	0.85105E–08	0.30880E–08
25	0.24855E–01	0.49827E–01	0.16919E–01	0.31502E–04	0.95969E–08	0.34822E–08
26	0.23267E–01	0.50663E–01	0.17203E–01	0.56473E–04	0.18187E–07	0.65990E–08

Table 4.76. (continued)

	^{241}Am			^{242m}Am		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.12036E–05	0.53315E–05	0.11927E–05	0.19430E–07	0.88636E–07	0.19387E–07
2	0.96260E–06	0.38294E–05	0.95023E–06	0.16186E–07	0.66318E–07	0.16148E–07
3	0.10116E–05	0.36920E–05	0.98982E–06	0.18035E–07	0.68475E–07	0.18001E–07
4	0.10264E–05	0.34417E–05	0.97497E–06	0.15337E–07	0.54871E–07	0.15284E–07
5	0.83541E–06	0.24327E–05	0.71762E–06	0.18866E–07	0.64715E–07	0.18769E–07
6	0.48798E–06	0.72079E–06	0.21776E–06	0.17957E–07	0.59711E–07	0.17755E–07
7	0.46917E–06	0.11294E–06	0.34644E–07	0.19695E–07	0.63723E–07	0.19228E–07
8	0.65972E–06	0.95914E–07	0.29695E–07	0.23499E–07	0.74104E–07	0.22531E–07
9	0.80571E–06	0.44621E–07	0.13857E–07	0.29142E–07	0.89585E–07	0.27346E–07
10	0.10715E–05	0.47808E–07	0.14847E–07	0.34004E–07	0.98329E–07	0.30070E–07
11	0.14451E–05	0.79433E–07	0.24745E–07	0.45636E–07	0.12683E–06	0.38821E–07
12	0.20687E–05	0.12709E–06	0.39593E–07	0.76683E–07	0.21536E–06	0.65961E–07
13	0.30783E–05	0.19064E–06	0.59389E–07	0.11727E–06	0.32864E–06	0.10066E–06
14	0.46011E–05	0.28060E–06	0.87415E–07	0.17421E–06	0.48712E–06	0.14924E–06
15	0.71515E–05	0.39717E–06	0.12373E–06	0.26641E–06	0.74367E–06	0.22784E–06
16	0.10913E–04	0.71490E–06	0.22271E–06	0.39759E–06	0.11084E–05	0.33958E–06
17	0.16431E–04	0.95320E–06	0.29695E–06	0.59110E–06	0.16463E–05	0.50439E–06
18	0.23632E–04	0.11915E–05	0.37118E–06	0.87383E–06	0.24319E–05	0.74506E–06
19	0.35269E–04	0.16990E–05	0.52927E–06	0.12909E–05	0.35930E–05	0.11008E–05
20	0.39949E–04	0.28366E–05	0.88366E–06	0.19086E–05	0.52990E–05	0.16235E–05
21	0.59737E–04	0.45425E–05	0.14151E–05	0.25263E–05	0.77547E–05	0.23758E–05
22	0.66666E–04	0.25238E–05	0.78622E–06	0.29062E–05	0.82840E–05	0.25380E–05
23	0.30813E–03	0.11169E–04	0.34794E–05	0.34411E–05	0.10183E–04	0.31199E–05
24	0.39010E–03	0.11396E–04	0.35503E–05	0.87985E–05	0.24421E–04	0.74819E–05
25	0.68457E–03	0.30051E–04	0.93617E–05	0.23418E–04	0.63502E–04	0.19455E–04
26	0.25065E–03	0.80445E–05	0.25061E–05	0.55792E–04	0.15072E–03	0.46178E–04

	^{243}Am			^{242}Cm		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.16493E–05	0.77232E–05	0.16457E–05	0.32691E–06	0.15958E–05	0.32688E–06
2	0.11175E–05	0.46600E–05	0.11130E–05	0.25447E–06	0.11095E–05	0.25441E–06
3	0.10557E–05	0.40397E–05	0.10474E–05	0.25510E–06	0.10273E–05	0.25491E–06
4	0.10800E–05	0.38477E–05	0.10614E–05	0.26568E–06	0.10068E–05	0.26523E–06
5	0.83368E–06	0.27612E–05	0.79574E–06	0.27527E–06	0.99685E–06	0.27378E–06
6	0.18578E–06	0.34793E–06	0.10300E–06	0.17733E–06	0.60399E–06	0.17023E–06
7	0.17414E–06	0.51166E–07	0.15393E–07	0.85671E–07	0.23350E–06	0.66810E–07
8	0.31917E–06	0.27361E–07	0.82987E–08	0.59224E–07	0.10862E–06	0.31329E–07
9	0.61176E–06	0.30980E–07	0.94364E–08	0.78600E–07	0.10344E–06	0.29958E–07
10	0.94451E–06	0.33545E–07	0.10240E–07	0.12176E–06	0.12061E–06	0.34991E–07
11	0.12628E–05	0.43590E–07	0.13318E–07	0.17855E–06	0.14603E–06	0.42414E–07
12	0.19761E–05	0.34369E–07	0.10507E–07	0.24756E–06	0.19249E–06	0.55940E–07
13	0.32666E–05	0.10946E–07	0.33463E–08	0.34749E–06	0.24799E–06	0.72070E–07
14	0.51468E–05	0.39198E–08	0.11987E–08	0.50911E–06	0.27938E–06	0.81213E–07
15	0.82924E–05	0.10942E–08	0.33463E–09	0.84248E–06	0.40594E–06	0.11801E–06
16	0.12666E–04	0.21908E–09	0.66996E–10	0.16881E–05	0.63928E–06	0.18584E–06
17	0.21574E–04	0.00000E+00	0.00000E+00	0.12637E–05	0.39993E–06	0.11626E–06
18	0.23414E–04	0.00000E+00	0.00000E+00	0.39040E–05	0.67105E–06	0.19507E–06
19	0.38009E–04	0.00000E+00	0.00000E+00	0.40167E–05	0.14852E–05	0.43174E–06

Table 4.76. (continued)

Group	^{243}Am Absorption[a]	^{243}Am $\nu\Sigma_f$[b]	^{243}Am Fission[c]	^{242}Cm Absorption[a]	^{242}Cm $\nu\Sigma_f$[b]	^{242}Cm Fission[c]
20	0.72847E–04	0.00000E+00	0.00000E+00	0.72390E–05	0.10614E–05	0.30855E–06
21	0.83562E–04	0.00000E+00	0.00000E+00	0.57866E–07	0.64534E–07	0.18760E–07
22	0.50669E–04	0.00000E+00	0.00000E+00	0.10745E–06	0.11041E–06	0.32097E–07
23	0.11979E–02	0.00000E+00	0.00000E+00	0.21412E–06	0.19897E–06	0.57839E–07
24	0.48339E–04	0.00000E+00	0.00000E+00	0.41105E–06	0.34487E–06	0.10025E–06
25	0.30173E–04	0.00000E+00	0.00000E+00	0.65980E–06	0.51982E–06	0.15111E–06
26	0.35166E–04	0.00000E+00	0.00000E+00	0.14138E–05	0.66992E–06	0.19474E–06

Group	^{243}Cm Absorption[a]	^{243}Cm $\nu\Sigma_f$[b]	^{243}Cm Fission[c]	^{244}Cm Absorption[a]	^{244}Cm $\nu\Sigma_f$[b]	^{244}Cm Fission[c]
1	0.41547E–08	0.19856E–07	0.41505E–08	0.31624E–06	0.15351E–05	0.31587E–06
2	0.36616E–08	0.15738E–07	0.36575E–08	0.24724E–06	0.10747E–05	0.24650E–06
3	0.41039E–08	0.16347E–07	0.40990E–08	0.24254E–06	0.96844E–06	0.24031E–06
4	0.48408E–08	0.18204E–07	0.48313E–08	0.23585E–06	0.87310E–06	0.22916E–06
5	0.46834E–08	0.16889E–07	0.46642E–08	0.25517E–06	0.87046E–06	0.23783E–06
6	0.38756E–08	0.13542E–07	0.38329E–08	0.12511E–06	0.35169E–06	0.96619E–07
7	0.33755E–08	0.11382E–07	0.32697E–08	0.60696E–07	0.52174E–07	0.14864E–07
8	0.39488E–08	0.12769E–07	0.36947E–08	0.73083E–07	0.21615E–07	0.61935E–08
9	0.47800E–08	0.14833E–07	0.43094E–08	0.11768E–06	0.25790E–07	0.74322E–08
10	0.55422E–08	0.16856E–07	0.49056E–08	0.15855E–06	0.30088E–07	0.86709E–08
11	0.67952E–08	0.20700E–07	0.60299E–08	0.20810E–06	0.42859E–07	0.12387E–07
12	0.10950E–07	0.32636E–07	0.95120E–08	0.24650E–06	0.55717E–07	0.16103E–07
13	0.17500E–07	0.51979E–07	0.15150E–07	0.32949E–06	0.72860E–07	0.21058E–07
14	0.26944E–07	0.79786E–07	0.23261E–07	0.46745E–06	0.10118E–06	0.29242E–07
15	0.42597E–07	0.12574E–06	0.36658E–07	0.91416E–06	0.18001E–06	0.52025E–07
16	0.65111E–07	0.19175E–06	0.55905E–07	0.16485E–05	0.25960E–06	0.75030E–07
17	0.98584E–07	0.28975E–06	0.84476E–07	0.13324E–05	0.27835E–06	0.80447E–07
18	0.14793E–06	0.43410E–06	0.12656E–06	0.20324E–05	0.32043E–06	0.92611E–07
19	0.13099E–06	0.35379E–06	0.10314E–06	0.26594E–05	0.68426E–06	0.19776E–06
20	0.30160E–06	0.90569E–06	0.26405E–06	0.47367E–05	0.62213E–06	0.17981E–06
21	0.71211E–06	0.22642E–05	0.66013E–06	0.10555E–03	0.63209E–05	0.18268E–05
22	0.13665E–06	0.38646E–06	0.11267E–06	0.34701E–06	0.36244E–07	0.10475E–07
23	0.19566E–06	0.55333E–06	0.16132E–06	0.28935E–06	0.48031E–07	0.13882E–07
24	0.29661E–06	0.83880E–06	0.24455E–06	0.37753E–06	0.80001E–07	0.23122E–07
25	0.42786E–06	0.12100E–05	0.35277E–06	0.52421E–06	0.12216E–06	0.35305E–07
26	0.93056E–06	0.26316E–05	0.76723E–06	0.11185E–05	0.27835E–06	0.80449E–07

Group	Absorption[a] ^{103}Rh	^{131}Xe	^{143}Nd	^{147}Pm	^{133}Cs
1	0.62337E–07	0.19957E–07	0.80076E–07	0.20319E–07	0.28779E–07
2	0.16623E–06	0.12829E–07	0.24824E–06	0.58495E–07	0.18706E–06
3	0.38536E–06	0.57020E–07	0.65929E–06	0.19704E–06	0.54680E–06
4	0.80471E–06	0.17106E–06	0.10437E–05	0.51168E–06	0.11763E–05
5	0.14092E–05	0.34355E–06	0.11264E–05	0.12592E–05	0.20937E–05
6	0.23650E–05	0.64005E–06	0.13052E–05	0.21569E–05	0.40543E–05
7	0.49095E–05	0.11347E–05	0.16949E–05	0.29063E–05	0.52702E–05
8	0.74200E–05	0.16963E–05	0.24530E–05	0.33546E–05	0.74574E–05

Table 4.76. (continued)

Group	Absorption[a]				
	^{103}Rh	^{131}Xe	^{143}Nd	^{147}Pm	^{133}Cs
9	0.11518E–04	0.30206E–05	0.38890E–05	0.44715E–05	0.11882E–04
10	0.17528E–04	0.48353E–05	0.75298E–05	0.64530E–05	0.18336E–04
11	0.24195E–04	0.74682E–05	0.12396E–04	0.10480E–04	0.27984E–04
12	0.31296E–04	0.11348E–04	0.20326E–04	0.18509E–04	0.43780E–04
13	0.41126E–04	0.18047E–04	0.28092E–04	0.33915E–04	0.73351E–04
14	0.50384E–04	0.30290E–04	0.51969E–04	0.60543E–04	0.94570E–04
15	0.80979E–04	0.39144E–04	0.77921E–04	0.11206E–03	0.18961E–03
16	0.18656E–03	0.71603E–04	0.24767E–03	0.17185E–03	0.45815E–03
17	0.29474E–03	0.17234E–03	0.92897E–03	0.27585E–03	0.57260E–03
18	0.38895E–04	0.12117E–03	0.64181E–03	0.42004E–03	0.97817E–03
19	0.66725E–05	0.30705E–03	0.11496E–04	0.53061E–03	0.11326E–02
20	0.15547E–05	0.15025E–01	0.38793E–04	0.27782E–03	0.46584E–04
21	0.10535E–04	0.25830E–03	0.12626E–03	0.11864E–01	0.15207E–01
22	0.16094E–03	0.10914E–03	0.35278E–03	0.41699E–03	0.37509E–03
23	0.20846E–01	0.15627E–03	0.72301E–03	0.15295E–03	0.20001E–03
24	0.30023E–02	0.23689E–03	0.13774E–02	0.19558E–03	0.23473E–03
25	0.13752E–02	0.34172E–03	0.21965E–02	0.29068E–03	0.31293E–03
26	0.18563E–02	0.74320E–03	0.51478E–02	0.67835E–03	0.64809E–03

Group	Absorption[a]				
	^{99}Tc	^{152}Sm	^{151}Sm	^{145}Nd	^{153}Eu
1	0.96628E–07	0.88579E–08	0.19992E–08	0.51935E–07	0.16121E–07
2	0.24324E–06	0.30063E–07	0.12118E–07	0.14382E–06	0.71675E–07
3	0.72638E–06	0.11676E–06	0.40630E–07	0.41947E–06	0.19270E–06
4	0.15694E–05	0.23353E–06	0.75170E–07	0.94282E–06	0.33903E–06
5	0.25890E–05	0.37659E–06	0.87873E–07	0.13923E–05	0.53645E–06
6	0.45915E–05	0.42947E–06	0.87565E–07	0.16240E–05	0.90821E–06
7	0.62542E–05	0.45041E–06	0.13841E–06	0.18956E–05	0.14610E–05
8	0.10156E–04	0.74272E–06	0.24849E–06	0.27705E–05	0.26736E–05
9	0.16777E–04	0.11392E–05	0.39307E–06	0.49618E–05	0.43055E–05
10	0.27436E–04	0.15198E–05	0.72248E–06	0.87351E–05	0.60043E–05
11	0.41017E–04	0.21331E–05	0.12595E–05	0.14004E–04	0.91044E–05
12	0.56011E–04	0.30036E–05	0.22603E–05	0.23950E–04	0.14729E–04
13	0.75203E–04	0.38089E–05	0.40599E–05	0.44464E–04	0.24875E–04
14	0.10901E–03	0.60668E–05	0.67132E–05	0.68361E–04	0.41144E–04
15	0.13278E–03	0.15151E–04	0.11371E–04	0.14139E–03	0.69567E–04
16	0.29445E–03	0.26587E–04	0.18414E–04	0.20705E–03	0.11163E–03
17	0.52512E–03	0.43309E–04	0.29191E–04	0.20709E–03	0.17584E–03
18	0.13335E–03	0.12109E–03	0.42457E–04	0.12985E–03	0.32043E–03
19	0.10749E–03	0.25487E–05	0.42044E–04	0.12941E–02	0.21745E–03
20	0.15027E–02	0.80928E–04	0.22240E–03	0.20500E–04	0.57587E–03
21	0.95228E–02	0.10943E–01	0.80594E–04	0.11191E–03	0.48232E–03
22	0.57418E–04	0.13955E–03	0.74377E–04	0.31246E–02	0.23638E–02
23	0.82211E–04	0.10629E–03	0.49472E–03	0.11177E–03	0.27274E–03
24	0.12463E–03	0.12505E–03	0.19047E–03	0.16281E–03	0.87157E–04
25	0.17978E–03	0.16451E–03	0.26923E–03	0.23487E–03	0.14757E–03
26	0.39099E–03	0.33622E–03	0.19529E–02	0.51253E–03	0.43733E–03

Table 4.76. (continued)

Group	Absorption[a]				
	^{109}Ag	^{155}Eu	^{95}Mo	^{154}Eu	^{101}Ru
1	0.14324E–07	0.14625E–08	0.31697E–06	0.53236E–08	0.17435E–06
2	0.21376E–07	0.87074E–08	0.41813E–06	0.24571E–08	0.40786E–06
3	0.60822E–07	0.36031E–07	0.87672E–06	0.10596E–07	0.77212E–06
4	0.11371E–06	0.94067E–07	0.11802E–05	0.29894E–07	0.11115E–05
5	0.17255E–06	0.13298E–06	0.18816E–05	0.70487E–07	0.16345E–05
6	0.29287E–06	0.65611E–07	0.27246E–05	0.19477E–06	0.35026E–05
7	0.53440E–06	0.51276E–07	0.31663E–05	0.48118E–06	0.77150E–05
8	0.76447E–06	0.76120E–07	0.46770E–05	0.70231E–06	0.12180E–04
9	0.11409E–05	0.11933E–06	0.76747E–05	0.99460E–06	0.19474E–04
10	0.17013E–05	0.20437E–06	0.13279E–04	0.14799E–05	0.31003E–04
11	0.23646E–05	0.36525E–06	0.21652E–04	0.23700E–05	0.45020E–04
12	0.31711E–05	0.65291E–06	0.32027E–04	0.39308E–05	0.60649E–04
13	0.44625E–05	0.11671E–05	0.44713E–04	0.64652E–05	0.82443E–04
14	0.67420E–05	0.20347E–05	0.65654E–04	0.10238E–04	0.11829E–03
15	0.14394E–04	0.37290E–05	0.82075E–04	0.16642E–04	0.11744E–03
16	0.14901E–04	0.63209E–05	0.89358E–04	0.26009E–04	0.35181E–03
17	0.40044E–04	0.74289E–05	0.58167E–04	0.40076E–04	0.27868E–03
18	0.75185E–04	0.84575E–05	0.13296E–03	0.61529E–04	0.76745E–03
19	0.10232E–03	0.15642E–04	0.44005E–02	0.81749E–04	0.77275E–03
20	0.40043E–05	0.13492E–04	0.21749E–04	0.40260E–04	0.17918E–02
21	0.37618E–02	0.13667E–05	0.25809E–04	0.13596E–03	0.17170E–04
22	0.21153E–03	0.32823E–04	0.42547E–04	0.62375E–04	0.95405E–05
23	0.52185E–04	0.46996E–04	0.60919E–04	0.89309E–04	0.13660E–04
24	0.50978E–04	0.71242E–04	0.92349E–04	0.13538E–03	0.20708E–04
25	0.63403E–04	0.10277E–03	0.13321E–03	0.19529E–03	0.29871E–04
26	0.12513E–03	0.22351E–03	0.28973E–03	0.42475E–03	0.64967E–04

Group	Absorption[a]				
	Region 2	Region 3			
	Zr	H	O	^{10}B	^{11}B
1	0.31302E–03	0.00000E+00	0.41391E–02	0.94688E–06	0.56380E–07
2	0.13113E–03	0.00000E+00	0.21300E–02	0.14677E–05	0.47942E–08
3	0.23688E–03	0.00000E+00	0.68459E–04	0.15150E–05	0.51778E–07
4	0.54567E–03	0.00000E+00	0.00000E+00	0.19411E–05	0.16818E–06
5	0.53721E–03	0.00000E+00	0.00000E+00	0.10416E–05	0.19982E–06
6	0.57528E–03	0.00000E+00	0.00000E+00	0.28880E–05	0.28324E–06
7	0.54144E–03	0.00000E+00	0.00000E+00	0.52078E–05	0.25774E–06
8	0.57951E–03	0.00000E+00	0.00000E+00	0.79065E–05	0.91474E–07
9	0.73685E–03	0.00000E+00	0.00000E+00	0.11126E–04	0.34519E–07
10	0.12517E–02	0.00000E+00	0.00000E+00	0.15908E–04	0.17259E–07
11	0.16413E–02	0.00000E+00	0.00000E+00	0.23199E–04	0.15342E–07
12	0.34916E–02	0.00000E+00	0.00000E+00	0.34040E–04	0.15342E–07
13	0.49829E–02	0.47830E–04	0.00000E+00	0.50185E–04	0.15342E–07
14	0.24933E–02	0.47830E–04	0.00000E+00	0.72966E–04	0.15342E–07
15	0.26442E–02	0.95660E–04	0.00000E+00	0.10984E–03	0.15342E–07
16	0.12414E–01	0.14349E–03	0.00000E+00	0.16144E–03	0.15342E–07
17	0.35934E–02	0.19132E–03	0.00000E+00	0.23814E–03	0.15342E–07

Table 4.76. (continued)

Group	Absorption[a]				
	Region 2	Region 3			
	Zr	H	O	^{10}B	^{11}B
18	0.13536E–03	0.28698E–03	0.00000E+00	0.35035E–03	0.15342E–07
19	0.20727E–03	0.43047E–03	0.00000E+00	0.51605E–03	0.15342E–07
20	0.32148E–03	0.66962E–03	0.00000E+00	0.75750E–03	0.15342E–07
21	0.48645E–03	0.95660E–03	0.00000E+00	0.11126E–02	0.15342E–07
22	0.73557E–03	0.14309E–02	0.58171E–06	0.16365E–02	0.95039E–08
23	0.10618E–02	0.20735E–02	0.84296E–06	0.23714E–02	0.13772E–07
24	0.15961E–02	0.31038E–02	0.12618E–05	0.35498E–02	0.20616E–07
25	0.23121E–02	0.45063E–02	0.18320E–05	0.51538E–02	0.29932E–07
26	0.50915E–02	0.10039E–01	0.40813E–05	0.11481E–01	0.66680E–07

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.77. The cell one-group cross section and flux values for Variant V4S6

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2617E–01	0.2972E–01	0.1123E–01	0.3324E+02

Table 4.78. Reaction rates for every region of cell for Variant V4S6

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.7778E+00	0.9879E+00	0.3734E+00	0.1107E+02	0.3330E+00
2	0.8304E–02	0.0000E+00	0.0000E+00	0.4522E+01	0.1360E+00
3	0.8366E–01	0.0000E+00	0.0000E+00	0.1765E+02	0.5310E+00

Table 4.79. Multigroup cross sections of nuclides (cm^{-1}) for Region 1 for Variant V4S6

	^{235}U			^{236}U		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.61287E–03	0.21362E–02	0.61192E–03	0.13041E–03	0.44305E–03	0.12955E–03
2	0.41764E–03	0.12599E–02	0.41514E–03	0.81183E–04	0.24155E–03	0.79456E–04
3	0.46074E–03	0.12558E–02	0.45109E–03	0.82047E–04	0.21997E–03	0.77728E–04
4	0.49957E–03	0.12514E–02	0.47493E–03	0.74274E–04	0.17490E–03	0.66501E–04
5	0.48568E–03	0.11328E–02	0.44617E–03	0.64774E–04	0.92134E–04	0.36273E–04
6	0.48772E–03	0.10705E–02	0.43027E–03	0.28500E–04	0.63737E–05	0.25909E–05
7	0.56749E–03	0.11748E–02	0.47758E–03	0.28500E–04	0.00000E+00	0.00000E+00
8	0.68269E–03	0.13391E–02	0.54834E–03	0.34546E–04	0.00000E+00	0.00000E+00
9	0.83656E–03	0.15653E–02	0.64522E–03	0.51819E–04	0.00000E+00	0.00000E+00
10	0.10375E–02	0.18978E–02	0.78259E–03	0.69092E–04	0.00000E+00	0.00000E+00
11	0.13249E–02	0.23980E–02	0.98682E–03	0.94598E–04	0.00000E+00	0.00000E+00
12	0.17574E–02	0.31419E–02	0.12919E–02	0.13707E–03	0.00000E+00	0.00000E+00
13	0.25383E–02	0.45833E–02	0.18846E–02	0.20893E–03	0.00000E+00	0.00000E+00
14	0.38907E–02	0.64429E–02	0.26492E–02	0.19088E–03	0.33161E–10	0.13968E–10
15	0.58871E–02	0.10393E–01	0.42736E–02	0.41260E–03	0.61909E–09	0.26078E–09
16	0.83507E–02	0.15010E–01	0.61718E–02	0.49528E–03	0.14209E–04	0.59853E–05
17	0.11520E–01	0.18806E–01	0.77327E–02	0.10844E–02	0.42460E–04	0.17885E–04
18	0.19180E–01	0.32025E–01	0.13168E–01	0.16223E–02	0.49584E–04	0.20886E–04
19	0.24825E–01	0.38375E–01	0.15779E–01	0.30209E–02	0.11527E–03	0.48553E–04
20	0.31494E–01	0.41639E–01	0.17121E–01	0.92577E–05	0.23969E–06	0.10096E–06
21	0.31235E–01	0.44672E–01	0.18368E–01	0.21458E–01	0.59585E–03	0.25099E–03
22	0.90642E–02	0.15499E–01	0.63731E–02	0.22590E–03	0.60691E–05	0.25565E–05
23	0.15421E–01	0.27067E–01	0.11130E–01	0.88451E–04	0.20644E–05	0.86957E–06
24	0.27484E–01	0.60234E–01	0.24767E–01	0.10129E–03	0.21183E–05	0.89229E–06
25	0.69251E–01	0.13869E+00	0.57027E–01	0.13668E–03	0.27033E–05	0.11387E–05
26	0.17911E+00	0.37239E+00	0.15312E+00	0.33363E–03	0.63131E–05	0.26593E–05

	^{238}U			^{237}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.17374E–01	0.60432E–01	0.17271E–01	0.53975E–04	0.20490E–03	0.53767E–04
2	0.10703E–01	0.32609E–01	0.10507E–01	0.38764E–04	0.13109E–03	0.38376E–04
3	0.10237E–01	0.27559E–01	0.98599E–02	0.41601E–04	0.12911E–03	0.40883E–04
4	0.94237E–02	0.22456E–01	0.85239E–02	0.42490E–04	0.12208E–03	0.41008E–04
5	0.27875E–02	0.18515E–02	0.72575E–03	0.39771E–04	0.10439E–03	0.36539E–04
6	0.21772E–02	0.50357E–04	0.20160E–04	0.24873E–04	0.48009E–04	0.17244E–04
7	0.22982E–02	0.45260E–05	0.18327E–05	0.17806E–04	0.61735E–05	0.22514E–05
8	0.29066E–02	0.00000E+00	0.00000E+00	0.24150E–04	0.21952E–05	0.80675E–06
9	0.47646E–02	0.00000E+00	0.00000E+00	0.32717E–04	0.12109E–05	0.44681E–06
10	0.80362E–02	0.00000E+00	0.00000E+00	0.44493E–04	0.69832E–06	0.25816E–06
11	0.10474E–01	0.00000E+00	0.00000E+00	0.64083E–04	0.64389E–06	0.23830E–06
12	0.13348E–01	0.00000E+00	0.00000E+00	0.97103E–04	0.72411E–06	0.26809E–06
13	0.17060E–01	0.00000E+00	0.00000E+00	0.15144E–03	0.58979E–06	0.21844E–06
14	0.18692E–01	0.00000E+00	0.00000E+00	0.23295E–03	0.14684E–05	0.54385E–06
15	0.25029E–01	0.00000E+00	0.00000E+00	0.36984E–03	0.19298E–05	0.71738E–06
16	0.25605E–01	0.00000E+00	0.00000E+00	0.56842E–03	0.25782E–05	0.96562E–06
17	0.47392E–01	0.00000E+00	0.00000E+00	0.82048E–03	0.54796E–05	0.20678E–05
18	0.35643E–01	0.00000E+00	0.00000E+00	0.14622E–02	0.32515E–05	0.12336E–05
19	0.73950E–01	0.00000E+00	0.00000E+00	0.20773E–02	0.32811E–04	0.12448E–04

Table 4.79. (continued)

	^{238}U			^{237}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
20	0.75796E–01	0.00000E+00	0.00000E+00	0.22602E–02	0.19531E–05	0.74098E–06
21	0.18742E+00	0.00000E+00	0.00000E+00	0.24145E–02	0.26352E–05	0.99978E–06
22	0.11675E–01	0.00000E+00	0.00000E+00	0.12372E–02	0.66475E–06	0.25220E–06
23	0.85405E–02	0.00000E+00	0.00000E+00	0.66588E–02	0.67485E–06	0.25603E–06
24	0.10728E–01	0.00000E+00	0.00000E+00	0.81465E–02	0.56111E–06	0.21288E–06
25	0.14767E–01	0.00000E+00	0.00000E+00	0.38804E–02	0.39626E–06	0.15034E–06
26	0.36339E–01	0.00000E+00	0.00000E+00	0.32065E–02	0.82173E–06	0.31176E–06

	^{238}Pu			^{239}Np		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.18412E–04	0.73827E–04	0.18360E–04	0.36022E–05	0.13405E–04	0.35949E–05
2	0.14213E–04	0.50995E–04	0.14083E–04	0.27564E–05	0.91994E–05	0.27241E–05
3	0.14930E–04	0.49541E–04	0.14749E–04	0.29777E–05	0.91931E–05	0.29203E–05
4	0.15257E–04	0.47654E–04	0.15004E–04	0.32952E–05	0.94621E–05	0.31678E–05
5	0.14269E–04	0.42332E–04	0.13861E–04	0.32778E–05	0.86081E–05	0.29900E–05
6	0.11604E–04	0.31766E–04	0.10660E–04	0.27712E–05	0.60429E–05	0.21467E–05
7	0.78768E–05	0.18736E–04	0.63770E–05	0.19566E–05	0.18378E–05	0.66178E–06
8	0.67644E–05	0.13359E–04	0.45813E–05	0.22999E–05	0.37225E–06	0.13492E–06
9	0.76891E–05	0.12389E–04	0.42646E–05	0.31403E–05	0.21166E–06	0.76994E–07
10	0.95682E–05	0.14948E–04	0.51456E–05	0.46780E–05	0.59358E–07	0.21632E–07
11	0.12342E–04	0.15282E–04	0.52606E–05	0.69295E–05	0.00000E+00	0.00000E+00
12	0.14964E–04	0.20221E–04	0.69608E–05	0.98076E–05	0.00000E+00	0.00000E+00
13	0.23983E–04	0.22644E–04	0.77947E–05	0.14336E–04	0.00000E+00	0.00000E+00
14	0.26152E–04	0.25186E–04	0.86700E–05	0.20663E–04	0.00000E+00	0.00000E+00
15	0.47691E–04	0.44856E–04	0.15441E–04	0.30944E–04	0.00000E+00	0.00000E+00
16	0.12008E–03	0.14571E–03	0.50160E–04	0.45445E–04	0.00000E+00	0.00000E+00
17	0.23159E–03	0.11252E–03	0.38735E–04	0.66655E–04	0.00000E+00	0.00000E+00
18	0.11223E–03	0.30095E–04	0.10360E–04	0.97746E–04	0.00000E+00	0.00000E+00
19	0.31783E–05	0.12120E–05	0.41721E–06	0.14341E–03	0.00000E+00	0.00000E+00
20	0.38692E–03	0.46405E–04	0.15974E–04	0.21063E–03	0.00000E+00	0.00000E+00
21	0.65957E–04	0.26940E–04	0.92736E–05	0.30871E–03	0.00000E+00	0.00000E+00
22	0.32715E–03	0.22797E–04	0.78477E–05	0.12720E–04	0.00000E+00	0.00000E+00
23	0.34392E–04	0.47214E–05	0.16253E–05	0.18288E–04	0.00000E+00	0.00000E+00
24	0.12986E–03	0.13999E–04	0.48188E–05	0.27468E–04	0.00000E+00	0.00000E+00
25	0.39947E–03	0.38351E–04	0.13202E–04	0.40137E–04	0.00000E+00	0.00000E+00
26	0.24507E–02	0.21914E–03	0.75434E–04	0.10263E–03	0.00000E+00	0.00000E+00

	^{239}Pu			^{240}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.28031E–03	0.11208E–02	0.27992E–03	0.77430E–04	0.30531E–03	0.77176E–04
2	0.22775E–03	0.81141E–03	0.22748E–03	0.58480E–04	0.20650E–03	0.57973E–04
3	0.24444E–03	0.80787E–03	0.24400E–03	0.61596E–04	0.19992E–03	0.60509E–04
4	0.25965E–03	0.80670E–03	0.25724E–03	0.62973E–04	0.18790E–03	0.60147E–04
5	0.24008E–03	0.70425E–03	0.23220E–03	0.60256E–04	0.17211E–03	0.53987E–04
6	0.22890E–03	0.62623E–03	0.21214E–03	0.27899E–04	0.68630E–04	0.21885E–04
7	0.22489E–03	0.58261E–03	0.20007E–03	0.11739E–04	0.14027E–04	0.48552E–05
8	0.22926E–03	0.57424E–03	0.19863E–03	0.13805E–04	0.84201E–05	0.29349E–05
9	0.24494E–03	0.58757E–03	0.20388E–03	0.19964E–04	0.83849E–05	0.29349E–05

Table 4.79. (continued)

	^{239}Pu			^{240}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
10	0.27777E–03	0.60848E–03	0.21135E–03	0.29602E–04	0.12090E–04	0.42393E–05
11	0.32162E–03	0.60461E–03	0.21015E–03	0.39006E–04	0.12077E–04	0.42376E–05
12	0.48548E–03	0.78511E–03	0.27289E–03	0.54249E–04	0.10011E–04	0.35152E–05
13	0.75836E–03	0.11383E–02	0.39565E–03	0.79543E–04	0.15799E–04	0.55492E–05
14	0.11071E–02	0.17073E–02	0.59364E–03	0.12327E–03	0.28739E–04	0.10094E–04
15	0.19459E–02	0.29986E–02	0.10426E–02	0.20726E–03	0.28102E–04	0.98707E–05
16	0.31722E–02	0.49161E–02	0.17094E–02	0.29468E–03	0.58032E–05	0.20383E–05
17	0.45527E–02	0.75180E–02	0.26141E–02	0.85655E–03	0.53828E–08	0.18517E–08
18	0.12466E–01	0.22565E–01	0.78506E–02	0.81641E–03	0.14243E–07	0.48994E–08
19	0.72319E–02	0.80179E–02	0.27902E–02	0.25599E–02	0.13822E–04	0.47546E–05
20	0.21301E–01	0.36897E–01	0.12842E–01	0.90840E–03	0.18602E–04	0.63991E–05
21	0.88006E–02	0.15234E–01	0.53021E–02	0.32431E–04	0.60035E–07	0.20652E–07
22	0.16510E–02	0.40366E–02	0.14050E–02	0.32630E–03	0.23177E–06	0.79727E–07
23	0.34414E–02	0.81290E–02	0.28294E–02	0.13863E+00	0.79839E–04	0.27464E–04
24	0.18845E–01	0.37559E–01	0.13154E–01	0.39939E–01	0.23062E–04	0.79332E–05
25	0.33361E+00	0.56974E+00	0.20036E+00	0.58796E–02	0.34902E–05	0.12006E–05
26	0.12058E+00	0.23903E+00	0.83385E–01	0.81075E–02	0.49297E–05	0.16958E–05

	^{241}Pu			^{242}Pu		
Group	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.41666E–04	0.16677E–03	0.41536E–04	0.76122E–05	0.29611E–04	0.76122E–05
2	0.30946E–04	0.11104E–03	0.30794E–04	0.58994E–05	0.20598E–04	0.58518E–05
3	0.32964E–04	0.10989E–03	0.32725E–04	0.59946E–05	0.19311E–04	0.58518E–05
4	0.37955E–04	0.11684E–03	0.36696E–04	0.63276E–05	0.18731E–04	0.60422E–05
5	0.36783E–04	0.10640E–03	0.34656E–04	0.66131E–05	0.18126E–04	0.60422E–05
6	0.34873E–04	0.98436E–04	0.32790E–04	0.22361E–05	0.44607E–05	0.15224E–05
7	0.40147E–04	0.11150E–03	0.37629E–04	0.10942E–05	0.82497E–06	0.28546E–06
8	0.48480E–04	0.12835E–03	0.43597E–04	0.13321E–05	0.40963E–06	0.14273E–06
9	0.57659E–04	0.14396E–03	0.49066E–04	0.19982E–05	0.27213E–06	0.95152E–07
10	0.69639E–04	0.16838E–03	0.57486E–04	0.24740E–05	0.27118E–06	0.95152E–07
11	0.84460E–04	0.19373E–03	0.66210E–04	0.33779E–05	0.13559E–06	0.47576E–07
12	0.11352E–03	0.27019E–03	0.92403E–04	0.48052E–05	0.13559E–06	0.47576E–07
13	0.17810E–03	0.40065E–03	0.13702E–03	0.76122E–05	0.00000E+00	0.00000E+00
14	0.26420E–03	0.58144E–03	0.19885E–03	0.12997E–04	0.00000E+00	0.00000E+00
15	0.35789E–03	0.80053E–03	0.27378E–03	0.21409E–04	0.00000E+00	0.00000E+00
16	0.65986E–03	0.14308E–02	0.48931E–03	0.42819E–04	0.54313E–11	0.19707E–11
17	0.72373E–03	0.16412E–02	0.56127E–03	0.51635E–04	0.70242E–06	0.25487E–06
18	0.11951E–02	0.27012E–02	0.91723E–03	0.16084E–03	0.52814E–06	0.19163E–06
19	0.17571E–02	0.42604E–02	0.14466E–02	0.21992E–04	0.12160E–08	0.44122E–09
20	0.48372E–02	0.92507E–02	0.31412E–02	0.74029E–05	0.63547E–09	0.23058E–09
21	0.56648E–02	0.14226E–01	0.48307E–02	0.33845E–05	0.14055E–08	0.50999E–09
22	0.37791E–02	0.67294E–02	0.22850E–02	0.60994E–02	0.13456E–05	0.48824E–06
23	0.37601E–03	0.72688E–03	0.24682E–03	0.77747E–04	0.18390E–07	0.66726E–08
24	0.13069E–02	0.23981E–02	0.81430E–03	0.30259E–04	0.85138E–08	0.30892E–08
25	0.26256E–01	0.52732E–01	0.17906E–01	0.31619E–04	0.96426E–08	0.34988E–08
26	0.25062E–01	0.54544E–01	0.18521E–01	0.65905E–04	0.21322E–07	0.77367E–08

Table 4.79. (continued)

Group	^{241}Am Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	^{242m}Am Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.12036E–05	0.53315E–05	0.11927E–05	0.19430E–07	0.88636E–07	0.19387E–07
2	0.96260E–06	0.38294E–05	0.95023E–06	0.16186E–07	0.66318E–07	0.16148E–07
3	0.10116E–05	0.36920E–05	0.98982E–06	0.18035E–07	0.68475E–07	0.18001E–07
4	0.10264E–05	0.34417E–05	0.97497E–06	0.15337E–07	0.54871E–07	0.15284E–07
5	0.83541E–06	0.24327E–05	0.71762E–06	0.18866E–07	0.64715E–07	0.18769E–07
6	0.48798E–06	0.72079E–06	0.21776E–06	0.17957E–07	0.59711E–07	0.17755E–07
7	0.46917E–06	0.11294E–06	0.34644E–07	0.19695E–07	0.63723E–07	0.19228E–07
8	0.65971E–06	0.95914E–07	0.29695E–07	0.23499E–07	0.74103E–07	0.22531E–07
9	0.80571E–06	0.44621E–07	0.13857E–07	0.29142E–07	0.89584E–07	0.27346E–07
10	0.10715E–05	0.47808E–07	0.14847E–07	0.34004E–07	0.98329E–07	0.30070E–07
11	0.14451E–05	0.79433E–07	0.24745E–07	0.45635E–07	0.12683E–06	0.38821E–07
12	0.20687E–05	0.12709E–06	0.39593E–07	0.76683E–07	0.21536E–06	0.65961E–07
13	0.30783E–05	0.19064E–06	0.59389E–07	0.11727E–06	0.32864E–06	0.10066E–06
14	0.46000E–05	0.28054E–06	0.87395E–07	0.17417E–06	0.48701E–06	0.14920E–06
15	0.71514E–05	0.39717E–06	0.12373E–06	0.26641E–06	0.74367E–06	0.22784E–06
16	0.10913E–04	0.71490E–06	0.22271E–06	0.39759E–06	0.11084E–05	0.33958E–06
17	0.16431E–04	0.95320E–06	0.29695E–06	0.59110E–06	0.16463E–05	0.50439E–06
18	0.23632E–04	0.11915E–05	0.37118E–06	0.87383E–06	0.24319E–05	0.74506E–06
19	0.34892E–04	0.16933E–05	0.52750E–06	0.12909E–05	0.35930E–05	0.11008E–05
20	0.39509E–04	0.28239E–05	0.87972E–06	0.19086E–05	0.52990E–05	0.16235E–05
21	0.59283E–04	0.45190E–05	0.14078E–05	0.25263E–05	0.77547E–05	0.23758E–05
22	0.67279E–04	0.25315E–05	0.78863E–06	0.29024E–05	0.82731E–05	0.25346E–05
23	0.31171E–03	0.11266E–04	0.35097E–05	0.34590E–05	0.10242E–04	0.31379E–05
24	0.38551E–03	0.11344E–04	0.35341E–05	0.86965E–05	0.24158E–04	0.74014E–05
25	0.68824E–03	0.30150E–04	0.93924E–05	0.24128E–04	0.65409E–04	0.20040E–04
26	0.29562E–03	0.98547E–05	0.30700E–05	0.58799E–04	0.15896E–03	0.48701E–04

Group	^{243}Am Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	^{242}Cm Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.16493E–05	0.77232E–05	0.16457E–05	0.32691E–06	0.15958E–05	0.32688E–06
2	0.11175E–05	0.46600E–05	0.11130E–05	0.25447E–06	0.11095E–05	0.25441E–06
3	0.10557E–05	0.40397E–05	0.10474E–05	0.25510E–06	0.10273E–05	0.25491E–06
4	0.10800E–05	0.38477E–05	0.10614E–05	0.26568E–06	0.10068E–05	0.26523E–06
5	0.83369E–06	0.27612E–05	0.79574E–06	0.27527E–06	0.99685E–06	0.27378E–06
6	0.18578E–06	0.34793E–06	0.10300E–06	0.17733E–06	0.60399E–06	0.17023E–06
7	0.17414E–06	0.51165E–07	0.15393E–07	0.85671E–07	0.23350E–06	0.66810E–07
8	0.31916E–06	0.27361E–07	0.82987E–08	0.59223E–07	0.10862E–06	0.31329E–07
9	0.61176E–06	0.30980E–07	0.94364E–08	0.78600E–07	0.10344E–06	0.29958E–07
10	0.94451E–06	0.33545E–07	0.10240E–07	0.12176E–06	0.12061E–06	0.34991E–07
11	0.12628E–05	0.43590E–07	0.13318E–07	0.17855E–06	0.14603E–06	0.42414E–07
12	0.19761E–05	0.34369E–07	0.10507E–07	0.24756E–06	0.19249E–06	0.55940E–07
13	0.32666E–05	0.10946E–07	0.33463E–08	0.34749E–06	0.24799E–06	0.72070E–07
14	0.51454E–05	0.39250E–08	0.12002E–08	0.50899E–06	0.27936E–06	0.81207E–07
15	0.82924E–05	0.10942E–08	0.33462E–09	0.84248E–06	0.40594E–06	0.11801E–06
16	0.12681E–04	0.21931E–09	0.67066E–10	0.16881E–05	0.63928E–06	0.18584E–06
17	0.21609E–04	0.00000E+00	0.00000E+00	0.12637E–05	0.39993E–06	0.11626E–06
18	0.23097E–04	0.00000E+00	0.00000E+00	0.37787E–05	0.67104E–06	0.19507E–06

Table 4.79. (continued)

Group	^{243}Am Absorption[a]	^{243}Am $\nu\Sigma_f$[b]	^{243}Am Fission[c]	^{242}Cm Absorption[a]	^{242}Cm $\nu\Sigma_f$[b]	^{242}Cm Fission[c]
19	0.38299E–04	0.00000E+00	0.00000E+00	0.40059E–05	0.14852E–05	0.43174E–06
20	0.71679E–04	0.00000E+00	0.00000E+00	0.70964E–05	0.10614E–05	0.30855E–06
21	0.85668E–04	0.00000E+00	0.00000E+00	0.57826E–07	0.64534E–07	0.18760E–07
22	0.50284E–04	0.00000E+00	0.00000E+00	0.10743E–06	0.11041E–06	0.32097E–07
23	0.11934E–02	0.00000E+00	0.00000E+00	0.21529E–06	0.19897E–06	0.57839E–07
24	0.50498E–04	0.00000E+00	0.00000E+00	0.40866E–06	0.34487E–06	0.10025E–06
25	0.29664E–04	0.00000E+00	0.00000E+00	0.66463E–06	0.51982E–06	0.15111E–06
26	0.40856E–04	0.00000E+00	0.00000E+00	0.16795E–05	0.76911E–06	0.22358E–06

Group	^{243}Cm Absorption[a]	^{243}Cm $\nu\Sigma_f$[b]	^{243}Cm Fission[c]	^{244}Cm Absorption[a]	^{244}Cm $\nu\Sigma_f$[b]	^{244}Cm Fission[c]
1	0.41547E–08	0.19856E–07	0.41506E–08	0.31624E–06	0.15351E–05	0.31587E–06
2	0.36616E–08	0.15738E–07	0.36575E–08	0.24724E–06	0.10747E–05	0.24650E–06
3	0.41039E–08	0.16347E–07	0.40990E–08	0.24254E–06	0.96844E–06	0.24031E–06
4	0.48408E–08	0.18204E–07	0.48313E–08	0.23585E–06	0.87310E–06	0.22916E–06
5	0.46834E–08	0.16889E–07	0.46642E–08	0.25517E–06	0.87046E–06	0.23783E–06
6	0.38756E–08	0.13542E–07	0.38329E–08	0.12511E–06	0.35169E–06	0.96618E–07
7	0.33755E–08	0.11382E–07	0.32697E–08	0.60696E–07	0.52174E–07	0.14864E–07
8	0.39488E–08	0.12769E–07	0.36947E–08	0.73083E–07	0.21615E–07	0.61935E–08
9	0.47799E–08	0.14833E–07	0.43094E–08	0.11768E–06	0.25790E–07	0.74322E–08
10	0.55422E–08	0.16856E–07	0.49056E–08	0.15855E–06	0.30088E–07	0.86709E–08
11	0.67952E–08	0.20700E–07	0.60299E–08	0.20810E–06	0.42859E–07	0.12387E–07
12	0.10950E–07	0.32636E–07	0.95120E–08	0.24650E–06	0.55717E–07	0.16103E–07
13	0.17500E–07	0.51979E–07	0.15150E–07	0.32949E–06	0.72860E–07	0.21058E–07
14	0.26937E–07	0.79766E–07	0.23255E–07	0.46735E–06	0.10115E–06	0.29236E–07
15	0.42597E–07	0.12574E–06	0.36658E–07	0.91416E–06	0.18001E–06	0.52025E–07
16	0.65111E–07	0.19175E–06	0.55905E–07	0.16185E–05	0.25652E–06	0.74139E–07
17	0.98584E–07	0.28975E–06	0.84476E–07	0.13305E–05	0.27750E–06	0.80202E–07
18	0.14793E–06	0.43410E–06	0.12656E–06	0.20446E–05	0.32024E–06	0.92554E–07
19	0.13099E–06	0.35379E–06	0.10315E–06	0.27394E–05	0.70399E–06	0.20347E–06
20	0.30160E–06	0.90570E–06	0.26405E–06	0.46117E–05	0.60562E–06	0.17504E–06
21	0.71211E–06	0.22642E–05	0.66013E–06	0.10424E–03	0.62423E–05	0.18041E–05
22	0.13663E–06	0.38640E–06	0.11265E–06	0.34731E–06	0.36258E–07	0.10479E–07
23	0.19644E–06	0.55553E–06	0.16196E–06	0.28980E–06	0.48266E–07	0.13950E–07
24	0.29505E–06	0.83440E–06	0.24327E–06	0.37589E–06	0.79497E–07	0.22976E–07
25	0.43113E–06	0.12192E–05	0.35546E–06	0.52798E–06	0.12319E–06	0.35605E–07
26	0.11024E–05	0.31175E–05	0.90890E–06	0.13233E–05	0.33107E–06	0.95685E–07

Group	Absorption[a] ^{103}Rh	^{131}Xe	^{143}Nd	^{147}Pm	^{133}Cs
1	0.62337E–07	0.19957E–07	0.80076E–07	0.20319E–07	0.28779E–07
2	0.16623E–06	0.12829E–07	0.24824E–06	0.58495E–07	0.18706E–06
3	3.38536E–06	0.57020E–07	0.65929E–06	0.19704E–06	0.54680E–06
4	0.80471E–06	0.17106E–06	0.10437E–05	0.51168E–06	0.11764E–05
5	0.14092E–05	0.34355E–06	0.11264E–05	0.12592E–05	0.20937E–05
6	0.23650E–05	0.64005E–06	0.13052E–05	0.21569E–05	0.40543E–05
7	0.49095E–05	0.11347E–05	0.16949E–05	0.29063E–05	0.52702E–05

Table 4.79. (continued)

Group	Absorption[a]				
	^{103}Rh	^{131}Xe	^{143}Nd	^{147}Pm	^{133}Cs
8	0.74200E–05	0.16963E–05	0.24530E–05	0.33545E–05	0.74574E–05
9	0.11528E–04	0.30206E–05	0.38890E–05	0.44715E–05	0.11882E–04
10	0.17507E–04	0.48353E–05	0.75298E–05	0.64530E–05	0.18336E–04
11	0.24239E–04	0.74682E–05	0.12396E–04	0.10480E–04	0.27984E–04
12	0.31335E–04	0.11348E–04	0.20326E–04	0.18509E–04	0.43780E–04
13	0.41606E–04	0.18047E–04	0.28065E–04	0.33915E–04	0.73351E–04
14	0.51274E–04	0.30281E–04	0.51823E–04	0.60523E–04	0.93386E–04
15	0.79428E–04	0.39144E–04	0.77728E–04	0.11206E–03	0.18922E–03
16	0.18644E–03	0.71603E–04	0.24686E–03	0.17185E–03	0.45958E–03
17	0.28947E–03	0.17234E–03	0.90286E–03	0.27585E–03	0.54515E–03
18	0.39142E–04	0.12117E–03	0.63542E–03	0.41734E–03	0.98996E–03
19	0.55380E–05	0.30705E–03	0.11511E–04	0.52089E–03	0.11699E–02
20	0.15493E–05	0.15025E–01	0.38667E–04	0.28039E–03	0.47132E–04
21	0.10611E–04	0.25830E–03	0.12697E–03	0.12339E–01	0.15201E–01
22	0.16055E–03	0.10912E–03	0.35268E–03	0.41819E–03	0.37581E–03
23	0.21307E–01	0.15689E–03	0.72809E–03	0.15300E–03	0.20004E–03
24	0.30591E–02	0.23565E–03	0.13674E–02	0.19456E–03	0.23390E–03
25	0.13709E–02	0.34433E–03	0.22165E–02	0.29319E–03	0.31500E–03
26	0.21241E–02	0.88043E–03	0.61363E–02	0.80976E–03	0.76485E–03

Group	Absorption[a]				
	^{99}Tc	^{152}Sm	^{151}Sm	^{145}Nd	^{153}Eu
1	0.96628E–07	0.88579E–08	0.19992E–08	0.51935E–07	0.16121E–07
2	0.24324E–06	0.30063E–07	0.12118E–07	0.14382E–06	0.71675E–07
3	0.72638E–06	0.11676E–06	0.40630E–07	0.41948E–06	0.19270E–06
4	0.15694E–05	0.23353E–06	0.75170E–07	0.94282E–06	0.33903E–06
5	0.25890E–05	0.37659E–06	0.87873E–07	0.13923E–05	0.53645E–06
6	0.45915E–05	0.42947E–06	0.87565E–07	0.16240E–05	0.90821E–06
7	0.62542E–05	0.45041E–06	0.13841E–06	0.18956E–05	0.14610E–05
8	0.10156E–04	0.74272E–06	0.24849E–06	0.27705E–05	0.26735E–05
9	0.16777E–04	0.11392E–05	0.39307E–06	0.49618E–05	0.43054E–05
10	0.27436E–04	0.15198E–05	0.72248E–06	0.87351E–05	0.60043E–05
11	0.41017E–04	0.21331E–05	0.12595E–05	0.14004E–04	0.91044E–05
12	0.56011E–04	0.30036E–05	0.22603E–05	0.23950E–04	0.14729E–04
13	0.75203E–04	0.38089E–05	0.40599E–05	0.44464E–04	0.24875E–04
14	0.10898E–03	0.59908E–05	0.67112E–05	0.68524E–04	0.41132E–04
15	0.13278E–03	0.14954E–04	0.11371E–04	0.14108E–03	0.69567E–04
16	0.29445E–03	0.27249E–04	0.18414E–04	0.20868E–03	0.11163E–03
17	0.52512E–03	0.43215E–04	0.29192E–04	0.22583E–03	0.17584E–03
18	0.13335E–03	0.11703E–03	0.42611E–04	0.12800E–03	0.32043E–03
19	0.10749E–03	0.25619E–05	0.42178E–04	0.12535E–02	0.21789E–03
20	0.15027E–02	0.80311E–04	0.22146E–03	0.20477E–04	0.57505E–03
21	0.95229E–02	0.10642E–01	0.87464E–04	0.11007E–03	0.47641E–03
22	0.57409E–04	0.13965E–03	0.74931E–04	0.31553E–02	0.23783E–02
23	0.82539E–04	0.10634E–03	0.51112E–03	0.11210E–03	0.26733E–03
24	0.12397E–03	0.12463E–03	0.18977E–03	0.16196E–03	0.86626E–04
25	0.18115E–03	0.16556E–03	0.27124E–03	0.23668E–03	0.14931E–03
26	0.46319E–03	0.39631E–03	0.27311E–02	0.60739E–03	0.53513E–03

Table 4.79. (continued)

Group	Absorption[a]				
	^{109}Ag	^{155}Eu	^{95}Mo	^{154}Eu	^{101}Ru
1	0.14324E–07	0.14625E–08	0.31697E–06	0.53237E–08	0.17435E–06
2	0.21376E–07	0.87074E–08	0.41813E–06	0.24571E–08	0.40786E–06
3	0.60822E–07	0.36031E–07	0.87672E–06	0.10596E–07	0.77212E–06
4	0.11371E–06	0.94068E–07	0.11802E–05	0.29894E–07	0.11115E–05
5	0.17255E–06	0.13298E–06	0.18816E–05	0.70487E–07	0.16345E–05
6	0.29287E–06	0.65611E–07	0.27246E–05	0.19477E–06	0.35026E–05
7	0.53440E–06	0.51276E–07	0.31663E–05	0.48118E–06	0.77150E–05
8	0.76446E–06	0.76120E–07	0.46770E–05	0.70231E–06	0.12180E–04
9	0.11409E–05	0.11933E–06	0.76747E–05	0.99460E–06	0.19474E–04
10	0.17013E–05	0.20437E–06	0.13279E–04	0.14799E–05	0.31003E–04
11	0.23646E–05	0.36525E–06	0.21652E–04	0.23700E–05	0.45020E–04
12	0.31711E–05	0.65291E–06	0.32027E–04	0.39308E–05	0.60649E–04
13	0.44625E–05	0.11671E–05	0.44713E–04	0.64652E–05	0.82443E–04
14	0.67404E–05	0.20340E–05	0.65638E–04	0.10236E–04	0.11827E–03
15	0.14460E–04	0.37290E–05	0.82074E–04	0.16642E–04	0.11744E–03
16	0.15032E–04	0.63209E–05	0.89358E–04	0.26009E–04	0.35181E–03
17	0.38233E–04	0.74289E–05	0.58167E–04	0.40076E–04	0.27868E–03
18	0.74272E–04	0.84575E–05	0.13296E–03	0.61529E–04	0.76745E–03
19	0.10073E–03	0.15642E–04	0.44005E–02	0.81749E–04	0.77275E–03
20	0.39856E–05	0.13492E–04	0.21749E–04	0.40260E–04	0.17918E–02
21	0.38410E–02	0.13667E–05	0.25809E–04	0.13596E–03	0.17170E–04
22	0.21174E–03	0.32818E–04	0.42541E–04	0.62365E–04	0.95390E–05
23	0.52060E–04	0.47183E–04	0.61162E–04	0.89664E–04	0.13714E–04
24	0.50870E–04	0.70868E–04	0.91864E–04	0.13467E–03	0.20599E–04
25	0.63764E–04	0.10355E–03	0.13423E–03	0.19679E–03	0.30099E–04
26	0.14709E–03	0.26478E–03	0.34323E–03	0.50317E–03	0.76962E–04

Group	Absorption[a]				
	Region 2	Region 3			
	Zr	H	O	^{10}B	^{11}B
1	0.31302E–03	0.00000E+00	0.57790E–02	0.13252E–05	0.78907E–07
2	0.13113E–03	0.00000E+00	0.29733E–02	0.20541E–05	0.67098E–08
3	0.23688E–03	0.00000E+00	0.94963E–04	0.21204E–05	0.72465E–07
4	0.54567E–03	0.00000E+00	0.00000E+00	0.27167E–05	0.23538E–06
5	0.53721E–03	0.00000E+00	0.00000E+00	0.14578E–05	0.27966E–06
6	0.57528E–03	0.00000E+00	0.00000E+00	0.40420E–05	0.39641E–06
7	0.54144E–03	0.00000E+00	0.00000E+00	0.72888E–05	0.36072E–06
8	0.57951E–03	0.00000E+00	0.00000E+00	0.11066E–04	0.12802E–06
9	0.73978E–03	0.00000E+00	0.00000E+00	0.15572E–04	0.48310E–07
10	0.12717E–02	0.00000E+00	0.00000E+00	0.22264E–04	0.24155E–07
11	0.16806E–02	0.00000E+00	0.00000E+00	0.32468E–04	0.21471E–07
12	0.35773E–02	0.00000E+00	0.00000E+00	0.47642E–04	0.21471E–07
13	0.51807E–02	0.66940E–04	0.00000E+00	0.70238E–04	0.21471E–07
14	0.25511E–02	0.66940E–04	0.00000E+00	0.10212E–03	0.21471E–07
15	0.27834E–02	0.13388E–03	0.00000E+00	0.15373E–03	0.21471E–07
16	0.12875E–01	0.20082E–03	0.00000E+00	0.22595E–03	0.21471E–07
17	0.35908E–02	0.26776E–03	0.00000E+00	0.33330E–03	0.21471E–07

Table 4.79. (continued)

	Absorption[a]				
	Region 2	Region 3			
Group	Zr	H	O	^{10}B	^{11}B
18	0.13536E–03	0.40164E–03	0.00000E+00	0.49034E–03	0.21471E–07
19	0.20727E–03	0.60246E–03	0.00000E+00	0.72226E–03	0.21471E–07
20	0.32148E–03	0.93716E–03	0.00000E+00	0.10602E–02	0.21471E–07
21	0.48645E–03	0.13388E–02	0.00000E+00	0.15572E–02	0.21471E–07
22	0.73542E–03	0.20018E–02	0.81399E–06	0.22895E–02	0.13296E–07
23	0.10660E–02	0.29128E–02	0.11844E–05	0.33315E–02	0.19347E–07
24	0.15879E–02	0.43222E–02	0.17575E–05	0.49434E–02	0.28708E–07
25	0.23292E–02	0.63541E–02	0.25837E–05	0.72673E–02	0.42205E–07
26	0.60593E–02	0.16858E–01	0.68548E–05	0.19281E–01	0.11197E–06

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.80. The cell one-group cross section and flux values for Variant V7S6

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2803E–01	0.3934E–01	0.1380E–01	0.3177E+02

Table 4.81. Reaction rates for every region of cell for Variant V7S6

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.8228E+00	0.1250E+01	0.4386E+00	0.1057E+02	0.3326E+00
2	0.7506E–02	0.0000E+00	0.0000E+00	0.4326E+01	0.1362E+00
3	0.6041E–01	0.0000E+00	0.0000E+00	0.1688E+02	0.5313E+00

Table 4.82. The cell one-group cross section and flux values for Variant V8S6

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2635E–01	0.3205E–01	0.1306E–01	0.3377E+02

Table 4.83. Reaction rates for every region of cell for Variant V8S6

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.7832E+00	0.1082E+01	0.4412E+00	0.1125E+02	0.3331E+00
2	0.9026E–02	0.0000E+00	0.0000E+00	0.4594E+01	0.1360E+00
3	0.9768E–01	0.0000E+00	0.0000E+00	0.1793E+02	0.5309E+00

Table 4.84. The cell one-group cross section and flux values for Variant V9S6

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2651E–01	0.4295E–01	0.1462E–01	0.3300E+02

Table 4.85. Reaction rates for every region of cell for Variant V9S6

Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
1	0.8095E+00	0.1417E+01	0.4825E+00	0.1098E+02	0.3328E+00
2	0.7062E–02	0.0000E+00	0.0000E+00	0.4491E+01	0.1361E+00
3	0.5835E–01	0.0000E+00	0.0000E+00	0.1752E+02	0.5311E+00

Table 4.86. The assembly cross section and flux values for Variant V11S4

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2068E–01	0.2749E–01	0.1120E–01	0.4067E+02

Table 4.87. Relative cell fission rates normalized to the average cell fission rate of 1 for Variant V11S4

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
1	1.0513	2	1.0280	3	1.0356	4	1.0164	5	1.0095	6	1.0034
7	1.0376	8	1.0383	9	1.0308	10	1.0328	11	1.0431	12	1.0280
13	1.0068	14	0.9705	15	0.9979	16	0.9862	17	0.9534	18	0.9787
19	0.9835	20	0.9801	21	0.9821	22	0.9979	23	1.0301	24	1.0225
25	0.9773	26	0.9547	27	0.9876	28	0.9671	29	0.9630	30	0.9602
31	0.9424	32	0.9623	33	0.9191	34	0.9657	35	0.9664	36	1.0390
37	1.0088	38	0.9924	39	0.9876	40	0.9650	41	0.9609	42	0.9698
43	1.0164	44	0.9883	45	0.9636	46	0.9636	47	0.9547	48	0.9671

Table 4.87. (continued)

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
49	0.9609	50	1.0095	51	1.0164	52	0.9705	53	0.9609	54	0.9684
55	1.0116	56	1.0068	57	1.0198	58	0.0000	59	1.0061	60	0.9910
61	0.9979	62	0.9582	63	0.9575	64	0.9767	65	1.0191	66	1.0177
67	0.9787	68	0.9506	69	0.9595	70	1.0116	71	0.0000	72	1.0383
73	1.0184	74	1.0205	75	0.9931	76	0.0000	77	0.9972	78	0.9732
79	0.9773	80	0.9725	81	1.0068	82	1.0417	83	0.9869	84	0.9739
85	1.0040	86	1.0143	87	1.0239	88	1.0376	89	1.0397	90	1.0417
91	1.0075	92	1.0356	93	1.0212	94	0.9897	95	0.9869	96	0.9534
97	0.9671	98	1.0129	99	1.0273	100	0.9821	101	0.9739	102	1.0082
103	0.0000	104	1.0219	105	1.0260	106	1.0431	107	0.0000	108	1.0102
109	1.0157	110	1.0260	111	1.0198	112	0.0000	113	0.9890	114	0.9527
115	0.9753	116	1.0171	117	1.0294	118	0.9623	119	0.9431	120	0.9636
121	1.0232	122	1.0301	123	1.0486	124	1.0465	125	1.0451	126	1.0458
127	1.0417	128	0.0000	129	0.9965	130	1.0253	131	1.0020	132	0.9513
133	0.9198	134	0.9684	135	0.9876	136	1.0390	137	0.9938	138	0.9520
139	0.9506	140	0.9903	141	1.0157	142	1.0219	143	0.0000	144	1.0356
145	1.0479	146	1.0219	147	1.0534	148	1.0513	149	1.0150	150	1.0280
151	1.0034	152	0.9746	153	0.9767	154	0.9698	155	1.0075	156	1.0534
157	0.9821	158	0.9534	159	0.9349	160	0.9958	161	0.0000	162	1.0157
163	1.0294	164	1.0499	165	1.0458	166	0.0000	167	1.0294	168	1.0438
169	1.0486	170	1.0349	171	0.0000	172	0.9951	173	0.9547	174	0.9910
175	0.9835	176	1.0725	177	1.0417	178	0.9705	179	0.9527	180	0.9465
181	0.9773	182	1.0020	183	1.0102	184	1.0527	185	1.0451	186	1.0732
187	1.0513	188	1.0842	189	0.0000	190	1.0321	191	1.0102	192	1.0383
193	0.9677	194	0.9623	195	0.9739	196	1.0403	197	1.0314	198	0.9561
199	0.9534	200	0.9554	201	0.9924	202	1.0246	203	1.0301	204	0.0000
205	1.0643	206	1.0397	207	1.0479	208	1.0205	209	1.0308	210	1.0225
211	1.0335	212	0.9739	213	0.9520	214	0.9595	215	1.0246	216	1.0308
217	0.9664	218	0.9712	219	1.0082	220	0.0000	221	1.0520	222	1.0287
223	1.0253	224	1.0321	225	0.0000	226	1.0383	227	1.0027	228	1.0047
229	0.0000	230	1.0027	231	0.9588	232	0.9671	233	1.0376	234	1.0219
235	0.9691	236	0.9486	237	0.9869	238	1.0266	239	1.0445	240	1.0390
241	1.0102	242	1.0239	243	1.0212	244	1.0177	245	1.0212	246	1.0061
247	1.0225	248	0.9657	249	0.9828	250	1.0383	251	1.0458	252	0.9876
253	0.9643	254	0.9732	255	0.9958	256	0.0000	257	1.0424	258	1.0123
259	1.0342	260	1.0479	261	0.0000	262	1.0232	263	0.9814	264	0.9561
265	0.9698	266	1.0246	267	1.0506	268	0.9630	269	0.9568	270	0.9547
271	0.9753	272	0.9993	273	0.9760	274	0.0000	275	1.0198	276	1.0109
277	1.0082	278	0.9664	279	0.9472	280	0.9821	281	1.0431	282	1.0294
283	0.9472	284	0.9479	285	0.9458	286	0.9506	287	0.9746	288	0.9951
289	0.9856	290	0.9636	291	0.9773	292	0.9712	293	0.9568	294	0.9773
295	1.0403	296	1.0040	297	0.9527	298	0.9582	299	0.9424	300	0.9390
301	0.9753	302	0.9561	303	0.9698	304	0.9623	305	0.9767	306	0.9739
307	0.9568	308	1.0369	309	1.0390	310	1.0143	311	0.9630	312	0.9643
313	0.9712	314	0.9623	315	0.9698	316	0.9794	317	0.9698	318	0.9924
319	0.9910	320	1.0486	321	1.0664	322	1.0369	323	1.0301	324	1.0143
325	1.0362	326	1.0376	327	1.0328	328	1.0088	329	1.0164	330	1.0349
331	1.0718										

Table 4.88. The cross section (cm^{-1}) and flux values (cm) of Cells 1, 29, and 72 for Variant V11S4

Cell	Absorption	$\nu\Sigma_f$	Fission	Flux	k_0
1	0.2344E–01	0.3164E–01	0.1290E–01	0.1190E+00	0.1350E+01
29	0.2168E–01	0.2921E–01	0.1190E–01	0.1181E+00	0.1347E+01
72	0.2302E–01	0.3123E–01	0.1273E–01	0.1191E+00	0.1357E+01

Table 4.89. Reaction rates for every region of cell for Variant V11S4

Cell	Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
	1	0.2566E–02	0.3766E–02	0.1535E–02	0.3953E–01	0.3321E+00
1	2	0.2835E–04	0.0000E+00	0.0000E+00	0.1624E–01	0.1365E+00
	3	0.1943E–03	0.0000E+00	0.0000E+00	0.6323E–01	0.5314E+00
	1	0.2361E–02	0.3450E–02	0.1406E–02	0.3925E–01	0.3323E+00
29	2	0.2680E–04	0.0000E+00	0.0000E+00	0.1611E–01	0.1364E+00
	3	0.1738E–03	0.0000E+00	0.0000E+00	0.6275E–01	0.5313E+00
	1	0.2521E–02	0.3718E–02	0.1516E–02	0.3966E–01	0.3331E+00
72	2	0.2781E–04	0.0000E+00	0.0000E+00	0.1622E–01	0.1362E+00
	3	0.1924E–03	0.0000E+00	0.0000E+00	0.6318E–01	0.5307E+00

Note: Values are integrated over region volume.

Table 4.90. Cross sections (cm^{-1}) and fluxes (cm) for Region 1 of Cell 1 for Variant V11S4

	Region 1							
		^{235}U			^{238}U			Absorption[a]
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	O
1	0.1090E–01	0.11124E–02	0.28568E–02	0.10585E–02	0.80576E–02	0.19542E–01	0.69756E–02	0.51294E–03
2	0.1369E–01	0.18362E–02	0.35593E–02	0.14548E–02	0.48839E–02	0.15562E–04	0.62342E–05	0.00000E+00
3	0.9897E–02	0.31635E–01	0.51926E–01	0.21351E–01	0.49630E–01	0.00000E+00	0.00000E+00	0.27007E–06
4	0.5038E–02	0.28387E+00	0.58731E+00	0.24149E+00	0.26661E–01	0.00000E+00	0.00000E+00	0.54747E–05

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.91. Cross sections (cm^{-1}) and fluxes (cm) for Region 2 of Cell 1 for Variant V11S4

Group	Flux	Zr Absorption
1	0.4352E–02	0.26690E–03
2	0.5493E–02	0.71854E–03
3	0.4177E–02	0.33251E–02
4	0.2219E–02	0.42144E–02

Table 4.92. Cross sections (cm^{-1}) and fluxes (cm) for Region 3 of Cell 1 for Variant V11S4

		Absorption			
Group	Flux	H	O	^{10}B	^{11}B
1	0.1628E–01	0.00000E+00	0.32124E–03	0.15120E–05	0.13419E–06
2	0.2135E–01	0.00000E+00	0.00000E+00	0.10749E–04	0.14850E–06
3	0.1650E–01	0.62495E–03	0.16200E–06	0.72234E–03	0.14980E–07
4	0.9106E–02	0.85334E–02	0.34692E–05	0.97595E–02	0.56680E–07

Table 4.93. Cross sections and fluxes for Region 1 of Cell 29 for Variant V11S4

		^{235}U			^{238}U		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1096E–01	0.11099E–02	0.28524E–02	0.10565E–02	0.80610E–02	0.19580E–01	0.69869E–02
2	0.1390E–01	0.18426E–02	0.35714E–02	0.14598E–02	0.48530E–02	0.15790E–04	0.63255E–05
3	0.9784E–02	0.31900E–01	0.52398E–01	0.21545E–01	0.46134E–01	0.00000E+00	0.00000E+00
4	0.4603E–02	0.27745E+00	0.57384E+00	0.23596E+00	0.26159E–01	0.00000E+00	0.00000E+00

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.94. Cross sections and fluxes of every region of Cell 29 for Variant V11S4

					Region 3				
	Region 1		Region 2			Absorption[a]			
Group	Flux	O Absorption[a]	Flux	Zr Absorption[a]	Flux	H	O	^{10}B	^{11}B
1	0.1096E–01	0.52810E–03	0.4261E–02	0.26488E–03	0.1632E–01	0.00000E+00	0.32596E–03	0.15082E–05	0.13301E–06
2	0.1390E–01	0.00000E+00	0.5664E–02	0.72037E–03	0.2187E–01	0.00000E+00	0.00000E+00	0.10682E–04	0.15027E–06
3	0.9784E–02	0.26236E–06	0.4167E–02	0.31566E–02	0.1637E–01	0.61297E–03	0.15681E–06	0.70862E–03	0.14998E–07
4	0.4603E–02	0.53688E–05	0.2021E–02	0.41727E–02	0.8190E–02	0.83490E–02	0.33942E–05	0.95487E–02	0.55455E–07

[a]Absorption is reaction 3.

Table 4.95. Cross sections and fluxes for Region 1 of Cell 72 for Variant V11S4

		^{235}U			^{238}U		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1094E–01	0.11102E–02	0.28539E–02	0.10569E–02	0.80915E–02	0.19675E–01	0.70214E–02
2	0.1390E–01	0.18350E–02	0.35573E–02	0.14540E–02	0.49002E–02	0.15740E–04	0.63056E–05
3	0.9757E–02	0.32201E–01	0.52891E–01	0.21748E–01	0.48018E–01	0.00000E+00	0.00000E+00
4	0.5058E–02	0.27785E+00	0.57447E+00	0.23621E+00	0.26160E–01	0.00000E+00	0.00000E+00

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.96. Cross sections and fluxes for every region of Cell 72 for Variant V11S4

					Region 3				
	Region 1		Region 2			Absorption[a]			
Group	Flux	O Absorption[a]	Flux	Zr Absorption[a]	Flux	H	O	^{10}B	^{11}B
1	0.1094E–01	0.53225E–03	0.4270E–02	0.26702E–03	0.1619E–01	0.00000E+00	0.32546E–03	0.15081E–05	0.13355E–06
2	0.1390E–01	0.00000E+00	0.5591E–02	0.71478E–03	0.2156E–01	0.00000E+00	0.00000E+00	0.10704E–04	0.14965E–06
3	0.9757E–02	0.28081E–06	0.4119E–02	0.32245E–02	0.1628E–01	0.62959E–03	0.16396E–06	0.72775E–03	0.14980E–07
4	0.5058E–02	0.53689E–05	0.2239E–02	0.41915E–02	0.9148E–02	0.83991E–02	0.34146E–05	0.96059E–02	0.55787E–07

[a]Absorption is reaction 3.

Table 4.97. The assembly cross section and flux values for Variant V11S2

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2161E–01	0.2222E–01	0.9032E–02	0.3903E+02

Table 4.98. Relative cell fission rates normalized to the average cell fission rate of 1 for Variant V11S2

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
1	1.3374	2	1.2913	3	1.2559	4	1.2347	5	1.2444	6	1.2152
7	1.2356	8	1.2232	9	1.2444	10	1.2922	11	1.2993	12	1.3205
13	1.2117	14	1.1966	15	1.1462	16	1.1559	17	1.1294	18	1.1223
19	1.1488	20	1.1480	21	1.1710	22	1.2081	23	1.3046	24	1.2763
25	1.2179	26	1.1356	27	1.0922	28	1.0515	29	1.0533	30	1.0364
31	1.0639	32	1.0267	33	1.0665	34	1.1382	35	1.1966	36	1.2692
37	1.2489	38	1.1834	39	1.1028	40	1.0294	41	0.9913	42	0.9488
43	0.8939	44	0.8957	45	0.9462	46	0.9842	47	1.0426	48	1.1046
49	1.1780	50	1.2391	51	1.2427	52	1.1727	53	1.0559	54	0.9736
55	0.8886	56	0.8322	57	0.8153	58	0.0000	59	0.8045	60	0.8410
61	0.8636	62	0.9674	63	1.0426	64	1.1373	65	1.2064	66	1.1674
67	1.1338	68	1.0320	69	0.9408	70	0.8362	71	0.0000	72	0.7308
73	0.7226	74	0.7311	75	0.7440	76	0.0000	77	0.8284	78	0.9408
79	1.0063	80	1.1002	81	1.2143	82	1.2161	83	1.1267	84	1.0364
85	0.9081	86	0.7933	87	0.7520	88	0.7352	89	0.6980	90	0.7152
91	0.7506	92	0.7053	93	0.7357	94	0.8183	95	0.8895	96	0.9851
97	1.0993	98	1.2719	99	1.2409	100	1.1453	101	1.0550	102	0.8815
103	0.0000	104	0.7298	105	0.7450	106	0.6854	107	0.0000	108	0.6985
109	0.6747	110	0.6913	111	0.7500	112	0.0000	113	0.9019	114	1.0373
115	1.1347	116	1.2391	117	1.2754	118	1.1577	119	1.0869	120	0.9568
121	0.8307	122	0.7283	123	0.7028	124	0.6841	125	0.7057	126	0.7180
127	0.6993	128	0.0000	129	0.7232	130	0.7202	131	0.8217	132	0.9364
133	1.0524	134	1.1533	135	1.2533	136	1.2851	137	1.2028	138	1.0887
139	0.9780	140	0.8357	141	0.7264	142	0.7164	143	0.0000	144	0.7166
145	0.7820	146	0.7907	147	0.7359	148	0.7222	149	0.7332	150	0.7657
151	0.8393	152	0.9789	153	1.0780	154	1.1825	155	1.2896	156	1.3648
157	1.2214	158	1.1241	159	1.0568	160	0.9037	161	0.0000	162	0.6982
163	0.6936	164	0.7238	165	0.7918	166	0.0000	167	0.8274	168	0.7243
169	0.7015	170	0.7187	171	0.0000	172	0.9028	173	1.0214	174	1.1356
175	1.2196	176	1.3577	177	1.2913	178	1.1780	179	1.1019	180	1.0285
181	0.8569	182	0.7464	183	0.7502	184	0.7113	185	0.7146	186	0.7993
187	0.7826	188	0.7157	189	0.0000	190	0.7122	191	0.7335	192	0.8419
193	0.9948	194	1.1205	195	1.1922	196	1.2869	197	1.2559	198	1.1639
199	1.0798	200	0.9594	201	0.8248	202	0.7404	203	0.7051	204	0.0000
205	0.7150	206	0.7083	207	0.7028	208	0.7190	209	0.7196	210	0.7254
211	0.8261	212	0.9647	213	1.0727	214	1.1542	215	1.2728	216	1.2400
217	1.1418	218	1.0488	219	0.9134	220	0.0000	221	0.7154	222	0.6935
223	0.6885	224	0.6827	225	0.0000	226	0.6925	227	0.7477	228	0.7292

Table 4.98. (continued)

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
229	0.0000	230	0.9178	231	1.0444	232	1.1320	233	1.2338	234	1.2515
235	1.1409	236	1.0444	237	0.9072	238	0.8296	239	0.7472	240	0.7271
241	0.7470	242	0.7264	243	0.6969	244	0.7206	245	0.7638	246	0.7914
247	0.9240	248	1.0258	249	1.0975	250	1.2285	251	1.2444	252	1.1285
253	1.0533	254	0.9462	255	0.8519	256	0.0000	257	0.7495	258	0.7518
259	0.7283	260	0.7714	261	0.0000	262	0.8301	263	0.9497	264	1.0090
265	1.1320	266	1.2506	267	1.2258	268	1.1232	269	1.0409	270	1.0046
271	0.8848	272	0.8525	273	0.8147	274	0.0000	275	0.8040	276	0.8453
277	0.8840	278	0.9842	279	1.0674	280	1.1329	281	1.2117	282	1.2772
283	1.1497	284	1.1055	285	1.0789	286	0.9709	287	0.9178	288	0.8975
289	0.8836	290	0.9692	291	0.9886	292	1.0276	293	1.0895	294	1.1683
295	1.2365	296	1.2604	297	1.1789	298	1.1329	299	1.1055	300	1.0550
301	1.0285	302	1.0240	303	1.0294	304	1.0533	305	1.0931	306	1.1639
307	1.1842	308	1.2781	309	1.3020	310	1.2152	311	1.1789	312	1.1285
313	1.1391	314	1.1409	315	1.1586	316	1.1400	317	1.1727	318	1.2135
319	1.2241	320	1.2878	321	1.3577	322	1.3011	323	1.2542	324	1.2223
325	1.2303	326	1.2250	327	1.2497	328	1.2506	329	1.2471	330	1.3250
331	1.3436										

Table 4.99. The cross section and flux values of Cells 1, 29, and 72 for Variant V11S2

Cell	Absorption	$\nu\Sigma_f$	Fission	Flux	k_0
1	0.2227E–01	0.2958E–01	0.1205E–01	0.1255E+00	0.1328E+01
29	0.1927E–01	0.2499E–01	0.1016E–01	0.1172E+00	0.1297E+01
72	0.1618E–01	0.1953E–01	0.7916E–02	0.1043E+00	0.1207E+01

Table 4.100. Reaction rates for every region of Cells 1, 29, and 72 for Variant V11S2

Cell	Region	Absorption	$\nu\Sigma_f$	Fission	Flux $(cm^2 \cdot s)^{-1}$	Flux/flux (cell)
	1	0.2577E–02	0.3711E–02	0.1511E–02	0.4180E–01	0.3332E+00
1	2	0.2749E–04	0.0000E+00	0.0000E+00	0.1704E–01	0.1358E+00
	3	0.1895E–03	0.0000E+00	0.0000E+00	0.6663E–01	0.5310E+00
	1	0.2088E–02	0.2928E–02	0.1190E–02	0.3913E–01	0.3339E+00
29	2	0.2508E–04	0.0000E+00	0.0000E+00	0.1592E–01	0.1358E+00
	3	0.1450E–03	0.0000E+00	0.0000E+00	0.6213E–01	0.5302E+00
	1	0.1567E–02	0.2037E–02	0.8257E–03	0.3471E–01	0.3328E+00
72	2	0.2294E–04	0.0000E+00	0.0000E+00	0.1419E–01	0.1361E+00
	3	0.9811E–04	0.0000E+00	0.0000E+00	0.5540E–01	0.5311E+00

Note: Values are integrated over region volume.

Table 4.101. Cross sections and fluxes for Region 1 of Cell 1 for Variant V11S2

		^{235}U			^{238}U		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1194E–01	0.11106E–02	0.28576E–02	0.10572E–02	0.80512E–02	0.19593E–01	0.69732E–02
2	0.1465E–01	0.18352E–02	0.35588E–02	0.14546E–02	0.48717E–02	0.15903E–04	0.63709E–05
3	0.1028E–01	0.31349E–01	0.51334E–01	0.21108E–01	0.51170E–01	0.00000E+00	0.00000E+00
4	0.4935E–02	0.28049E+00	0.58015E+00	0.23855E+00	0.26370E–01	0.00000E+00	0.00000E+00

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.102. Cross sections and fluxes for every region of Cell 1 for Variant V11S2

	Region 1		Region 2		Region 3				
						Absorption[a]			
Group	Flux	O Absorption[a]	Flux	Zr Absorption[a]	Flux	H	O	^{10}B	^{11}B
1	0.1194E–01	0.54727E–03	0.4654E–02	0.26847E–03	0.1770E–01	0.00000E+00	0.33568E–03	0.15008E–05	0.13330E–06
2	0.1465E–01	0.00000E+00	0.5926E–02	0.72339E–03	0.2292E–01	0.00000E+00	0.00000E+00	0.10738E–04	0.14888E–06
3	0.1028E–01	0.26365E–06	0.4294E–02	0.30032E–02	0.1710E–01	0.60418E–03	0.15593E–06	0.69866E–03	0.14972E–07
4	0.4935E–02	0.54131E–05	0.2167E–02	0.41788E–02	0.8903E–02	0.84350E–02	0.34292E–05	0.96470E–02	0.56026E–07

[a]Absorption is reaction 3.

Table 4.103. Cross sections and fluxes for Region 1 of Cell 29 for Variant V11S2

		^{235}U			^{238}U		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1138E–01	0.11101E–02	0.28501E–02	0.10562E–02	0.79970E–02	0.19371E–01	0.69086E–02
2	0.1438E–01	0.18374E–02	0.35638E–02	0.14565E–02	0.48365E–02	0.16161E–04	0.64739E–05
3	0.9610E–02	0.31829E–01	0.51895E–01	0.21338E–01	0.46929E–01	0.00000E+00	0.00000E+00
4	0.3763E–02	0.27317E+00	0.56467E+00	0.23218E+00	0.25780E–01	0.00000E+00	0.00000E+00

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.104. Cross sections and fluxes for every region of Cell 29 for Variant V11S2

					Region 3				
	Region 1		Region 2			Absorption[a]			
Group	Flux	O Absorption[a]	Flux	Zr Absorption[a]	Flux	H	O	^{10}B	^{11}B
1	0.1138E–01	0.53572E–03	0.4481E–02	0.26835E–03	0.1708E–01	0.00000E+00	0.32232E–03	0.15048E–05	0.13409E–06
2	0.1438E–01	0.00000E+00	0.5788E–02	0.71861E–03	0.2228E–01	0.00000E+00	0.00000E+00	0.10595E–04	0.15115E–06
3	0.9610E–02	0.25908E–06	0.4011E–02	0.32336E–02	0.1605E–01	0.59740E–03	0.15206E–06	0.69096E–03	0.14995E–07
4	0.3763E–02	0.52876E–05	0.1638E–02	0.41182E–02	0.6732E–02	0.82157E–02	0.33400E–05	0.93961E–02	0.54569E–07

[a]Absorption is reaction 3.

Table 4.105. Cross sections and fluxes for Region 1 of Cell 72 for Variant V11S2

		^{235}U			^{238}U		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1019E–01	0.11112E–02	0.28521E–02	0.10573E–02	0.80355E–02	0.19464E–01	0.69520E–02
2	0.1360E–01	0.18492E–02	0.35798E–02	0.14634E–02	0.48963E–02	0.15554E–04	0.62307E–05
3	0.8475E–02	0.30631E–01	0.49944E–01	0.20536E–01	0.48211E–01	0.00000E+00	0.00000E+00
4	0.2447E–02	0.26445E+00	0.54655E+00	0.22473E+00	0.25119E–01	0.00000E+00	0.00000E+00

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.106. Cross sections and fluxes for every region of Cell 72 for Variant V11S2

					Region 3				
	Region 1		Region 2			Absorption[a]			
Group	Flux	O Absorption[a]	Flux	Zr Absorption[a]	Flux	H	O	^{10}B	^{11}B
1	0.1019E–01	0.51646E–03	0.4011E–02	0.26819E–03	0.1541E–01	0.00000E+00	0.31986E–03	0.15014E–05	0.13548E–06
2	0.1360E–01	0.00000E+00	0.5495E–02	0.72337E–03	0.2129E–01	0.00000E+00	0.00000E+00	0.10713E–04	0.14889E–06
3	0.8475E–02	0.22443E–06	0.3589E–02	0.37850E–02	0.1425E–01	0.54124E–03	0.13031E–06	0.62670E–03	0.15022E–07
4	0.2447E–02	0.51475E–05	0.1099E–02	0.39187E–02	0.4448E–02	0.79983E–02	0.32516E–05	0.91475E–02	0.53125E–07

[a]Absorption is reaction 3.

Table 4.107. The assembly cross section and flux values for Variant V11S6

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2693E–01	0.3675E–01	0.1501E–01	0.3317E+02

Table 4.108. Relative cell fission rates normalized to the average cell fission rate of 1 for Variant V11S6

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
1	1.0866	2	1.0872	3	1.0534	4	1.0502	5	1.0559	6	1.0409
7	1.0239	8	1.0515	9	1.0189	10	1.0371	11	1.1129	12	1.0784
13	0.9907	14	0.9469	15	0.9951	16	0.9525	17	0.9700	18	0.9606
19	0.9594	20	0.9506	21	0.9613	22	1.0095	23	1.0778	24	1.0327
25	0.9713	26	0.9456	27	0.9694	28	0.9224	29	0.9462	30	0.9375
31	0.9356	32	0.9180	33	0.9299	34	0.9675	35	0.9650	36	1.0440
37	1.0352	38	0.9788	39	0.9086	40	0.9299	41	0.9080	42	0.9450
43	0.9569	44	1.0070	45	0.9531	46	0.9456	47	0.9456	48	0.9243
49	0.9700	50	1.0252	51	1.0321	52	0.9732	53	0.9575	54	0.9732
55	1.0114	56	0.9863	57	1.0189	58	0.0000	59	0.9945	60	0.9982
61	0.9957	62	0.9312	63	0.9168	64	0.9418	65	1.0296	66	1.0810
67	0.9606	68	0.9475	69	0.9519	70	1.0202	71	0.0000	72	1.0452
73	1.0271	74	1.0258	75	1.0214	76	0.0000	77	1.0170	78	0.9512
79	0.9644	80	0.9801	81	1.0396	82	1.0465	83	0.9575	84	0.9600
85	1.0045	86	1.0377	87	1.0477	88	1.0264	89	1.0421	90	1.0239
91	0.9769	92	1.0064	93	1.0390	94	1.0133	95	1.0214	96	0.9613
97	0.9381	98	1.0170	99	1.0596	100	0.9638	101	0.9475	102	0.9788
103	0.0000	104	1.0170	105	1.0007	106	1.0596	107	0.0000	108	1.0678
109	1.0127	110	1.0427	111	1.0321	112	0.0000	113	1.0170	114	0.9318
115	0.9412	116	1.0465	117	1.0528	118	0.9469	119	0.9719	120	0.9400
121	1.0070	122	1.0477	123	1.0546	124	1.0296	125	1.0459	126	1.0509
127	1.0521	128	0.0000	129	1.0559	130	1.0208	131	1.0277	132	0.9563
133	0.9368	134	0.9870	135	1.0609	136	1.0302	137	0.9619	138	0.9437
139	0.9312	140	1.0001	141	1.0333	142	1.0496	143	0.0000	144	1.0697
145	1.0239	146	1.0647	147	1.0477	148	1.0390	149	0.9794	150	1.0390
151	1.0296	152	0.9469	153	0.9406	154	0.9738	155	1.0991	156	1.0734
157	0.9644	158	0.9475	159	0.9199	160	0.9989	161	0.0000	162	1.0327
163	1.0596	164	1.0734	165	1.0709	166	0.0000	167	1.0315	168	1.0246
169	1.0484	170	1.0189	171	0.0000	172	1.0214	173	0.9563	174	0.9600
175	0.9694	176	1.0709	177	1.0665	178	0.9556	179	0.9475	180	0.9337
181	1.0064	182	1.0233	183	0.9769	184	1.0271	185	1.0853	186	1.0640
187	1.0283	188	1.0101	189	0.0000	190	1.0271	191	1.0164	192	1.0127
193	0.9945	194	0.9375	195	0.9782	196	1.0622	197	1.0690	198	0.9738
199	0.9368	200	0.9393	201	1.0064	202	1.0170	203	1.0502	204	0.0000
205	1.0622	206	1.0383	207	1.0177	208	1.0559	209	1.0246	210	1.0239
211	1.0139	212	0.9807	213	0.9456	214	0.9707	215	1.0446	216	1.0371
217	0.9343	218	0.9287	219	0.9976	220	0.0000	221	1.0327	222	1.0452
223	1.0415	224	1.0521	225	0.0000	226	1.0521	227	1.0302	228	1.0484
229	0.0000	230	0.9895	231	0.9462	232	0.9832	233	1.0647	234	1.0490
235	0.9638	236	0.9155	237	1.0045	238	1.0026	239	1.0502	240	1.0045

Table 4.108. (continued)

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
241	1.0214	242	1.0477	243	1.0289	244	1.0315	245	1.0170	246	1.0177
247	0.9725	248	0.9306	249	0.9688	250	1.0415	251	1.0634	252	0.9563
253	0.9719	254	0.9375	255	1.0095	256	0.0000	257	1.0283	258	1.0340
259	1.0177	260	1.0076	261	0.0000	262	1.0058	263	0.9487	264	0.9431
265	0.9744	266	1.0590	267	1.0659	268	0.9751	269	0.9443	270	0.9287
271	0.9995	272	0.9926	273	0.9832	274	0.0000	275	1.0177	276	1.0076
277	0.9744	278	0.9663	279	0.9425	280	0.9776	281	1.0697	282	1.0697
283	0.9556	284	0.9537	285	0.9262	286	0.9475	287	0.9475	288	0.9657
289	1.0064	290	0.9663	291	0.9400	292	0.9613	293	0.9475	294	0.9738
295	1.0434	296	1.0164	297	0.9506	298	0.9193	299	0.9243	300	0.9312
301	0.9512	302	0.9456	303	0.9431	304	0.9631	305	0.9487	306	0.9168
307	0.9732	308	1.0446	309	1.0452	310	0.9832	311	0.9650	312	0.9443
313	0.9494	314	0.9619	315	0.9431	316	0.9675	317	0.9757	318	0.9694
319	1.0020	320	1.0728	321	1.0747	322	1.0665	323	1.0528	324	1.0546
325	1.0509	326	1.0252	327	1.0183	328	1.0684	329	1.0647	330	1.1129
331	1.1092										

Table 4.109. The cross section and flux values of Cells 1, 29, and 72 for Variant V11S6

Cell	Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)	k_0
1	0.3102E–01	0.4353E–01	0.1778E–01	0.9748E–01	0.1403E+01
29	0.2781E–01	0.3862E–01	0.1576E–01	0.9583E–01	0.1389E+01
72	0.2996E–01	0.4194E–01	0.1713E–01	0.9735E–01	0.1400E+01

Table 4.110. Reaction rates for every region of Cells 1, 29, and 72 for Variant V11S6

Cell	Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
	1	0.2678E–02	0.4243E–02	0.1734E–02	0.3230E–01	0.3313E+00
1	2	0.2477E–04	0.0000E+00	0.0000E+00	0.1331E–01	0.1365E+00
	3	0.3219E–03	0.0000E+00	0.0000E+00	0.5187E–01	0.5321E+00
	1	0.2363E–02	0.3701E–02	0.1510E–02	0.3206E–01	0.3345E+00
29	2	0.2703E–04	0.0000E+00	0.0000E+00	0.1298E–01	0.1354E+00
	3	0.2749E–03	0.0000E+00	0.0000E+00	0.5080E–01	0.5301E+00
	1	0.2587E–02	0.4083E–02	0.1668E–02	0.3250E–01	0.3339E+00
72	2	0.2543E–04	0.0000E+00	0.0000E+00	0.1325E–01	0.1361E+00
	3	0.3038E–03	0.0000E+00	0.0000E+00	0.5160E–01	0.5300E+00

Note: Values are integrated over region volume.

Table 4.111. The assembly cross section and flux values for Variant V12S4

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2228E–01	0.2799E–01	0.9821E–02	0.3782E+02

Table 4.112. Relative cell fission rates normalized to the average cell fission rate of 1 for Variant V12S4

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
1	1.1214	2	1.0735	3	1.0701	4	1.0760	5	1.0416	6	1.0483
7	1.0407	8	1.0433	9	1.0508	10	1.0491	11	1.1088	12	1.0785
13	0.9677	14	0.9559	15	0.9752	16	0.9777	17	0.9416	18	0.9332
19	0.9635	20	0.9542	21	0.9811	22	1.0105	23	1.0533	24	1.0659
25	0.9559	26	0.9635	27	0.9408	28	0.9525	29	0.9265	30	0.9441
31	0.9240	32	0.9089	33	0.9215	34	0.9332	35	0.9525	36	1.0651
37	1.0659	38	0.9635	39	0.9265	40	0.9131	41	0.9399	42	0.9668
43	1.0013	44	1.0155	45	0.9752	46	0.9542	47	0.9374	48	0.9383
49	0.9509	50	1.0433	51	1.0315	52	0.9769	53	0.9542	54	0.9080
55	0.9744	56	1.0013	57	1.0130	58	0.0000	59	1.0349	60	1.0013
61	0.9719	62	0.9668	63	0.9332	64	0.9677	65	1.0491	66	1.0458
67	0.9727	68	0.9450	69	0.9609	70	1.0097	71	0.0000	72	1.0374
73	1.0273	74	1.0122	75	1.0223	76	0.0000	77	1.0055	78	0.9492
79	0.9458	80	0.9441	81	1.0735	82	1.0424	83	0.9702	84	0.9324
85	0.9794	86	1.0491	87	1.0617	88	1.0441	89	0.9971	90	1.0181
91	0.9769	92	1.0550	93	1.0433	94	1.0265	95	0.9803	96	0.9399
97	0.9803	98	1.0399	99	1.0651	100	0.9668	101	0.9559	102	1.0256
103	0.0000	104	1.0365	105	0.9845	106	1.0559	107	0.0000	108	1.0500
109	1.0172	110	1.0508	111	1.0374	112	0.0000	113	0.9996	114	0.9441
115	0.9576	116	1.0466	117	1.0340	118	0.9601	119	0.9013	120	0.9332
121	1.0273	122	1.0466	123	1.0407	124	1.0634	125	1.0332	126	1.0626
127	1.0172	128	0.0000	129	1.0214	130	1.0189	131	1.0248	132	0.9542
133	0.9315	134	0.9551	135	1.0575	136	1.0869	137	0.9643	138	0.9374
139	0.9467	140	0.9819	141	1.0869	142	1.0861	143	0.0000	144	1.0517
145	1.0357	146	1.0332	147	1.0332	148	1.0651	149	1.0130	150	1.0223
151	0.9920	152	0.9433	153	0.9147	154	0.9643	155	1.0433	156	1.1172
157	1.0265	158	0.9416	159	0.9559	160	0.9962	161	0.0000	162	1.0634
163	1.0676	164	1.0777	165	1.0626	166	0.0000	167	1.0491	168	1.0189
169	1.0399	170	1.0130	171	0.0000	172	1.0197	173	0.9307	174	0.9257
175	0.9668	176	1.0886	177	1.0601	178	0.9668	179	0.9391	180	0.9483
181	1.0189	182	1.0601	183	1.0172	184	1.0517	185	1.0827	186	1.0617
187	1.0659	188	1.0659	189	0.0000	190	1.0517	191	1.0248	192	1.0231
193	0.9416	194	0.9206	195	0.9567	196	1.0584	197	1.0643	198	0.9744
199	0.9206	200	0.9551	201	1.0113	202	1.0584	203	1.0533	204	0.0000
205	1.0567	206	1.0449	207	1.0508	208	1.0231	209	1.0340	210	1.0231
211	1.0273	212	0.9475	213	0.9475	214	0.9500	215	1.0441	216	1.0374
217	0.9601	218	0.9828	219	1.0122	220	0.0000	221	1.0743	222	1.0575
223	1.0382	224	1.0550	225	0.0000	226	1.0265	227	0.9920	228	1.0248
229	0.0000	230	1.0071	231	0.9290	232	0.9626	233	1.0407	234	1.0491

Table 4.112. (continued)

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
235	0.9231	236	0.9584	237	1.0113	238	1.0399	239	1.0550	240	1.0601
241	0.9987	242	1.0382	243	1.0248	244	1.0315	245	1.0424	246	0.9954
247	1.0013	248	0.9374	249	0.9542	250	1.0601	251	1.0861	252	0.9425
253	0.9618	254	0.9164	255	1.0273	256	0.0000	257	1.0550	258	0.9929
259	1.0088	260	1.0206	261	0.0000	262	1.0172	263	0.9425	264	0.9290
265	0.9567	266	1.0517	267	1.0617	268	0.9979	269	0.9215	270	0.9475
271	1.0130	272	1.0231	273	1.0231	274	0.0000	275	1.0281	276	1.0021
277	0.9845	278	0.9181	279	0.9416	280	0.9399	281	1.0752	282	1.0626
283	0.9593	284	0.9273	285	0.9248	286	0.9551	287	0.9257	288	1.0021
289	0.9861	290	0.9677	291	0.9164	292	0.9198	293	0.9089	294	0.9593
295	1.0819	296	1.0449	297	0.9719	298	0.9576	299	0.9357	300	0.9475
301	0.9425	302	0.9467	303	0.9341	304	0.9240	305	0.9265	306	0.9265
307	0.9416	308	1.0458	309	1.0567	310	0.9912	311	0.9441	312	0.9458
313	0.9097	314	0.9383	315	0.9651	316	0.9324	317	0.9752	318	0.9332
319	0.9819	320	1.0609	321	1.0878	322	1.0752	323	1.0483	324	1.0105
325	1.0063	326	1.0575	327	1.0307	328	1.0340	329	1.0332	330	1.0231
331	1.0727										

Table 4.113. The cross section and flux values of Cells 1, 29, and 72 for Variant V12S4

Cell	Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)	k_0
1	0.2628E–01	0.3386E–01	0.1188E–01	0.1124E+00	0.1289E+01
29	0.2287E–01	0.2874E–01	0.1008E–01	0.1094E+00	0.1257E+01
72	0.2456E–01	0.3179E–01	0.1115E–01	0.1107E+00	0.1294E+01

Table 4.114. Reaction rates for every region of Cells 1, 29, and 72 for Variant V12S4

Cell	Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
	1	0.2817E–02	0.3805E–02	0.1335E–02	0.3748E–01	0.3336E+00
1	2	0.2298E–04	0.0000E+00	0.0000E+00	0.1532E–01	0.1363E+00
	3	0.1129E–03	0.0000E+00	0.0000E+00	0.5956E–01	0.5301E+00
	1	0.2381E–02	0.3143E–02	0.1103E–02	0.3629E–01	0.3318E+00
29	2	0.2431E–04	0.0000E+00	0.0000E+00	0.1490E–01	0.1362E+00
	3	0.9608E–04	0.0000E+00	0.0000E+00	0.5819E–01	0.5320E+00
	1	0.2593E–02	0.3520E–02	0.1235E–02	0.3673E–01	0.3317E+00
72	2	0.2348E–04	0.0000E+00	0.0000E+00	0.1507E–01	0.1360E+00
	3	0.1041E–03	0.0000E+00	0.0000E+00	0.5894E–01	0.5323E+00

Note: Values are integrated over region volume.

Table 4.115. Cross sections and fluxes for Region 1 of Cell 1 for Variant V12S4

		^{235}U			^{238}U			^{239}Pu		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1126E–01	0.48845E–04	0.12566E–03	0.46497E–04	0.81656E–02	0.19878E–01	0.70817E–02	0.12447E–02	0.39391E–02	0.12277E–02
2	0.1395E–01	0.81556E–04	0.15781E–03	0.64517E–04	0.50306E–02	0.15565E–04	0.62352E–05	0.13194E–02	0.30801E–02	0.10595E–02
3	0.9966E–02	0.14603E–02	0.23570E–02	0.96915E–03	0.48596E–01	0.00000E+00	0.00000E+00	0.26383E–01	0.46121E–01	0.16054E–01
4	0.2305E–02	0.12361E–01	0.25653E–01	0.10548E–01	0.26987E–01	0.00000E+00	0.00000E+00	0.67890E+00	0.12579E+01	0.44043E+00

		^{240}Pu			^{241}Pu		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1126E–01	0.72119E–04	0.22237E–03	0.68379E–04	0.11628E–04	0.36524E–04	0.11250E–04
2	0.1395E–01	0.29312E–04	0.31866E–04	0.10438E–04	0.17707E–04	0.45258E–04	0.15343E–04
3	0.9966E–02	0.15538E–01	0.20356E–04	0.70640E–05	0.50376E–03	0.10753E–02	0.36550E–03
4	0.2305E–02	0.84944E–02	0.51099E–05	0.17578E–05	0.66718E–02	0.14283E–01	0.48500E–02

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.116. Cross sections and fluxes for every region of Cell 1 for Variant V12S4

	Region 1		Region 2		Region 3				
						Absorption[a]			
Group	Flux	O Absorption[a]	Flux	Zr Absorption[a]	Flux	H	O	^{10}B	^{11}B
1	0.1126E–01	0.58239E–03	0.4403E–02	0.26705E–03	0.1676E–01	0.00000E+00	0.34448E–03	0.15056E–05	0.13330E–06
2	0.1395E–01	0.00000E+00	0.5600E–02	0.72431E–03	0.2137E–01	0.00000E+00	0.00000E+00	0.10824E–04	0.14814E–06
3	0.9966E–02	0.26124E–06	0.4206E–02	0.31206E–02	0.1661E–01	0.61292E–03	0.15623E–06	0.70855E–03	0.14937E–07
4	0.2305E–02	0.58331E–05	0.1110E–02	0.41697E–02	0.4812E–02	0.82296E–02	0.33457E–05	0.94121E–02	0.54662E–07

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.117. Cross sections and fluxes for Region 1 of Cell 29 for Variant V12S4

		^{235}U			^{238}U			^{239}Pu		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1104E–01	0.48742E–04	0.12562E–03	0.46416E–04	0.81679E–02	0.19957E–01	0.70897E–02	0.12427E–02	0.39381E–02	0.12257E–02
2	0.1390E–01	0.81010E–04	0.15696E–03	0.64158E–04	0.49337E–02	0.15922E–04	0.63783E–05	0.13241E–02	0.30929E–02	0.10637E–02
3	0.9453E–02	0.14179E–02	0.22736E–02	0.93487E–03	0.47868E–01	0.00000E+00	0.00000E+00	0.24769E–01	0.43142E–01	0.15017E–01
4	0.1902E–02	0.12136E–01	0.25197E–01	0.10361E–01	0.26634E–01	0.00000E+00	0.00000E+00	0.65609E+00	0.12172E+01	0.42616E+00

		^{240}Pu			^{241}Pu		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1104E–01	0.72044E–04	0.22254E–03	0.68325E–04	0.11603E–04	0.36498E–04	0.11228E–04
2	0.1390E–01	0.29392E–04	0.32349E–04	0.10589E–04	0.17597E–04	0.45039E–04	0.15266E–04
3	0.9453E–02	0.13205E–01	0.21906E–04	0.76127E–05	0.49360E–03	0.10584E–02	0.35978E–03
4	0.1902E–02	0.84953E–02	0.51075E–05	0.17570E–05	0.65412E–02	0.14011E–01	0.47577E–02

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.118. Cross sections and fluxes for every region of Cell 29 for Variant V12S4

	Region 1		Region 2		Region 3				
						Absorption[a]			
Group	Flux	O Absorption[a]	Flux	Zr Absorption[a]	Flux	H	O	^{10}B	^{11}B
1	0.1104E–01	0.62525E–03	0.4365E–02	0.26650E–03	0.1672E–01	0.00000E+00	0.34737E–03	0.15069E–05	0.13206E–06
2	0.1390E–01	0.00000E+00	0.5583E–02	0.72238E–03	0.2151E–01	0.00000E+00	0.00000E+00	0.10739E–04	0.14829E–06
3	0.9453E–02	0.25538E–06	0.4040E–02	0.38003E–02	0.1598E–01	0.59067E–03	0.14748E–06	0.68318E–03	0.14941E–07
4	0.1902E–02	0.57540E–05	0.9124E–03	0.41264E–02	0.3987E–02	0.81488E–02	0.33128E–05	0.93197E–02	0.54125E–07

[a]Absorption is reaction 3.

Table 4.119. Cross sections and fluxes for Region 1 of Cell 72 for Variant V12S4

		^{235}U			^{238}U			^{239}Pu		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1104E–01	0.48753E–04	0.12559E–03	0.46432E–04	0.81919E–02	0.20004E–01	0.71193E–02	0.12433E–02	0.39390E–02	0.12265E–02
2	0.1381E–01	0.81566E–04	0.15786E–03	0.64534E–04	0.49634E–02	0.15768E–04	0.63165E–05	0.13297E–02	0.30983E–02	0.10657E–02
3	0.9782E–02	0.14071E–02	0.22568E–02	0.92796E–03	0.46726E–01	0.00000E+00	0.00000E+00	0.27105E–01	0.47259E–01	0.16450E–01
4	0.2097E–02	0.12429E–01	0.25798E–01	0.10608E–01	0.27122E–01	0.00000E+00	0.00000E+00	0.67518E+00	0.12522E+01	0.43842E+00

		^{240}Pu			^{241}Pu		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1104E–01	0.72062E–04	0.22250E–03	0.68362E–04	0.11602E–04	0.36488E–04	0.11229E–04
2	0.1381E–01	0.29582E–04	0.32172E–04	0.10535E–04	0.17692E–04	0.45236E–04	0.15335E–04
3	0.9782E–02	0.12288E–01	0.19774E–04	0.68718E–05	0.51218E–03	0.10837E–02	0.36835E–03
4	0.2097E–02	0.85253E–02	0.51288E–05	0.17643E–05	0.66683E–02	0.14282E–01	0.48495E–02

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.120. Cross sections and fluxes for every region of Cell 72 of Variant V12S4

	Region 1		Region 2		Region 3				
						Absorption[a]			
Group	Flux	O Absorption[a]	Flux	Zr Absorption[a]	Flux	H	O	^{10}B	^{11}B
1	0.1104E–01	0.59366E–03	0.4301E–02	0.26652E–03	0.1663E–01	0.00000E+00	0.34197E–03	0.15035E–05	0.13265E–06
2	0.1381E–01	0.00000E+00	0.5574E–02	0.72541E–03	0.2158E–01	0.00000E+00	0.00000E+00	0.10752E–04	0.14799E–06
3	0.9782E–02	0.26369E–06	0.4162E–02	0.33732E–02	0.1638E–01	0.59661E–03	0.15032E–06	0.68990E–03	0.14946E–07
4	0.2097E–02	0.58630E–05	0.1028E–02	0.41346E–02	0.4358E–02	0.82434E–02	0.33513E–05	0.94278E–02	0.54753E–07

[a]Absorption is reaction 3.

Table 4.121. The assembly cross section and flux values for Variant V12S2

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2278E–01	0.2330E–01	0.8173E–02	0.3708E+02

Table 4.122. Relative cell fission rates normalized to the average cell fission rate of 1 for Variant V12S2

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
1	1.3374	2	1.3096	3	1.2591	4	1.2344	5	1.1912	6	1.2509
7	1.2210	8	1.2354	9	1.2838	10	1.3260	11	1.3827	12	1.2952
13	1.2138	14	1.1510	15	1.1119	16	1.0944	17	1.1253	18	1.1253
19	1.1253	20	1.1428	21	1.1181	22	1.2540	23	1.2972	24	1.2622
25	1.1737	26	1.1098	27	1.0615	28	1.0262	29	1.0054	30	0.9923
31	1.0098	32	0.9933	33	1.0215	34	1.1273	35	1.1593	36	1.3096
37	1.2746	38	1.1623	39	1.0728	40	1.0347	41	1.0056	42	0.9501
43	0.8947	44	0.8855	45	0.9360	46	1.0131	47	1.0166	48	1.0625
49	1.1150	50	1.2828	51	1.2715	52	1.1212	53	1.0460	54	0.9805
55	0.8952	56	0.8224	57	0.7961	58	0.0000	59	0.8350	60	0.8641
61	0.8820	62	0.9667	63	1.0202	64	1.0625	65	1.2241	66	1.2128
67	1.1160	68	1.0019	69	0.9382	70	0.8902	71	0.0000	72	0.7675
73	0.7637	74	0.7540	75	0.7730	76	0.0000	77	0.8184	78	0.9119
79	1.0081	80	1.0872	81	1.2128	82	1.2293	83	1.1335	84	1.0282
85	0.8867	86	0.8097	87	0.7674	88	0.7551	89	0.7410	90	0.7529
91	0.7803	92	0.7515	93	0.7694	94	0.8012	95	0.8811	96	1.0176
97	1.0759	98	1.2468	99	1.2427	100	1.1263	101	1.0470	102	0.8790
103	0.0000	104	0.7312	105	0.7827	106	0.7265	107	0.0000	108	0.7412
109	0.7461	110	0.7571	111	0.7397	112	0.0000	113	0.8950	114	1.0018
115	1.1026	116	1.2602	117	1.2849	118	1.1376	119	1.0542	120	0.9414
121	0.8134	122	0.7568	123	0.7390	124	0.7480	125	0.7596	126	0.7529
127	0.7543	128	0.0000	129	0.7237	130	0.7566	131	0.8145	132	0.9407
133	1.0290	134	1.1212	135	1.1984	136	1.2993	137	1.1490	138	1.0676
139	0.9660	140	0.8262	141	0.8001	142	0.7241	143	0.0000	144	0.8006
145	0.8840	146	0.8633	147	0.7842	148	0.7554	149	0.7618	150	0.7530
151	0.8579	152	0.9413	153	1.0759	154	1.1366	155	1.2756	156	1.3425
157	1.1932	158	1.0995	159	1.0213	160	0.8929	161	0.0000	162	0.7727
163	0.7238	164	0.7643	165	0.8951	166	0.0000	167	0.8775	168	0.7733
169	0.7772	170	0.7559	171	0.0000	172	0.8819	173	1.0265	174	1.1212
175	1.2138	176	1.3837	177	1.2982	178	1.1582	179	1.0923	180	0.9800
181	0.8530	182	0.7813	183	0.8038	184	0.7408	185	0.7858	186	0.8754
187	0.8791	188	0.7742	189	0.0000	190	0.7360	191	0.7838	192	0.8346
193	0.9839	194	1.0573	195	1.1603	196	1.2653	197	1.2972	198	1.1109
199	1.0718	200	0.9322	201	0.8017	202	0.7679	203	0.7761	204	0.0000
205	0.7589	206	0.8019	207	0.7585	208	0.7405	209	0.7353	210	0.7564
211	0.8260	212	0.9457	213	1.0044	214	1.0985	215	1.2807	216	1.2540
217	1.1140	218	1.0512	219	0.8592	220	0.0000	221	0.7567	222	0.7471
223	0.7694	224	0.7444	225	0.0000	226	0.7612	227	0.7542	228	0.7563

Table 4.122. (continued)

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
229	0.0000	230	0.8753	231	1.0075	232	1.0944	233	1.2581	234	1.2282
235	1.1160	236	1.0061	237	0.8861	238	0.8279	239	0.7823	240	0.7848
241	0.8053	242	0.7209	243	0.7492	244	0.7597	245	0.7659	246	0.8147
247	0.8887	248	1.0040	249	1.1191	250	1.2262	251	1.2221	252	1.0759
253	0.9993	254	0.9236	255	0.8916	256	0.0000	257	0.7941	258	0.7738
259	0.7552	260	0.7880	261	0.0000	262	0.8280	263	0.9240	264	1.0199
265	1.0862	266	1.2375	267	1.2406	268	1.1315	269	1.0200	270	0.9399
271	0.8799	272	0.8554	273	0.8435	274	0.0000	275	0.8246	276	0.8304
277	0.8881	278	0.9432	279	1.0388	280	1.0954	281	1.2540	282	1.2663
283	1.0903	284	1.0738	285	0.9489	286	0.9964	287	0.9461	288	0.8850
289	0.8747	290	0.9070	291	0.9440	292	1.0088	293	1.0347	294	1.1284
295	1.2457	296	1.2437	297	1.1346	298	1.0985	299	1.0450	300	1.0247
301	1.0149	302	1.0136	303	1.0174	304	1.0409	305	1.0450	306	1.0934
307	1.1562	308	1.3250	309	1.2869	310	1.1737	311	1.1479	312	1.1428
313	1.1170	314	1.0810	315	1.1222	316	1.0625	317	1.1232	318	1.1263
319	1.1943	320	1.3446	321	1.3199	322	1.2591	323	1.2622	324	1.2149
325	1.2210	326	1.2632	327	1.2107	328	1.2756	329	1.2550	330	1.2797
331	1.3549										

Table 4.123. The cross section and flux values of Cells 1, 29, and 72 for Variant V12S2

Cell	Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)	k_0
1	0.2462E–01	0.3114E–01	0.1093E–01	0.1189E+00	0.1265E+01
29	0.2050E–01	0.2518E–01	0.8831E–02	0.1106E+00	0.1228E+01
72	0.1811E–01	0.2105E–01	0.7384E–02	0.1010E+00	0.1163E+01

Table 4.124. Reaction rates for every region of Cells 1, 29, and 72 for Variant V12S2

Cell	Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
	1	0.792E–02	0.3702E–02	0.1299E–02	0.3980E–01	0.3348E+00
1	2	0.2378E–04	0.0000E+00	0.0000E+00	0.1623E–01	0.1366E+00
	3	0.1107E–03	0.0000E+00	0.0000E+00	0.6283E–01	0.5286E+00
	1	0.2163E–02	0.2784E–02	0.9766E–03	0.3686E–01	0.3333E+00
29	2	0.1979E–04	0.0000E+00	0.0000E+00	0.1508E–01	0.1364E+00
	3	0.8370E–04	0.0000E+00	0.0000E+00	0.5865E–01	0.5303E+00
	1	0.1746E–02	0.2125E–02	0.7455E–03	0.3366E–01	0.3333E+00
72	2	0.2088E–04	0.0000E+00	0.0000E+00	0.1378E–01	0.1365E+00
	3	0.6132E–04	0.0000E+00	0.0000E+00	0.5352E–01	0.5301E+00

Note: Values are integrated over region volume.

Table 4.125. Cross sections and fluxes for Region 1 of Cell 1 for Variant V12S2

		^{235}U			^{238}U			^{239}Pu		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1229E–01	0.48791E–04	0.12575E–03	0.46467E–04	0.81978E–02	0.20035E–01	0.71236E–02	0.12438E–02	0.39414E–02	0.12269E–02
2	0.1500E–01	0.80781E–04	0.15659E–03	0.64003E–04	0.49153E–02	0.15856E–04	0.63518E–05	0.13254E–02	0.30968E–02	0.10650E–02
3	0.1030E–01	0.14281E–02	0.23079E–02	0.94898E–03	0.50414E–01	0.00000E+00	0.00000E+00	0.26103E–01	0.45231E–01	0.15744E–01
4	0.2202E–02	0.12374E–01	0.25681E–01	0.10560E–01	0.27012E–01	0.00000E+00	0.00000E+00	0.67728E+00	0.12550E+01	0.43942E+00

		^{240}Pu			^{241}Pu		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1229E–01	0.72099E–04	0.22268E–03	0.68394E–04	0.11610E–04	0.36522E–04	0.11236E–04
2	0.1500E–01	0.29351E–04	0.32262E–04	0.10563E–04	0.17553E–04	0.44966E–04	0.15241E–04
3	0.1030E–01	0.14672E–01	0.22113E–04	0.76862E–05	0.49717E–03	0.10507E–02	0.35717E–03
4	0.2202E–02	0.84325E–02	0.50745E–05	0.17456E–05	0.66559E–02	0.14267E–01	0.48443E–02

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.126. Cross sections and fluxes for every region of Cell 1 for Variant V12S2

	Region 1		Region 2		Region 3				
						Absorption[a]			
Group	Flux	O Absorption[a]	Flux	Zr Absorption[a]	Flux	H	O	^{10}B	^{11}B
1	0.1229E–01	0.61604E–03	0.4790E–02	0.26702E–03	0.1803E–01	0.00000E+00	0.35118E–03	0.15055E–05	0.13235E–06
2	0.1500E–01	0.00000E+00	0.6050E–02	0.71623E–03	0.2307E–01	0.00000E+00	0.00000E+00	0.10700E–04	0.14969E–06
3	0.1030E–01	0.25061E–06	0.4307E–02	0.31684E–02	0.1703E–01	0.59049E–03	0.14766E–06	0.68301E–03	0.14991E–07
4	0.2202E–02	0.58403E–05	0.1088E–02	0.41525E–02	0.4706E–02	0.81707E–02	0.33217E–05	0.93446E–02	0.54270E–07

[a]Absorption is reaction 3.

Table 4.127. Cross sections and fluxes for Region 1 of Cell 29 for Variant V12S2

		^{235}U			^{238}U			^{239}Pu		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1141E–01	0.48810E–04	0.12580E–03	0.46486E–04	0.82131E–02	0.20079E–01	0.71402E–02	0.12443E–02	0.39430E–02	0.12275E–02
2	0.1438E–01	0.81489E–04	0.15781E–03	0.64508E–04	0.49586E–02	0.15856E–04	0.63519E–05	0.13176E–02	0.30810E–02	0.10596E–02
3	0.9467E–02	0.14021E–02	0.22651E–02	0.93139E–03	0.46753E–01	0.00000E+00	0.00000E+00	0.26562E–01	0.45301E–01	0.15768E–01
4	0.1600E–02	0.11920E–01	0.24754E–01	0.10179E–01	0.26252E–01	0.00000E+00	0.00000E+00	0.65260E+00	0.12098E+01	0.42358E+00

		^{240}Pu			^{241}Pu		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1141E–01	0.72117E–04	0.22272E–03	0.68415E–04	0.11616E–04	0.36542E–04	0.11242E–04
2	0.1438E–01	0.29502E–04	0.32278E–04	0.10568E–04	0.17636E–04	0.45130E–04	0.15298E–04
3	0.9467E–02	0.12010E–01	0.17673E–04	0.61427E–05	0.47872E–03	0.10317E–02	0.35071E–03
4	0.1600E–02	0.85306E–02	0.51247E–05	0.17629E–05	0.63491E–02	0.13595E–01	0.46164E–02

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.128. Cross sections and fluxes for every region of Cell 29 for Variant V12S2

	Region 1		Region 2		Region 3				
						Absorption[a]			
Group	Flux	O Absorption[a]	Flux	Zr Absorption[a]	Flux	H	O	^{10}B	^{11}B
1	0.1141E–01	0.60806E–03	0.4495E–02	0.26648E–03	0.1714E–01	0.00000E+00	0.34269E–03	0.15056E–05	0.13264E–06
2	0.1438E–01	0.00000E+00	0.5806E–02	0.72945E–03	0.2234E–01	0.00000E+00	0.00000E+00	0.10710E–04	0.14891E–06
3	0.9467E–02	0.23323E–06	0.4007E–02	0.27996E–02	0.1582E–01	0.56285E–03	0.13736E–06	0.65154E–03	0.14982E–07
4	0.1600E–02	0.56676E–05	0.7767E–03	0.40399E–02	0.3342E–02	0.81423E–02	0.33102E–05	0.93122E–02	0.54082E–07

[a]Absorption is reaction 3.

Table 4.129. Cross sections and fluxes for Region 1 of Cell 72 for Variant V12S2

		^{235}U			^{238}U			^{239}Pu		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1033E–01	0.48797E–04	0.12547E–03	0.46444E–04	0.81094E–02	0.19707E–01	0.70185E–02	0.12434E–02	0.39335E–02	0.12262E–02
2	0.1369E–01	0.80921E–04	0.15672E–03	0.64063E–04	0.49746E–02	0.15531E–04	0.62217E–05	0.13231E–02	0.30883E–02	0.10623E–02
3	0.8507E–02	0.13619E–02	0.21892E–02	0.90016E–03	0.48185E–01	0.00000E+00	0.00000E+00	0.25521E–01	0.43699E–01	0.15209E–01
4	0.1137E–02	0.11583E–01	0.24048E–01	0.98881E–02	0.25611E–01	0.00000E+00	0.00000E+00	0.66311E+00	0.12233E+01	0.42843E+00

		^{240}Pu			^{241}Pu		
Group	Flux	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]	Absorption[a]	$\nu\Sigma_f$[b]	Fission[c]
1	0.1033E–01	0.72065E–04	0.22217E–03	0.68302E–04	0.11615E–04	0.36470E–04	0.11236E–04
2	0.1369E–01	0.29369E–04	0.31862E–04	0.10439E–04	0.17654E–04	0.45155E–04	0.15307E–04
3	0.8507E–02	0.11648E–01	0.20462E–04	0.71178E–05	0.44148E–03	0.94230E–03	0.32038E–03
4	0.1137E–02	0.84424E–02	0.50686E–05	0.17436E–05	0.63042E–02	0.13463E–01	0.45715E–02

[a]Absorption is reaction 3.
[b]$\nu\Sigma_f$ is reaction 918.
[c]Fission is reaction 18.

Table 4.130. Cross sections and fluxes for every region of Cell 72 for Variant V12S2

					Region 3				
	Region 1		Region 2			Absorption[a]			
Group	Flux	O Absorption[a]	Flux	Zr Absorption[a]	Flux	H	O	^{10}B	^{11}B
1	0.1033E–01	0.58317E–03	0.4132E–02	0.26798E–03	0.1570E–01	0.00000E+00	0.34276E–03	0.15044E–05	0.13349E–06
2	0.1369E–01	0.00000E+00	0.5505E–02	0.72575E–03	0.2126E–01	0.00000E+00	0.00000E+00	0.10794E–04	0.14773E–06
3	0.8507E–02	0.20192E–06	0.3579E–02	0.37935E–02	0.1417E–01	0.51892E–03	0.12119E–06	0.60134E–03	0.15013E–07
4	0.1137E–02	0.55242E–05	0.5690E–03	0.38598E–02	0.2391E–02	0.77650E–02	0.31568E–05	0.88807E–02	0.51576E–07

[a]Absorption is reaction 3.

Table 4.131. The assembly cross section and flux values for Variant V12S6

Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)
0.2873E–01	0.3826E–01	0.1342E–01	0.3106E+02

Table 4.132. Relative cell fission rates normalized to the average cell fission rate of 1 for Variant V12S6

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
1	1.1059	2	1.0639	3	1.0534	4	1.0976	5	1.0744	6	1.0198
7	1.0302	8	1.0332	9	1.0609	10	1.0729	11	1.1283	12	1.0198
13	0.9366	14	0.9419	15	0.9546	16	0.9726	17	0.9651	18	0.9539
19	0.9172	20	0.9254	21	0.9157	22	0.9217	23	1.0692	24	1.0340
25	0.9434	26	0.9119	27	0.9262	28	0.9164	29	0.9134	30	0.9509
31	0.9232	32	0.9494	33	0.9329	34	0.9194	35	1.0048	36	1.0722
37	1.0549	38	0.9404	39	0.9351	40	0.9172	41	0.9374	42	0.9149
43	0.9846	44	1.0377	45	0.9426	46	0.9307	47	0.9614	48	0.9209
49	0.9366	50	1.0692	51	1.0519	52	0.9733	53	0.9494	54	0.9142
55	0.9935	56	1.0130	57	1.0265	58	0.0000	59	1.0018	60	1.0160
61	0.9861	62	0.9262	63	0.9172	64	0.9471	65	1.0609	66	1.0662
67	0.9396	68	0.9509	69	0.9576	70	0.9883	71	0.0000	72	1.0467
73	1.0519	74	1.0362	75	1.0632	76	0.0000	77	1.0317	78	0.9756
79	0.9104	80	0.9509	81	1.0639	82	1.0564	83	0.9239	84	0.9247
85	1.0070	86	1.0145	87	1.0145	88	1.0385	89	1.0534	90	1.0310
91	0.9823	92	1.0198	93	1.0205	94	1.0153	95	1.0003	96	0.9434
97	0.9958	98	1.0774	99	1.0542	100	0.9494	101	0.9119	102	0.9726
103	0.0000	104	1.0430	105	0.9546	106	1.0340	107	0.0000	108	1.1021
109	1.0662	110	1.0415	111	1.0542	112	0.0000	113	1.0115	114	0.9419
115	0.9756	116	1.0430	117	1.0961	118	0.9464	119	0.9224	120	0.9554
121	1.0175	122	1.0467	123	1.0527	124	1.0572	125	1.0654	126	1.0662
127	1.0782	128	0.0000	129	1.0475	130	1.0220	131	1.0377	132	0.9411
133	0.9501	134	0.9516	135	1.0624	136	1.0490	137	0.9643	138	0.9187
139	0.9247	140	1.0183	141	1.0796	142	1.0160	143	0.0000	144	1.0841
145	1.0856	146	1.0901	147	1.0804	148	1.0819	149	1.0055	150	1.0317
151	1.0385	152	0.9224	153	0.9149	154	0.9786	155	1.0609	156	1.1470
157	0.9846	158	0.9419	159	0.9239	160	1.0010	161	0.0000	162	1.0153
163	1.0684	164	1.0594	165	1.0774	166	0.0000	167	1.0422	168	1.0639
169	1.0602	170	1.0355	171	0.0000	172	1.0100	173	0.9037	174	0.9194
175	0.9336	176	1.0819	177	1.0684	178	0.9396	179	0.9059	180	0.9599
181	1.0242	182	1.0310	183	1.0093	184	1.0542	185	1.0789	186	1.0916
187	1.0504	188	1.0430	189	0.0000	190	1.0497	191	1.0497	192	1.0063
193	0.9089	194	0.9247	195	0.9164	196	1.0317	197	1.0407	198	0.9381
199	0.9224	200	0.9531	201	1.0198	202	1.0310	203	1.0422	204	0.0000
205	1.0826	206	1.0752	207	1.0460	208	1.0654	209	1.0212	210	1.0317
211	1.0430	212	0.9658	213	0.9479	214	0.9314	215	1.0437	216	1.0467
217	0.9591	218	0.9628	219	0.9816	220	0.0000	221	1.0602	222	1.0242
223	1.0737	224	1.0931	225	0.0000	226	1.0347	227	0.9786	228	1.0325

Table 4.132. (continued)

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
229	0.0000	230	1.0168	231	0.8925	232	0.9748	233	1.0265	234	1.0624
235	0.9479	236	0.9359	237	0.9756	238	1.0100	239	1.0534	240	1.0362
241	0.9906	242	1.0767	243	1.0654	244	1.0460	245	0.9928	246	1.0407
247	1.0153	248	0.9688	249	0.9479	250	1.0504	251	1.0692	252	0.9389
253	0.9554	254	0.9554	255	1.0168	256	0.0000	257	1.0497	258	1.0370
259	1.0519	260	1.0669	261	0.0000	262	1.0445	263	0.9509	264	0.9067
265	0.9396	266	1.0774	267	1.0722	268	0.9127	269	0.9359	270	0.9254
271	1.0130	272	1.0302	273	1.0385	274	0.0000	275	1.0490	276	1.0467
277	1.0295	278	0.9172	279	0.9284	280	0.9539	281	1.0639	282	1.0587
283	0.9816	284	0.9127	285	0.9217	286	0.9404	287	0.9202	288	1.0175
289	1.0212	290	0.9673	291	0.9501	292	0.9164	293	0.9127	294	0.9569
295	1.0744	296	1.0602	297	0.9576	298	0.9104	299	0.9232	300	0.9089
301	0.9112	302	0.9134	303	0.9044	304	0.9284	305	0.9149	306	0.9172
307	0.9359	308	1.0564	309	1.1171	310	0.9846	311	0.9366	312	0.9314
313	0.9531	314	0.9539	315	0.9711	316	0.9434	317	0.9396	318	0.9688
319	0.9434	320	1.0205	321	1.1156	322	1.0647	323	1.0175	324	1.0647
325	1.0534	326	1.0557	327	1.0549	328	1.0609	329	1.0609	330	1.0841
331	1.0826										

Table 4.133. The cross section and flux values of Cells 1, 29, and 72 for Variant V12S6

Cell	Absorption (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Fission (cm^{-1})	Flux (cm)	k_0
1	0.3425E–01	0.4613E–01	0.1618E–01	0.9127E–01	0.1347E+01
29	0.2883E–01	0.3855E–01	0.1352E–01	0.9027E–01	0.1337E+01
72	0.3233E–01	0.4386E–01	0.1538E–01	0.9088E–01	0.1356E+01

Table 4.134. Reaction rates for every region of Cells 1, 29, and 72 for Variant V12S6

Cell	Region	Absorption	$\nu\Sigma_f$	Fission	Flux (cm)	Flux/flux (cell)
	1	0.2896E–02	0.4211E–02	0.1477E–02	0.3060E–01	0.3352E+00
1	2	0.2555E–04	0.0000E+00	0.0000E+00	0.1242E–01	0.1360E+00
	3	0.2052E–03	0.0000E+00	0.0000E+00	0.4826E–01	0.5287E+00
	1	0.2411E–02	0.3480E–02	0.1220E–02	0.2987E–01	0.3309E+00
29	2	0.1894E–04	0.0000E+00	0.0000E+00	0.1230E–01	0.1363E+00
	3	0.1723E–03	0.0000E+00	0.0000E+00	0.4810E–01	0.5328E+00
	1	0.2721E–02	0.3986E–02	0.1398E–02	0.3027E–01	0.3331E+00
72	2	0.2357E–04	0.0000E+00	0.0000E+00	0.1235E–01	0.1359E+00
	3	0.1937E–03	0.0000E+00	0.0000E+00	0.4825E–01	0.5310E+00

Note: Values are integrated over region volume.

Time, in Monte Carlo calculations, is arbitrary. Reaction rates for MCU calculations are unitless and reflect the number of reactions in the stated region normalized according to the previous definition. MCU fluxes are volume averaged over the region specified and normalized according to the previous definition. The average cross sections are defined as the ratio of the reaction rates to the cell flux. Note that all the results given depend on the value of the buckling constant. The numbering sequence of the cells in the Variant 13 configuration reported in Table 4.135 is shown in Figs. 4.5 and 4.6.

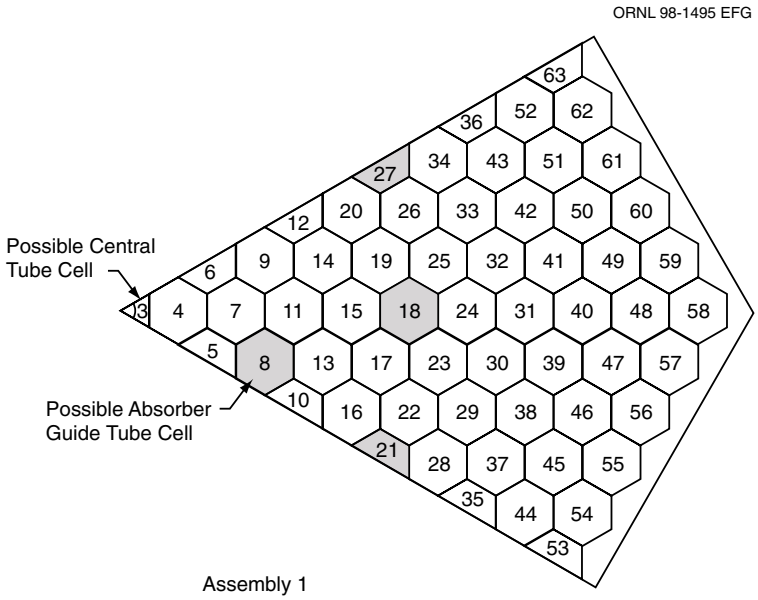

Fig. 4.5. Numbering scheme for assembly type K1 (see Fig. 4.4) for normalized pin powers reported in Table 4.135.

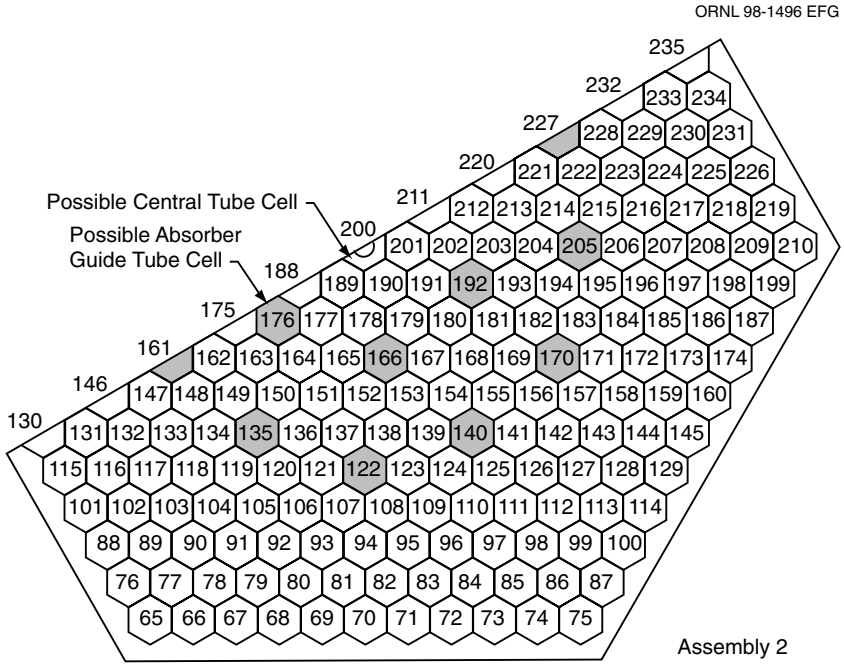

Fig. 4.6. Numbering scheme for assembly type K2 (see Fig. 4.4) for normalized pin powers reported in Table 4.135.

Table 4.135. Relative cell fission rates normalized to the average cell fission rate of 1 for Variant V13

Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate	Cell	Rate
				3	0.8146	4	0.8015	5	0.8105	6	0.8114
7	0.8090	8	0.8011	9	0.8066	10	0.8094	11	0.7977	12	0.8158
13	0.8129	14	0.8228	15	0.8187	16	0.8129	17	0.8079	18	0.8189
19	0.8167	20	0.8094	21	0.8236	22	0.8141	23	0.8173	24	0.8275
25	0.8249	26	0.8265	27	0.8147	28	0.8225	29	0.8178	30	0.8331
31	0.8434	32	0.8406	33	0.8279	34	0.8354	35	0.8461	36	0.8420
37	0.8639	38	0.8545	39	0.8698	40	0.8756	41	0.8685	42	0.8488
43	0.8582	44	0.9123	45	0.9169	46	0.9275	47	0.9477	48	0.9699
49	0.9301	50	0.9236	51	0.9114	52	0.9115	53	1.0909	54	1.1065
55	1.1022	56	1.1171	57	1.1545	58	1.2554	59	1.1335	60	1.1162
61	1.1194	62	1.1065	63	1.1162	64	0.0000	65	1.1292	66	1.1465
67	1.1579	68	1.1550	69	1.1618	70	1.1680	71	1.1559	72	1.1703
73	1.1803	74	1.1917	75	1.2394	76	1.0660	77	1.0545	78	1.0617
79	1.0695	80	1.0585	81	1.0753	82	1.0596	83	1.0798	84	1.0751
85	1.0904	86	1.1098	87	1.1997	88	1.0542	89	1.0155	90	1.0255
91	1.0301	92	1.0109	93	1.0228	94	1.0248	95	1.0325	96	1.0349
97	1.0379	98	1.0596	99	1.0812	100	1.1784	101	1.0488	102	1.0130
103	1.0094	104	1.0154	105	0.9970	106	1.0232	107	1.0155	108	1.0204
109	1.0182	110	1.0225	111	1.0207	112	1.0271	113	1.0681	114	1.1742
115	1.0333	116	1.0105	117	0.9980	118	0.9952	119	1.0094	120	1.0100
121	1.0108	122	1.0094	123	1.0050	124	0.9974	125	1.0073	126	1.0123
127	1.0346	128	1.0760	129	1.1721	130	1.0294	131	1.0059	132	0.9916
133	0.9817	134	0.9941	135	1.0123	136	0.9905	137	1.0004	138	1.0050
139	1.0079	140	1.0015	141	1.0086	142	1.0229	143	1.0367	144	1.0702
145	1.1827	146	1.0083	147	0.9902	148	1.0107	149	0.9945	150	0.9994
151	0.9979	152	0.9949	153	1.0075	154	1.0000	155	1.0087	156	1.0052
157	1.0169	158	1.0349	159	1.0707	160	1.1677	161	0.9858	162	0.9933
163	1.0036	164	1.0051	165	0.9981	166	1.0059	167	1.0011	168	1.0043
169	1.0050	170	1.0137	171	1.0331	172	1.0314	173	1.0727	174	1.1780
175	1.0025	176	1.0040	177	1.0087	178	1.0063	179	1.0084	180	0.9994
181	1.0050	182	1.0070	183	1.0137	184	1.0176	185	1.0350	186	1.0755
187	1.1599	188	1.0047	189	1.0058	190	1.0016	191	0.9995	192	0.9995
193	0.9966	194	0.9990	195	0.9988	196	1.0086	197	1.0346	198	1.0639
199	1.1584	200	1.0094	201	1.0127	202	0.9922	203	1.0032	204	0.9894
205	1.0011	206	1.0104	207	1.0076	208	1.0244	209	1.0563	210	1.1447
211	0.9877	212	0.9981	213	0.9973	214	1.0047	215	0.9994	216	1.0095
217	1.0015	218	1.0121	219	1.0734	220	0.9994	221	1.0016	222	0.9959
223	0.9929	224	0.9891	225	1.0000	226	1.0542	227	0.9849	228	0.9897
229	0.9822	230	1.0066	231	1.0363	232	1.0011	233	0.9977	234	1.0357
235	1.0211										

Estimates of normalized pin powers can be improved by combining values for symmetric locations in the VVER assembly (see Fig. 4.3). These improved estimates are reported for Variant 11 in Table 4.136 and Variant 12 in Table 4.137.

Table 4.136. Normalized pin powers for Variant 11 with variance reduction due to symmetry

Pin No. (see Fig. 4.3)	State S1	State S2	State S6
1	1.0598 ± 0.0050	1.3434 ± 0.0097	1.0879 ± 0.0076
2	1.0352 ± 0.0021	1.2991 ± 0.0061	1.0692 ± 0.0122
3	1.0248 ± 0.0053	1.2635 ± 0.0045	1.0460 ± 0.0067
4	1.0215 ± 0.0048	1.2461 ± 0.0067	1.0563 ± 0.0069
5	1.0320 ± 0.0062	1.2285 ± 0.0067	1.0429 ± 0.0071
6	1.0227 ± 0.0069	1.2195 ± 0.0121	1.0515 ± 0.0082
7	1.0280 ± 0.0051	1.2406 ± 0.0083	1.0404 ± 0.0080
8	1.0249 ± 0.0054	1.2350 ± 0.0042	1.0447 ± 0.0032
9	1.0232 ± 0.0074	1.2604 ± 0.0056	1.0465 ± 0.0075
10	1.0326 ± 0.0058	1.2971 ± 0.0050	1.0701 ± 0.0082
13	0.9959 ± 0.0053	1.2167 ± 0.0025	0.9865 ± 0.0073
14	0.9740 ± 0.0071	1.1919 ± 0.0090	0.9628 ± 0.0044
15	0.9663 ± 0.0070	1.1597 ± 0.0052	0.9690 ± 0.0068
16	0.9757 ± 0.0037	1.1389 ± 0.0046	0.9640 ± 0.0061
17	0.9755 ± 0.0054	1.1235 ± 0.0092	0.9626 ± 0.0053
18	0.9710 ± 0.0027	1.1282 ± 0.0064	0.9599 ± 0.0049
19	0.9748 ± 0.0028	1.1450 ± 0.0060	0.9559 ± 0.0071
20	0.9731 ± 0.0053	1.1576 ± 0.0077	0.9680 ± 0.0069
21	0.9699 ± 0.0038	1.1854 ± 0.0068	0.9667 ± 0.0030
26	0.9661 ± 0.0059	1.1384 ± 0.0055	0.9428 ± 0.0085
27	0.9656 ± 0.0061	1.1008 ± 0.0048	0.9462 ± 0.0062
28	0.9565 ± 0.0034	1.0580 ± 0.0074	0.9440 ± 0.0089
29	0.9678 ± 0.0029	1.0403 ± 0.0078	0.9532 ± 0.0049
30	0.9597 ± 0.0037	1.0253 ± 0.0086	0.9417 ± 0.0072
31	0.9581 ± 0.0052	1.0366 ± 0.0076	0.9396 ± 0.0037
32	0.9563 ± 0.0134	1.0292 ± 0.0280	0.9370 ± 0.0052
33	0.9559 ± 0.0100	1.0907 ± 0.0064	0.9331 ± 0.0062
40	0.9544 ± 0.0053	1.0428 ± 0.0089	0.9399 ± 0.0069
41	0.9616 ± 0.0039	0.9874 ± 0.0053	0.9389 ± 0.0119
42	0.9696 ± 0.0020	0.9544 ± 0.0045	0.9534 ± 0.0069
43	0.9978 ± 0.0054	0.8956 ± 0.0058	0.9929 ± 0.0094
44	1.0012 ± 0.0054	0.9068 ± 0.0044	0.9941 ± 0.0083
45	0.9643 ± 0.0047	0.9417 ± 0.0058	0.9495 ± 0.0024
46	0.9617 ± 0.0044	0.9867 ± 0.0086	0.9522 ± 0.0060
55	0.9973 ± 0.0052	0.8879 ± 0.0060	1.0002 ± 0.0065
56	1.0066 ± 0.0071	0.8392 ± 0.0036	1.0055 ± 0.0045
57	1.0188 ± 0.0062	0.8207 ± 0.0042	1.0122 ± 0.0026
58	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000
59	0.9995 ± 0.0055	0.8084 ± 0.0058	1.0112 ± 0.0084
60	1.0010 ± 0.0065	0.8427 ± 0.0041	1.0088 ± 0.0056
71	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000
72	1.0296 ± 0.0065	0.7408 ± 0.0067	1.0319 ± 0.0068

Table 4.136. (continued)

Pin No. (see Fig. 4.3)	State S1	State S2	State S6
73	1.0295 ± 0.0051	0.7283 ± 0.0048	1.0302 ± 0.0042
74	1.0182 ± 0.0033	0.7338 ± 0.0045	1.0272 ± 0.0050
75	1.0184 ± 0.0073	0.7536 ± 0.0037	1.0294 ± 0.0048
88	1.0301 ± 0.0043	0.7175 ± 0.0056	1.0201 ± 0.0050
89	1.0283 ± 0.0028	0.7014 ± 0.0042	1.0393 ± 0.0037
90	1.0286 ± 0.0074	0.7154 ± 0.0039	1.0428 ± 0.0060
91	1.0119 ± 0.0033	0.7456 ± 0.0026	0.9976 ± 0.0097
106	1.0334 ± 0.0050	0.6894 ± 0.0037	1.0457 ± 0.0072
107	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000
108	1.0356 ± 0.0072	0.7030 ± 0.0070	1.0453 ± 0.0065
125	1.0488 ± 0.0033	0.7118 ± 0.0044	1.0460 ± 0.0088
126	1.0506 ± 0.0071	0.7182 ± 0.0038	1.0503 ± 0.0106
145	1.0449 ± 0.0073	0.7956 ± 0.0069	1.0472 ± 0.0088
166	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000

Table 4.137. Normalized pin powers for Variant 12 with variance reduction due to symmetry

Pin No. (see Fig. 4.3)	State S1	State S2	State S3
1	1.0994 ± 0.0079	1.3535 ± 0.0104	1.1102 ± 0.0105
2	1.0587 ± 0.0088	1.2897 ± 0.0064	1.0692 ± 0.0121
3	1.0486 ± 0.0064	1.2722 ± 0.0099	1.0644 ± 0.0074
4	1.0536 ± 0.0068	1.2600 ± 0.0077	1.0612 ± 0.0094
5	1.0476 ± 0.0049	1.2204 ± 0.0070	1.0615 ± 0.0040
6	1.0605 ± 0.0065	1.2332 ± 0.0085	1.0587 ± 0.0083
7	1.0404 ± 0.0092	1.2404 ± 0.0084	1.0565 ± 0.0065
8	1.0476 ± 0.0100	1.2475 ± 0.0085	1.0528 ± 0.0061
9	1.0554 ± 0.0035	1.2715 ± 0.0175	1.0453 ± 0.0073
10	1.0612 ± 0.0057	1.2998 ± 0.0129	1.0512 ± 0.0100
13	0.9908 ± 0.0097	1.2071 ± 0.0112	0.9507 ± 0.0111
14	0.9536 ± 0.0044	1.1394 ± 0.0110	0.9630 ± 0.0126
15	0.9618 ± 0.0046	1.1128 ± 0.0069	0.9484 ± 0.0074
16	0.9675 ± 0.0087	1.0953 ± 0.0121	0.9500 ± 0.0093
17	0.9530 ± 0.0050	1.1105 ± 0.0095	0.9496 ± 0.0070
18	0.9507 ± 0.0093	1.1001 ± 0.0087	0.9551 ± 0.0085
19	0.9513 ± 0.0096	1.1126 ± 0.0047	0.9554 ± 0.0086
20	0.9587 ± 0.0040	1.1347 ± 0.0075	0.9406 ± 0.0049
21	0.9590 ± 0.0061	1.1485 ± 0.0079	0.9416 ± 0.0084
26	0.9413 ± 0.0066	1.1083 ± 0.0056	0.9200 ± 0.0046
27	0.9318 ± 0.0033	1.0613 ± 0.0040	0.9197 ± 0.0022
28	0.9300 ± 0.0076	1.0276 ± 0.0072	0.9280 ± 0.0050
29	0.9422 ± 0.0060	1.0141 ± 0.0070	0.9147 ± 0.0087
30	0.9432 ± 0.0037	1.0103 ± 0.0051	0.9395 ± 0.0080
31	0.9446 ± 0.0084	1.0166 ± 0.0075	0.9328 ± 0.0092
32	0.9419 ± 0.0132	1.0087 ± 0.0250	0.9406 ± 0.0109
33	0.9244 ± 0.0048	1.0570 ± 0.0112	0.9208 ± 0.0048

Table 4.137. (continued)

Pin No. (see Fig. 4.3)	State S1	State S2	State S3
40	0.9303 ± 0.0062	1.0095 ± 0.0126	0.9241 ± 0.0080
41	0.9431 ± 0.0066	0.9677 ± 0.0101	0.9288 ± 0.0057
42	0.9468 ± 0.0081	0.9299 ± 0.0075	0.9557 ± 0.0088
43	1.0020 ± 0.0068	0.8818 ± 0.0031	0.9952 ± 0.0085
44	1.0017 ± 0.0052	0.8834 ± 0.0051	1.0118 ± 0.0074
45	0.9523 ± 0.0069	0.9362 ± 0.0031	0.9443 ± 0.0055
46	0.9378 ± 0.0081	0.9758 ± 0.0117	0.9308 ± 0.0070
55	0.9933 ± 0.0081	0.8867 ± 0.0026	1.0055 ± 0.0063
56	1.0069 ± 0.0067	0.8373 ± 0.0111	1.0221 ± 0.0060
57	1.0270 ± 0.0035	0.8149 ± 0.0056	1.0269 ± 0.0065
58	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000
59	1.0231 ± 0.0076	0.8199 ± 0.0065	1.0255 ± 0.0065
60	1.0104 ± 0.0048	0.8581 ± 0.0082	1.0236 ± 0.0082
71	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000
72	1.0447 ± 0.0099	0.7818 ± 0.0050	1.0528 ± 0.0082
73	1.0362 ± 0.0092	0.7548 ± 0.0033	1.0494 ± 0.0040
74	1.0239 ± 0.0091	0.7566 ± 0.0060	1.0336 ± 0.0029
75	1.0440 ± 0.0074	0.7725 ± 0.0058	1.0305 ± 0.0102
88	1.0445 ± 0.0079	0.7633 ± 0.0052	1.0319 ± 0.0048
89	1.0447 ± 0.0124	0.7424 ± 0.0047	1.0417 ± 0.0076
90	1.0343 ± 0.0053	0.7413 ± 0.0084	1.0452 ± 0.0078
91	0.9970 ± 0.0065	0.7814 ± 0.0086	0.9868 ± 0.0082
106	1.0409 ± 0.0076	0.7507 ± 0.0091	1.0562 ± 0.0071
107	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000
108	1.0514 ± 0.0062	0.7451 ± 0.0024	1.0756 ± 0.0081
125	1.0424 ± 0.0096	0.7615 ± 0.0027	1.0659 ± 0.0054
126	1.0568 ± 0.0071	0.7833 ± 0.0074	1.0713 ± 0.0062
145	1.0514 ± 0.0058	0.8791 ± 0.0043	1.0729 ± 0.0087
166	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000

4.4.2 Calculations with Deterministic Methods

Three sets of calculations were performed with programs routinely used for design and analyses of VVER fuel assemblies. The varying methodologies represent the compromise between speed and accuracy.

4.4.2.1 Spectral code (TVS-M) calculations (A. Lazarenko, V. Sidorenko, and S. Bolshagin)

The results presented in this section were obtained with the use of the TVS-M code. The calculational Variants 1–13 were considered in States 1–6 (see Tables 4.138–4.165). Benchmark problem specifications are given in Sect. 4.3.

Calculations were performed with the buckling $B^2 = 0.003\ cm^{-2}$ for burnups up to 60 MWd/kg uranium. Calculations of Variants 3–9 and Variant 13 were done only at the zero burnup point. For States 1 and 2, the following values were reported:

- k_{eff} and k_0 at burnup intervals of 2 MWd/kg uranium;
- concentrations of ^{235}U, ^{236}U, ^{238}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{237}Np, ^{239}Np, ^{241}Am, ^{242m}Am, ^{243}Am, ^{242}Cm, ^{243}Cm, and ^{244}Cm at the same burnup points;
- one-group diffusion constants of the cell at 0, 10, 20, 30, 40, 50, and 60 MWd/kg uranium;
- zone flux-to-cell flux ratios at 0, 10, 20, 30, and 40 MWd/kg uranium;

- microscopic cross sections and reaction rates for these nuclides at 0, 10, 20, 30 and 40 MWd/kg uranium; and
- pin-by-pin power distributions (see Figs. 4.7–4.57).

The following definitions of functionals were used. For the cell cross sections,

$$\Sigma_x^g = \sum_k \Sigma_k^g \Phi_k^g \omega_k \Big/ \sum_k \Phi_k^g \omega_k \quad , \tag{4.1}$$

and

$$\Phi_k^g = \frac{1}{V_k} \int_{V_k} \Phi^g(\vec{r}) d\vec{r} \quad , \tag{4.2}$$

where g is group number, k is zone number, x is type of cross section, and $\omega_k = V_k/V_{cell}$. For the flux-to-flux ratios,

$$f_k^g = \omega_k \, \Phi_k^g \Big/ \Phi_{cell}^g \quad , \tag{4.3}$$

and

$$\Phi_{cell}^g = \sum_k \Phi_k^g \omega_k \quad . \tag{4.4}$$

For the relative reaction rates for process x for nuclide 1, R_x^1,

$$R_x^1 = \frac{\sum_g \sum_k \rho_k^l \sigma_{x,l}^g \Phi_k^g \omega_k}{\sum_g \Sigma_a^g \Phi_{cell}^g} \tag{4.5}$$

where l is nuclide index, k is fuel zone index, ρ is the nuclide atom density, and Σ_a is the total absorption cross section. For fission products (except Xe and Sm), Eq. (4.5) is summed over all fission products.

The one-group cross section for process x for nuclide 1 is:

$$\sigma_x^1 = \frac{\sum_g \sum_k \sigma_{x,l}^g \Phi_k^g \omega_k}{\sum_g \omega_k \Phi_{cell}^g} \quad .$$

For fission products,

$$\sigma_{F.P.} = \frac{1}{\rho_{F.P.}} \frac{\sum_l \sum_g \sum_k \rho_l \sigma^g_{x,l} \Phi^g_k \omega_k}{\sum_g \sum_k \omega_k \Phi^g_k} ,$$

where l is the nuclide index, k is the fuel zone index, and $\rho_{F.P}$ is the total concentration of fission products in fuel.

For power distribution,

$$\varepsilon_k = \frac{P_k}{\frac{1}{Nrod} \sum P_i} , \qquad (4.6)$$

where ε_k is relative power in fuel rod k, P_k is absolute power in fuel rod k, and Nrod is the number of pins in the problem.

For States 3–6, only k_{eff} and k_0 were reported at burnup points 0, 10, 20, 30, 40, 50, and 60 MWd/kg uranium.

The assembly calculations were performed for a symmetry angle of 60° (30° for Variant 13). Mesh nodes numeration used in the TVS-M code differs from the one from benchmark specification and is given in Figs. 4.7 and 4.36. As the figures illustrate, cells 1, 29, and 72 from benchmark specification correspond to 3, 25, and 35, respectively, in the TVS-M output.

In the case of V1–V2 and V10–V13 variants, all calculation results (excapt for results from Table 4.138) in States S1–S3 have been obtained with equilibrium concentrations of ^{135}Xe and ^{149}Sm. In the case of V3–V4 and V7–V9 variants calculation results for State S1 correspond $\rho(^{135}Xe)$ = 9.4581E–9, $\rho(^{149}Sm)$ = 7.3667E–8 and for State S3 $\rho(^{135}Xe)$ = 0.0, $\rho(^{149}Sm)$ = 0.0.

Table 4.138. Values of k_{eff} and k_0 at zero burnup point for Variants 1–13, States 1–6

	S1[a]		S2[b]		S3[c]		S4		S5		S6	
Variant	k_{eff}	k_0	k_{eff}	k_0	k_{eff}	k_0	k_{eff}	k_0	k_{eff}	k_0	k_{eff}	k_0
1	1.0611	1.2656			1.1526	1.3758	1.1021	1.3149	1.1151	1.3311	1.2202	1.3721
2	1.0229	1.2144			1.0670	1.2671	1.0408	1.2358	1.0562	1.2547	1.1818	1.3259
3	0.9123	1.0883			0.9889	1.1805	0.9471	1.1301	0.9615	1.1479	1.0614	1.1941
4	0.8564	1.0204			0.9243	1.1022	0.8871	1.0573	0.9001	1.0734	0.9985	1.1226
7	1.0967	1.3035			1.1464	1.3630	1.1169	1.3277	1.1303	1.3444	1.2515	1.4051
8	0.9275	1.1047			1.0207	1.2170	0.9702	1.1561	0.9846	1.1740	1.0888	1.2234
9	1.2798	1.1598			1.3322	1.5824	1.3003	1.5443	1.3166	1.5644	1.4343	1.0695
10	0.9639	1.1191			0.9815	1.1398	0.9695	1.1257	0.9837	1.1427	1.0934	1.2104
11	1.0744	1.2798	0.8666	1.0297	1.1787	1.4054	1.1175	1.3316	1.1292	1.3461	1.2200	1.3679
12	1.0474	1.2420	0.8698	1.0300	1.0998	1.3047	1.0670	1.2654	1.0812	1.2828	1.1956	1.3378
13	1.0611	1.2625			1.1456	1.3639	1.0971	1.3056	1.1101	1.3217	1.2135	1.3614

[a]Note: $^{Xe}\rho$ = 9.4581E–9, $^{Sm}\rho$ = 7.3667E–8 [atoms/(b·cm)].
[b]Note: $^{Xe}\rho$ = 0.0, $^{Sm}\rho$ = 0.0.
[c]Note: $^{Xe}\rho$ = 0.0, $^{Sm}\rho$ = 0.0.

Table 4.139. Values of k_{eff} and k_0 vs burnup for Variants 1, 2, 10, 11, and 12; State 1

Burnup (MWd/kg)[a]	V1		V2		V10		V11		V12	
	k_{eff}	k_0	k_{eff}	k_0	k_{eff}	k_0	k_{eff}	k_0	k_{eff}	k_0
0.0	1.0609	1.2654	1.0098	1.1988	0.9513	1.1045	1.0748	1.2803	1.0336	1.2256
2.0	1.0452	1.2463	0.9863	1.1708	0.9426	1.0945	1.0599	1.2620	1.0098	1.1973
4.0	1.0282	1.2260	0.9674	1.1485	0.9352	1.0861	1.0434	1.2424	0.9901	1.1740
6.0	1.0109	1.2053	0.9506	1.1286	0.9283	1.0781	1.0266	1.2224	0.9724	1.1531
8.0	0.9941	1.1853	0.9353	1.1106	0.9216	1.0704	1.0099	1.2026	0.9560	1.1339
10.0	0.9780	1.1661	0.9211	1.0938	0.9151	1.0630	0.9938	1.1835	0.9406	1.1158
12.0	0.9628	1.1480	0.9078	1.0781	0.9088	1.0558	0.9783	1.1651	0.9260	1.0987
14.0	0.9483	1.1308	0.8952	1.0633	0.9026	1.0488	0.9634	1.1475	0.9121	1.0823
16.0	0.9344	1.1144	0.8832	1.0492	0.8966	1.0419	0.9490	1.1304	0.8987	1.0665
18.0	0.9211	1.0986	0.8717	1.0357	0.8907	1.0351	0.9350	1.1139	0.8857	1.0514
20.0	0.9084	1.0835	0.8607	1.0228	0.8849	1.0285	0.9214	1.0978	0.8732	1.0367
22.0	0.8960	1.0688	0.8502	1.0104	0.8792	1.0220	0.9081	1.0822	0.8611	1.0225
24.0	0.8840	1.0547	0.8401	0.9985	0.8736	1.0156	0.8952	1.0669	0.8495	1.0089
26.0	0.8724	1.0409	0.8303	0.9871	0.8681	1.0093	0.8824	1.0519	0.8371	0.9944
28.0	0.8611	1.0275	0.8210	0.9762	0.8627	1.0032	0.8700	1.0372	0.8243	0.9793
30.0	0.8501	1.0145	0.8127	0.9665	0.8573	0.9971	0.8577	1.0228	0.8130	0.9660
32.0	0.8393	1.0018	0.8039	0.9561	0.8521	0.9911	0.8457	1.0086	0.8023	0.9535
34.0	0.8289	0.9895	0.7975	0.9487	0.8470	0.9853	0.8338	0.9946	0.7920	0.9415
36.0	0.8187	0.9775	0.7886	0.9383	0.8419	0.9795	0.8221	0.9808	0.7821	0.9299
38.0	0.8088	0.9658	0.7803	0.9285	0.8369	0.9738	0.8106	0.9672	0.7725	0.9186
40.0	0.7980	0.9529	0.7723	0.9191	0.8320	0.9682	0.7993	0.9539	0.7632	0.9078
42.0	0.7884	0.9417	0.7646	0.9101	0.8271	0.9627	0.7882	0.9409	0.7542	0.8972
44.0	0.7792	0.9308	0.7572	0.9014	0.8224	0.9573	0.7774	0.9281	0.7453	0.8868
46.0	0.7702	0.9202	0.7501	0.8931	0.8177	0.9520	0.7669	0.9157	0.7369	0.8770
48.0	0.7615	0.9099	0.7433	0.8851	0.8131	0.9467	0.7566	0.9035	0.7288	0.8674
50.0	0.7531	0.8999	0.7368	0.8775	0.8085	0.9416	0.7466	0.8917	0.7208	0.8581
52.0	0.7449	0.8902	0.7305	0.8701	0.8041	0.9365	0.7368	0.8802	0.7138	0.8499
54.0	0.7369	0.8808	0.7244	0.8630	0.7997	0.9316	0.7274	0.8691	0.7068	0.8417
56.0	0.7292	0.8717	0.7186	0.8562	0.7954	0.9267	0.7182	0.8583	0.6990	0.8326
58.0	0.7216	0.8628	0.7130	0.8497	0.7911	0.9218	0.7094	0.8479	0.6924	0.8249
60.0	0.7143	0.8542	0.7076	0.8434	0.7869	0.9170	0.7007	0.8376	0.6877	0.8194

[a]Uranium plus plutonium.

Table 4.140. Values of k_{eff} and k_0 vs burnup for Variants 1, 2, 10, 11, and 12; States 2–6

Burnup (MWd/kg)[a]	State	V1		V2		V10		V11		V12	
		k_{eff}	k_0	k_{eff}	k_0	k_{eff}	k_0	k_{eff}	k_0	k_{eff}	k_0
0.0	S2							0.8387	0.9964	0.8461	1.0017
	S3	1.1069	1.3208	1.0338	1.2275	0.9626	1.1177	1.1306	1.3476	1.0637	1.2616
	S4	1.1021	1.3149	1.0408	1.2358	0.9695	1.1257	1.1175	1.3316	1.0670	1.2654
	S5	1.1151	1.3311	1.0562	1.2547	0.9837	1.1427	1.1292	1.3461	1.0812	1.2828
	S6	1.2202	1.3721	1.1818	1.3259	1.0934	1.2104	1.2200	1.3678	1.1956	1.3378
10.0	S2							0.7821	0.9290	0.7673	0.9088
	S3	1.0172	1.2134	0.9446	1.1219	0.9261	1.0759	1.0431	1.2428	0.9707	1.1518
	S4	1.0148	1.2103	0.9503	1.1287	0.9333	1.0842	1.0322	1.2296	0.9720	1.1533
	S5	1.0274	1.2260	0.9647	1.1464	0.9467	1.1003	1.0436	1.2437	0.9853	1.1695
	S6	1.1335	1.2748	1.0798	1.2118	1.0545	1.1676	1.1343	1.2720	1.0868	1.2166
20.0	S2							0.7255	0.8624	0.7082	0.8394
	S3	0.9442	1.1266	0.8843	1.0511	0.8958	1.0412	0.9674	1.1532	0.9040	1.0736
	S4	0.9414	1.1232	0.8882	1.0556	0.9027	1.0492	0.9558	1.1392	0.9024	1.0715
	S5	0.9544	1.1392	0.9015	1.0720	0.9156	1.0647	0.9675	1.1537	0.9146	1.0865
	S6	1.0575	1.1897	1.0074	1.1311	1.0221	1.1322	1.0541	1.1827	1.0039	1.1243
30.0	S2							0.6744	0.8022	0.6558	0.7779
	S3	0.8838	1.0551	0.8367	0.9952	0.8682	1.0098	0.9018	1.0758	0.8446	1.0039
	S4	0.8801	1.0506	0.8386	0.9974	0.8749	1.0176	0.8887	1.0600	0.8398	0.9981
	S5	0.8929	1.0665	0.8513	1.0130	0.8873	1.0325	0.9003	1.0743	0.8512	1.0122
	S6	0.9901	1.1143	0.9484	1.0654	0.9926	1.1000	0.9790	1.0990	0.9284	1.0405
40.0	S2							0.6269	0.7463	0.6119	0.7264
	S3	0.8301	0.9916	0.7966	0.9482	0.8428	0.9808	0.8419	1.0053	0.7957	0.9467
	S4	0.8253	0.9858	0.7967	0.9483	0.8493	0.9884	0.8270	0.9873	0.7880	0.9374
	S5	0.8377	1.0011	0.8089	0.9633	0.8613	1.0029	0.8382	1.0010	0.7988	0.9507
	S6	0.9274	1.0443	0.8983	1.0096	0.9654	1.0702	0.9068	1.0187	0.8648	0.9697
50.0	S2							0.5841	0.6960	0.5749	0.6830
	S3	0.7838	0.9371	0.7613	0.9069	0.8193	0.9542	0.7879	0.9417	0.7539	0.8979
	S4	0.7780	0.9299	0.7604	0.9056	0.8256	0.9616	0.7714	0.9216	0.7436	0.8854
	S5	0.7899	0.9446	0.7715	0.9195	0.8374	0.9756	0.7819	0.9347	0.7539	0.8982
	S6	0.8717	0.9821	0.8542	0.9605	0.9401	1.0426	0.8396	0.9438	0.8101	0.9089
60.0	S2							0.5472	0.6524	0.5454	0.6485
	S3	0.7439	0.8899	0.7323	0.8730	0.7977	0.9297	0.7409	0.8862	0.7214	0.8600
	S4	0.7372	0.8817	0.7295	0.8696	0.8038	0.9367	0.7229	0.8644	0.7089	0.8449
	S5	0.7485	0.8958	0.7408	0.8835	0.8152	0.9504	0.7329	0.8769	0.7189	0.8572
	S6	0.8226	0.9271	0.8178	0.9200	0.9166	1.0170	0.7800	0.8772	0.7673	0.8615

[a]Uranium plus plutonium.

Table 4.141. Cell macro sections and flux relations, Variants 1–4 and 7–10, State 1

Burnup (MWd/kg)[a]	Σ_a (cm^{-1})	Σ_f (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Φ_{fuel}/Φ_{cell}	Φ_{clad}/Φ_{cell}	Φ_{mod}/Φ_{cell}
			Variant 1, State 1			
0.0	2.070E–2	1.066E–2	2.619E–2	3.338E–1	1.360E–1	5.303E–1
10.0	2.101E–2	9.612E–3	2.450E–2	3.337E–1	1.360E–1	5.303E–1
20.0	2.111E–2	8.756E–3	2.287E–2	3.337E–1	1.360E–1	5.303E–1
30.0	2.113E–2	8.046E–3	2.144E–2	3.337E–1	1.360E–1	5.303E–1
40.0	2.113E–2	7.430E–3	2.013E–2	3.337E–1	1.360E–1	5.303E–1
50.0	2.111E–2	6.908E–3	1.899E–2	3.337E–1	1.360E–1	5.303E–1
60.0	2.108E–2	6.471E–3	1.801E–2	3.337E–1	1.360E–1	5.303E–1
			Variant 2, State 1			
0.0	2.212E–2	9.303E–3	2.652E–2	3.334E–1	1.360E–1	5.306E–1
10.0	2.208E–2	8.460E–3	2.415E–2	3.334E–1	1.360E–1	5.306E–1
20.0	2.198E–2	7.861E–3	2.248E–2	3.334E–1	1.360E–1	5.305E–1
30.0	2.187E–2	7.376E–3	2.114E–2	3.335E–1	1.360E–1	5.305E–1
40.0	2.176E–2	6.967E–3	2.000E–2	3.335E–1	1.360E–1	5.305E–1
50.0	2.166E–2	6.615E–3	1.901E–2	3.335E–1	1.360E–1	5.305E–1
60.0	2.158E–2	6.326E–3	1.820E–2	3.336E–1	1.360E–1	5.304E–1
			Variant 10, State 1			
0.0	2.471E–2	9.491E–3	2.729E–2	3.330E–1	1.361E–1	5.309E–1
10.0	2.470E–2	9.119E–3	2.625E–2	3.330E–1	1.361E–1	5.309E–1
20.0	2.466E–2	8.801E–3	2.536E–2	3.330E–1	1.361E–1	5.309E–1
30.0	2.461E–2	8.509E–3	2.454E–2	3.331E–1	1.361E–1	5.308E–1
40.0	2.456E–2	8.239E–3	2.378E–2	3.331E–1	1.361E–1	5.308E–1
50.0	2.450E–2	7.988E–3	2.307E–2	3.331E–1	1.361E–1	5.308E–1
60.0	2.443E–2	7.755E–3	2.241E–2	3.331E–1	1.361E–1	5.308E–1
			Variant 3, State 1			
0.0	2.086E–2	8.532E–3	2.270E–2	3.337E–1	1.360E–1	5.303E–1
			Variant 4, State 1			
0.0	2.113E–2	8.100E–3	2.156E–2	3.337E–1	1.360E–1	5.303E–1
			Variant 7, State 1			
0.0	2.184E–2	9.993E–3	2.847E–2	3.338E–1	1.361E–1	5.300E–1
			Variant 8, State 1			
0.0	2.054E–2	9.217E–3	2.269E–2	3.341E–1	1.361E–1	5.298E–1
			Variant 9, State 1			
0.0	2.201E–2	1.145E–2	3.346E–2	3.339E–1	1.361E–1	5.300E–1

[a]Uranium plus plutonium.

Table 4.142. Cell macro sections and flux relations, Variant 11, States 1 and 2

State	Burnup (MWd/kg)[a]	Σ_a (cm^{-1})	Σ_f (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Φ_{fuel}/Φ_{cell}	Φ_{clad}/Φ_{cell}	Φ_{mod}/Φ_{cell}
			Pin 1				
S1	0.0	2.344E–2	1.250E–2	3.066E–2	3.329E–1	1.360E–1	5.311E–1
	10.0	2.369E–2	1.121E–2	2.847E–2	3.329E–1	1.360E–1	5.312E–1
	20.0	2.363E–2	1.006E–2	2.619E–2	3.329E–1	1.360E–1	5.312E–1
	30.0	2.345E–2	9.069E–3	2.409E–2	3.329E–1	1.360E–1	5.312E–1
	40.0	2.323E–2	8.195E–3	2.217E–2	3.329E–1	1.360E–1	5.312E–1
	50.0	2.303E–2	7.455E–3	2.050E–2	3.329E–1	1.360E–1	5.311E–1
	60.0	2.285E–2	6.856E–3	1.912E–2	3.329E–1	1.360E–1	5.311E–1
S2	0.0	2.188E–2	1.148E–2	2.821E–2	3.335E–1	1.360E–1	5.306E–1
	10.0	2.235E–2	1.044E–2	2.653E–2	3.334E–1	1.360E–1	5.307E–1
	20.0	2.232E–2	9.381E–3	2.442E–2	3.333E–1	1.360E–1	5.307E–1
	30.0	2.216E–2	8.454E–3	2.246E–2	3.333E–1	1.360E–1	5.307E–1
	40.0	2.195E–2	7.635E–3	2.066E–2	3.333E–1	1.360E–1	5.307E–1
	50.0	2.176E–2	6.940E–3	1.909E–2	3.334E–1	1.360E–1	5.307E–1
	60.0	2.159E–2	6.379E–3	1.779E–2	3.334E–1	1.360E–1	5.306E–1
			Pin 29				
S1	0.0	2.198E–2	1.155E–2	2.835E–2	3.334E–1	1.360E–1	5.306E–1
	10.0	2.229E–2	1.049E–2	2.664E–2	3.334E–1	1.360E–1	5.306E–1
	20.0	2.240E–2	9.588E–3	2.493E–2	3.334E–1	1.360E–1	5.306E–1
	30.0	2.243E–2	8.800E–3	2.333E–2	3.334E–1	1.360E–1	5.306E–1
	40.0	2.240E–2	8.085E–3	2.181E–2	3.334E–1	1.360E–1	5.306E–1
	50.0	2.235E–2	7.444E–3	2.039E–2	3.334E–1	1.360E–1	5.306E–1
	60.0	2.228E–2	6.889E–3	1.913E–2	3.334E–1	1.360E–1	5.306E–1
S2	0.0	1.922E–2	9.746E–3	2.398E–2	3.343E–1	1.360E–1	5.297E–1
	10.0	1.961E–2	8.918E–3	2.268E–2	3.343E–1	1.360E–1	5.297E–1
	20.0	1.974E–2	8.149E–3	2.121E–2	3.343E–1	1.360E–1	5.298E–1
	30.0	1.976E–2	7.469E–3	1.982E–2	3.343E–1	1.360E–1	5.298E–1
	40.0	1.973E–2	6.850E–3	1.849E–2	3.343E–1	1.360E–1	5.298E–1
	50.0	1.968E–2	6.295E–3	1.726E–2	3.343E–1	1.360E–1	5.297E–1
	60.0	1.962E–2	5.818E–3	1.616E–2	3.343E–1	1.360E–1	5.297E–1
			Pin 72				
S1	0.0	2.284E–2	1.210E–2	2.971E–2	3.331E–1	1.360E–1	5.309E–1
	10.0	2.316E–2	1.094E–2	2.779E–2	3.331E–1	1.360E–1	5.310E–1
	20.0	2.319E–2	9.905E–3	2.576E–2	3.331E–1	1.360E–1	5.310E–1
	30.0	2.311E–2	8.998E–3	2.388E–2	3.330E–1	1.360E–1	5.310E–1
	40.0	2.298E–2	8.187E–3	2.212E–2	3.330E–1	1.360E–1	5.310E–1
	50.0	2.284E–2	7.478E–3	2.053E–2	3.330E–1	1.360E–1	5.310E–1
	60.0	2.271E–2	6.884E–3	1.917E–2	3.331E–1	1.360E–1	5.310E–1
S2	0.0	1.658E–2	8.027E–3	1.981E–2	3.352E–1	1.360E–1	5.288E–1
	10.0	1.685E–2	7.237E–3	1.846E–2	3.351E–1	1.360E–1	5.289E–1
	20.0	1.693E–2	6.543E–3	1.708E–2	3.351E–1	1.360E–1	5.289E–1
	30.0	1.691E–2	5.929E–3	1.578E–2	3.351E–1	1.360E–1	5.289E–1
	40.0	1.684E–2	5.382E–3	1.458E–2	3.351E–1	1.360E–1	5.289E–1
	50.0	1.676E–2	4.908E–3	1.350E–2	3.351E–1	1.360E–1	5.289E–1
	60.0	1.668E–2	4.516E–3	1.259E–2	3.351E–1	1.360E–1	5.289E–1

[a]Uranium plus plutonium.

Table 4.143. Cell macro sections and flux relations, Variant 12, States 1 and 2

State	Burnup (MWd/kg)[a]	Σ_a (cm^{-1})	Σ_f (cm^{-1})	$\nu\Sigma_f$ (cm^{-1})	Φ_{fuel}/Φ_{cell}	Φ_{clad}/Φ_{cell}	Φ_{mod}/Φ_{cell}
			Pin 1				
S1	0.0	2.590E–2	1.141E–2	3.252E–2	3.323E–1	1.360E–1	5.317E–1
	10.0	2.552E–2	1.007E–2	2.874E–2	3.323E–1	1.360E–1	5.317E–1
	20.0	2.494E–2	9.056E–3	2.590E–2	3.324E–1	1.360E–1	5.316E–1
	30.0	2.435E–2	8.219E–3	2.355E–2	3.325E–1	1.360E–1	5.315E–1
	40.0	2.392E–2	7.554E–3	2.169E–2	3.326E–1	1.360E–1	5.314E–1
	50.0	2.372E–2	7.033E–3	2.022E–2	3.326E–1	1.360E–1	5.313E–1
	60.0	2.347E–2	6.650E–3	1.913E–2	3.327E–1	1.360E–1	5.313E–1
S2	0.0	2.465E–2	1.077E–2	3.071E–2	3.327E–1	1.360E–1	5.312E–1
	10.0	2.435E–2	9.537E–3	2.722E–2	3.327E–1	1.360E–1	5.312E–1
	20.0	2.378E–2	8.564E–3	2.449E–2	3.328E–1	1.360E–1	5.312E–1
	30.0	2.320E–2	7.758E–3	2.223E–2	3.329E–1	1.360E–1	5.311E–1
	40.0	2.276E–2	7.116E–3	2.043E–2	3.330E–1	1.360E–1	5.310E–1
	50.0	2.255E–2	6.610E–3	1.900E–2	3.331E–1	1.360E–1	5.309E–1
	60.0	2.228E–2	6.236E–3	1.794E–2	3.332E–1	1.360E–1	5.308E–1
			Pin 29				
S1	0.0	2.345E–2	1.006E–2	2.867E–2	3.331E–1	1.360E–1	5.309E–1
	10.0	2.345E–2	9.235E–3	2.636E–2	3.331E–1	1.360E–1	5.309E–1
	20.0	2.343E–2	8.606E–3	2.460E–2	3.331E–1	1.360E–1	5.308E–1
	30.0	2.333E–2	8.026E–3	2.299E–2	3.332E–1	1.360E–1	5.308E–1
	40.0	2.325E–2	7.515E–3	2.156E–2	3.332E–1	1.360E–1	5.308E–1
	50.0	2.311E–2	7.062E–3	2.030E–2	3.333E–1	1.360E–1	5.307E–1
	60.0	2.301E–2	6.686E–3	1.923E–2	3.333E–1	1.360E–1	5.307E–1
S2	0.0	2.096E–2	8.783E–3	2.504E–2	3.339E–1	1.360E–1	5.301E–1
	10.0	2.095E–2	8.044E–3	2.296E–2	3.339E–1	1.360E–1	5.301E–1
	20.0	2.089E–2	7.462E–3	2.133E–2	3.340E–1	1.360E–1	5.300E–1
	30.0	2.077E–2	6.928E–3	1.985E–2	3.340E–1	1.360E–1	5.300E–1
	40.0	2.065E–2	6.457E–3	1.853E–2	3.341E–1	1.360E–1	5.299E–1
	50.0	2.050E–2	6.047E–3	1.737E–2	3.341E–1	1.360E–1	5.299E–1
	60.0	2.037E–2	5.702E–3	1.640E–2	3.342E–1	1.360E–1	5.298E–1
			Pin 72				
S1	0.0	2.484E–2	1.082E–2	3.085E–2	3.326E–1	1.360E–1	5.314E–1
	10.0	2.469E–2	9.746E–3	2.782E–2	3.326E–1	1.360E–1	5.313E–1
	20.0	2.440E–2	8.915E–3	2.549E–2	3.327E–1	1.360E–1	5.313E–1
	30.0	2.470E–2	8.153E–3	2.336E–2	3.328E–1	1.360E–1	5.312E–1
	40.0	2.432E–2	7.563E–3	2.171E–2	3.328E–1	1.360E–1	5.312E–1
	50.0	2.414E–2	7.053E–3	2.027E–2	3.329E–1	1.360E–1	5.311E–1
	60.0	2.382E–2	6.693E–3	1.926E–2	3.329E–1	1.360E–1	5.311E–1
S2	0.0	1.836E–2	7.451E–3	2.124E–2	3.347E–1	1.360E–1	5.293E–1
	10.0	1.824E–2	6.645E–3	1.897E–2	3.347E–1	1.360E–1	5.293E–1
	20.0	1.803E–2	6.036E–3	1.726E–2	3.348E–1	1.360E–1	5.292E–1
	30.0	1.825E–2	5.488E–3	1.572E–2	3.348E–1	1.360E–1	5.292E–1
	40.0	1.796E–2	5.062E–3	1.452E–2	3.349E–1	1.360E–1	5.291E–1
	50.0	1.781E–2	4.702E–3	1.351E–2	3.349E–1	1.360E–1	5.291E–1
	60.0	1.757E–2	4.443E–3	1.277E–2	3.349E–1	1.360E–1	5.291E–1

[a]Uranium plus plutonium.

Table 4.144. Absorption and production microscopic cross sections (b) of main isotopes, Variants 1–4 and 7–10

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Variant 1, Absorption						
0	4.228E+1	8.742E+0	9.853E–1	2.663E+1	1.429E+2	2.015E+2	1.274E+2	2.820E+1	1.499E+5	4.712E+3	0.000E+0
10	3.891E+1	7.841E+0	9.832E–1	2.461E+1	1.211E+2	1.515E+2	1.124E+2	2.818E+1	1.357E+5	4.247E+3	4.004E+0
20	3.775E+1	7.318E+0	9.846E–1	2.398E+1	1.125E+2	1.146E+2	1.066E+2	2.769E+1	1.312E+5	4.088E+3	3.660E+0
30	3.750E+1	6.989E+0	9.873E–1	2.391E+1	1.089E+2	9.518E+1	1.045E+2	2.670E+1	1.307E+5	4.056E+3	3.453E+0
40	3.760E+1	6.775E+0	9.903E–1	2.405E+1	1.073E+2	8.394E+1	1.039E+2	2.538E+1	1.319E+5	4.077E+3	3.325E+0
50	3.789E+1	6.643E+0	9.935E–1	2.431E+1	1.069E+2	7.705E+1	1.040E+2	2.397E+1	1.337E+5	4.121E+3	3.169E+0
60	3.816E+1	6.568E+0	9.967E–1	2.454E+1	1.068E+2	7.260E+1	1.044E+2	2.262E+1	1.355E+5	4.165E+3	3.023E+0
					Variant 1, Production						
0	8.363E+1	7.934E–1	2.875E–1	6.641E+0	2.589E+2	1.916E+0	2.715E+2	1.255E+0			
10	7.662E+1	7.802E–1	2.944E–1	6.531E+0	2.206E+2	1.923E+0	2.402E+2	1.280E+0			
20	7.418E+1	7.718E–1	2.981E–1	6.509E+0	2.056E+2	1.919E+0	2.282E+2	1.293E+0			
30	7.363E+1	7.664E–1	3.004E–1	6.520E+0	1.994E+2	1.918E+0	2.238E+2	1.300E+0			
40	7.384E+1	7.632E–1	3.021E–1	6.544E+0	1.968E+2	1.918E+0	2.227E+2	1.305E+0			
50	7.441E+1	7.617E–1	3.035E–1	6.572E+0	1.963E+2	1.919E+0	2.232E+2	1.308E+0			
60	7.498E+1	7.615E–1	3.047E–1	6.598E+0	1.964E+2	1.921E+0	2.240E+2	1.311E+0			
					Variant 2, Absorption						
0	2.514E+1	9.144E+0	9.632E–1	1.523E+1	5.815E+1	8.994E+1	6.178E+1	2.952E+1	6.752E+4	2.135E+3	0.000E+0
10	2.619E+1	8.915E+0	9.664E–1	1.607E+1	6.286E+1	6.080E+1	6.559E+1	2.848E+1	7.372E+4	2.316E+3	4.617E+0
20	2.756E+1	8.723E+0	9.702E–1	1.707E+1	6.839E+1	5.298E+1	7.012E+1	2.661E+1	8.108E+4	2.533E+3	4.119E+0
30	2.902E+1	8.578E+0	9.746E–1	1.811E+1	7.406E+1	5.033E+1	7.487E+1	2.443E+1	8.870E+4	2.760E+3	3.754E+0
40	3.043E+1	8.455E+0	9.789E–1	1.911E+1	7.938E+1	4.988E+1	7.943E+1	2.232E+1	9.607E+4	2.978E+3	3.506E+0
50	3.167E+1	8.359E+0	9.831E–1	1.999E+1	8.390E+1	5.040E+1	8.340E+1	2.053E+1	1.025E+5	3.170E+3	3.356E+0
60	3.277E+1	8.279E+0	9.872E–1	2.077E+1	8.775E+1	5.155E+1	8.690E+1	1.912E+1	1.083E+5	3.341E+3	3.188E+0
					Variant 2, Production						
0	4.778E+1	8.522E–1	3.145E–1	5.915E+0	1.074E+2	1.993E+0	1.330E+2	1.354E+0			
10	4.998E+1	8.460E–1	3.145E–1	5.989E+0	1.159E+2	1.974E+0	1.412E+2	1.353E+0			
20	5.284E+1	8.398E–1	3.140E–1	6.068E+0	1.259E+2	1.965E+0	1.509E+2	1.350E+0			
30	5.588E+1	8.344E–1	3.133E–1	6.147E+0	1.362E+2	1.958E+0	1.611E+2	1.346E+0			
40	5.883E+1	8.298E–1	3.127E–1	6.223E+0	1.460E+2	1.953E+0	1.708E+2	1.343E+0			
50	6.141E+1	8.262E–1	3.122E–1	6.290E+0	1.542E+2	1.949E+0	1.793E+2	1.340E+0			
60	6.371E+1	8.232E–1	3.118E–1	6.349E+0	1.613E+2	1.947E+0	1.868E+2	1.337E+0			

Table 4.144. (continued)

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Variant 10, Absorption						
0	1.494E+1	8.232E+0	8.671E–1	8.574E+0	2.748E+1	2.170E+1	3.205E+1	1.392E+1	2.274E+4	7.594E+2	0.000E+0
10	1.500E+1	7.973E+0	8.667E–1	8.635E+0	2.820E+1	2.130E+1	3.227E+1	1.357E+1	2.333E+4	7.771E+2	3.405E+0
20	1.513E+1	7.776E+0	8.672E–1	8.740E+0	2.909E+1	2.117E+1	3.273E+1	1.319E+1	2.421E+4	8.038E+2	3.063E+0
30	1.531E+1	7.624E+0	8.684E–1	8.872E+0	3.008E+1	2.122E+1	3.333E+1	1.280E+1	2.524E+4	8.352E+2	2.840E+0
40	1.552E+1	7.505E+0	8.701E–1	9.022E+0	3.114E+1	2.141E+1	3.404E+1	1.242E+1	2.639E+4	8.703E+2	2.673E+0
50	1.576E+1	7.411E+0	8.722E–1	9.190E+0	3.226E+1	2.174E+1	3.485E+1	1.205E+1	2.764E+4	9.087E+2	2.537E+0
60	1.603E+1	7.334E+0	8.745E–1	9.373E+0	3.344E+1	2.219E+1	3.574E+1	1.171E+1	2.900E+4	9.501E+2	2.427E+0
					Variant 10, Production						
0	2.695E+1	8.482E–1	3.257E–1	5.508E+0	5.071E+1	2.035E+0	6.983E+1	1.408E+0			
10	2.710E+1	8.424E–1	3.264E–1	5.519E+0	5.195E+1	2.038E+0	7.030E+1	1.410E+0			
20	2.741E+1	8.379E–1	3.270E–1	5.531E+0	5.351E+1	2.041E+0	7.128E+1	1.412E+0			
30	2.780E+1	8.345E–1	3.274E–1	5.544E+0	5.526E+1	2.042E+0	7.255E+1	1.413E+0			
40	2.825E+1	8.318E–1	3.277E–1	5.558E+0	5.715E+1	2.044E+0	7.407E+1	1.414E+0			
50	2.876E+1	8.297E–1	3.280E–1	5.572E+0	5.916E+1	2.045E+0	7.577E+1	1.414E+0			
60	2.932E+1	8.279E–1	3.282E–1	5.586E+0	6.127E+1	2.045E+0	7.765E+1	1.414E+0			
					Variant 3, Absorption						
0	3.963E+1	7.274E+0	1.003E+0	2.534E+1	1.153E+2	1.011E+2	1.109E+2	2.766E+1	1.405E+5	4.351E+3	0.000E+0
					Variant 3, Production						
0	7.798E+1	7.663E–1	2.961E–1	6.606E+0	2.112E+2	1.896E+0	2.376E+2	1.282E+0			
					Variant 4, Absorption						
0	3.749E+1	7.031E+0	9.913E–1	2.389E+1	1.090E+2	9.651E+1	1.045E+2	2.687E+1	1.305E+5	4.052E+3	1.467E+1
					Variant 4, Production						
0	7.361E+1	7.659E–1	2.996E–1	6.517E+0	1.995E+2	1.914E+0	2.239E+2				
					Variant 7, Absorption						
0	2.721E+1	9.097E+0	9.648E–1	1.649E+1	6.348E+1	2.133E+2	6.692E+1	2.940E+1	7.661E+4	2.417E+3	
					Variant 7, Production						
0	5.211E+1	8.461E–1	3.120E–1	5.984E+0	1.175E+2	2.047E+0	1.440E+2	1.342E+0			
					Variant 8, Absorption						
0	4.518E+1	8.849E+0	9.977E–1	2.892E+1	1.497E+2	9.664E+1	1.357E+2	2.867E+1	1.662E+5	5.172E+3	0.000E+0

Table 4.144. (continued)

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Variant 8, Production						
0	8.955E+1	7.920E–1	2.852E–1	6.822E+0	2.719E+2	1.841E+0	2.896E+2	1.245E+0			
					Variant 9, Absorption						
0	2.612E+1	8.127E+0	9.451E–1	1.533E+1	7.494E+1	2.022E+2	6.447E+1	2.726E+1	6.862E+4	2.200E+3	0.000E+0
					Variant 9, Production						
0	4.994E+1	8.252E–1	3.150E–1	5.903E+0	1.360E+2	2.055E+0	1.387E+2	1.352E+0			

Table 4.145. Absorption and production reaction rates, Variants 1–4 and 7–10

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Variant 1, Absorption						
0	5.958E–1	0.000E+0	2.978E–1	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	2.299E–2	5.606E–3	0.000E+0
10	4.107E–1	4.794E–3	2.908E–1	4.432E–5	1.410E–1	2.164E–2	5.891E–3	9.215E–5	2.139E–2	5.249E–3	2.602E–2
20	2.987E–1	7.749E–3	2.877E–1	2.523E–4	1.985E–1	4.186E–2	2.096E–2	7.564E–4	2.011E–2	4.884E–3	4.700E–2
30	2.192E–1	9.682E–3	2.859E–1	7.087E–4	2.266E–1	5.584E–2	3.702E–2	2.142E–3	1.916E–2	4.589E–3	6.606E–2
40	1.587E–1	1.091E–2	2.843E–1	1.458E–3	2.405E–1	6.590E–2	5.098E–2	4.033E–3	1.833E–2	4.328E–3	8.442E–2
50	1.126E–1	1.162E–2	2.829E–1	2.496E–3	2.472E–1	7.327E–2	6.207E–2	6.152E–3	1.761E–2	4.104E–3	1.003E–1
60	7.769E–2	1.192E–2	2.813E–1	3.755E–3	2.495E–1	7.849E–2	7.021E–2	8.277E–3	1.696E–2	3.909E–3	1.145E–1
					Variant 1, Production						
0	1.178E+0	0.000E+0	8.692E–2	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0			
10	8.088E–1	4.770E–4	8.708E–2	1.176E–5	2.569E–1	2.746E–4	1.259E–2	4.187E–6			
20	5.870E–1	8.172E–4	8.710E–2	6.847E–5	3.627E–1	7.010E–4	4.485E–2	3.532E–5			
30	4.304E–1	1.062E–3	8.698E–2	1.933E–4	4.149E–1	1.125E–3	7.932E–2	1.043E–4			
40	3.117E–1	1.229E–3	8.675E–2	3.967E–4	4.412E–1	1.506E–3	1.093E–1	2.074E–4			
50	2.211E–1	1.333E–3	8.642E–2	6.750E–4	4.540E–1	1.825E–3	1.331E–1	3.357E–4			
60	1.526E–1	1.382E–3	8.599E–2	1.009E–3	4.585E–1	2.077E–3	1.507E–1	4.798E–4			
					Variant 2, Absorption						
0	1.455E–2	0.000E+0	2.746E–1	0.000E+0	5.773E–1	5.737E–2	6.541E–3	0.000E+0	1.627E–2	5.065E–3	0.000E+0
10	1.255E–2	1.902E–4	2.741E–1	1.918E–5	4.900E–1	8.849E–2	3.455E–2	1.066E–3	1.638E–2	4.853E–3	2.707E–2
20	1.068E–2	3.446E–4	2.742E–1	1.063E–4	4.198E–1	1.042E–1	6.325E–2	3.401E–3	1.632E–2	4.598E–3	4.853E–2
30	8.848E–3	4.641E–4	2.746E–1	3.090E–4	3.634E–1	1.123E–1	8.689E–2	6.448E–3	1.624E–2	4.396E–3	6.669E–2
40	7.093E–3	5.494E–4	2.747E–1	6.539E–4	3.209E–1	1.152E–1	1.027E–1	9.608E–3	1.610E–2	4.219E–3	8.348E–2
50	5.480E–3	6.032E–4	2.745E–1	1.125E–3	2.910E–1	1.140E–1	1.103E–1	1.250E–2	1.589E–2	4.052E–3	1.003E–1
60	4.095E–3	6.293E–4	2.739E–1	1.670E–3	2.723E–1	1.108E–1	1.118E–1	1.494E–2	1.569E–2	3.907E–3	1.148E–1
					Variant 2, Production						
0	2.765E–2	0.000E+0	8.967E–2	0.000E+0	1.066E+0	1.271E–3	1.408E–2	0.000E+0			
10	2.395E–2	1.805E–5	8.920E–2	7.148E–6	9.033E–1	2.874E–3	7.439E–2	5.066E–5			
20	2.047E–2	3.318E–5	8.875E–2	3.780E–5	7.730E–1	3.865E–3	1.361E–1	1.726E–4			
30	1.703E–2	4.515E–5	8.827E–2	1.049E–4	6.686E–1	4.371E–3	1.869E–1	3.553E–4			
40	1.371E–2	5.391E–5	8.774E–2	2.129E–4	5.900E–1	4.509E–3	2.209E–1	5.780E–4			
50	1.063E–2	5.961E–5	8.715E–2	3.539E–4	5.350E–1	4.409E–3	2.372E–1	8.156E–4			
60	7.962E–3	6.257E–5	8.653E–2	5.105E–4	5.005E–1	4.186E–3	2.402E–1	1.045E–3			

Table 4.145. (continued)

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Variant 10, Absorption						
0	1.007E–2	0.000E+0	2.582E–1	3.466E–3	4.295E–1	1.433E–1	8.204E–2	1.969E–2	7.518E–3	4.764E–3	0.000E+0
10	8.870E–3	1.662E–4	2.563E–1	3.487E–3	3.942E–1	1.416E–1	9.350E–2	1.980E–2	7.658E–3	4.821E–3	2.215E–2
20	7.817E–3	2.985E–4	2.548E–1	3.793E–3	3.656E–1	1.400E–1	1.026E–1	2.015E–2	7.782E–3	4.690E–3	3.988E–2
30	6.868E–3	4.035E–4	2.536E–1	4.204E–3	3.413E–1	1.381E–1	1.095E–1	2.068E–2	7.934E–3	4.567E–3	5.553E–2
40	6.009E–3	4.856E–4	2.525E–1	4.673E–3	3.205E–1	1.360E–1	1.146E–1	2.132E–2	8.102E–3	4.451E–3	6.978E–2
50	5.229E–3	5.480E–4	2.515E–1	5.180E–3	3.029E–1	1.336E–1	1.181E–1	2.203E–2	8.282E–3	4.343E–3	8.291E–2
60	4.524E–3	5.934E–4	2.506E–1	5.711E–3	2.880E–1	1.308E–1	1.201E–1	2.275E–2	8.467E–3	4.240E–3	9.539E–2
					Variant 10, Production						
0	1.816E–2	0.000E+0	9.699E–2	2.226E–3	7.925E–1	1.344E–2	1.788E–1	1.991E–3			
10	1.603E–2	1.756E–5	9.654E–2	2.229E–3	7.261E–1	1.355E–2	2.037E–1	2.057E–3			
20	1.416E–2	3.217E–5	9.608E–2	2.400E–3	6.725E–1	1.349E–2	2.234E–1	2.156E–3			
30	1.247E–2	4.416E–5	9.561E–2	2.627E–3	6.271E–1	1.330E–2	2.385E–1	2.282E–3			
40	1.094E–2	5.381E–5	9.512E–2	2.878E–3	5.883E–1	1.298E–2	2.494E–1	2.428E–3			
50	9.544E–3	6.135E–5	9.460E–2	3.140E–3	5.554E–1	1.256E–2	2.568E–1	2.585E–3			
60	8.277E–3	6.699E–5	9.406E–2	3.404E–3	5.278E–1	1.206E–2	2.610E–1	2.749E–3			
					Variant 3, Absorption						
0	2.400E–1	1.005E–2	2.941E–1	2.726E–3	2.418E–1	5.858E–2	3.850E–2	2.106E–3	2.126E–2	5.128E–3	0.000E+0
					Variant 3, Production						
0	4.721E–1	1.059E–3	8.683E–2	7.107E–4	4.430E–1	1.099E–3	8.249E–2	9.759E–5			
					Variant 4, Absorption						
0	2.241E–1	9.591E–3	2.870E–1	2.538E–3	2.256E–1	5.523E–2	3.583E–2	2.019E–3	1.950E–2	4.715E–3	5.294E–2
					Variant 4, Production						
0	4.400E–1	1.045E–3	8.672E–2	6.923E–4	4.131E–1	1.096E–3	7.676E–2	9.743E–5			
					Variant 7, Absorption						
0	1.597E–2	0.000E+0	2.790E–1	0.000E+0	6.392E–1	0.000E+0	0.000E+0	0.000E+0	1.108E–2	2.721E–3	0.000E+0
					Variant 7, Production						
0	3.058E–2	0.000E+0	9.023E–2	0.000E+0	1.183E+0	0.000E+0	0.000E+0	0.000E+0			
					Variant 8, Absorption						
0	5.125E–1	0.000E+0	3.071E–1	0.000E+0	0.000E+0	6.655E–2	0.000E+0	0.000E+0	2.557E–2	6.200E–3	0.000E+0
					Variant 8, Production						
0	1.016E+0	0.000E+0	8.779E–2	0.000E+0	0.000E+0	1.268E–3	0.000E+0	0.000E+0			

Table 4.145. (continued)

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Variant 9, Absorption						
0	1.521E–2	0.000E+0	2.712E–1	0.000E+0	0.000E+0	0.000E+0	6.510E–1	0.000E+0	9.843E–3	2.459E–3	0.000E+0
					Variant 9, Production						
0	2.908E–2	0.000E+0	9.038E–2	0.000E+0	0.000E+0	0.000E+0	1.400E+0	0.000E+0			

Table 4.146. Absorption and production microscopic cross sections (b) of main isotopes, Variant 11, State 1

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 1, Absorption						
0	4.984E+1	8.976E+0	1.015E+0	3.199E+1	1.653E+2	2.095E+2	1.501E+2	2.891E+1	1.889E+5	5.880E+3	0.000E+0
10	4.736E+1	8.064E+0	1.015E+0	3.058E+1	1.470E+2	1.620E+2	1.381E+2	2.893E+1	1.789E+5	5.541E+3	4.393E+0
20	4.704E+1	7.523E+0	1.018E+0	3.054E+1	1.408E+2	1.248E+2	1.347E+2	2.849E+1	1.786E+5	5.502E+3	4.035E+0
30	4.773E+1	7.176E+0	1.023E+0	3.116E+1	1.397E+2	1.051E+2	1.352E+2	2.753E+1	1.830E+5	5.609E+3	3.819E+0
40	4.887E+1	6.948E+0	1.028E+0	3.206E+1	1.409E+2	9.403E+1	1.375E+2	2.619E+1	1.894E+5	5.782E+3	3.653E+0
50	5.020E+1	6.807E+0	1.034E+0	3.307E+1	1.433E+2	8.752E+1	1.406E+2	2.471E+1	1.967E+5	5.981E+3	3.488E+0
60	5.147E+1	6.727E+0	1.039E+0	3.403E+1	1.460E+2	8.361E+1	1.438E+2	2.327E+1	2.036E+5	6.173E+3	3.286E+0
					Pin 1, Production						
0	9.927E+1	7.968E–1	2.865E–1	7.034E+0	3.007E+2	1.894E+0	3.203E+2	1.240E+0			
10	9.412E+1	7.811E–1	2.922E–1	6.965E+0	2.687E+2	1.895E+0	2.953E+2	1.260E+0			
20	9.341E+1	7.705E–1	2.950E–1	6.984E+0	2.582E+2	1.886E+0	2.884E+2	1.269E+0			
30	9.483E+1	7.627E–1	2.963E–1	7.044E+0	2.569E+2	1.879E+0	2.898E+2	1.272E+0			
40	9.718E+1	7.572E–1	2.970E–1	7.122E+0	2.596E+2	1.873E+0	2.949E+2	1.272E+0			
50	9.992E+1	7.536E–1	2.973E–1	7.205E+0	2.643E+2	1.868E+0	3.017E+2	1.272E+0			
60	1.026E+2	7.515E–1	2.976E–1	7.283E+0	2.695E+2	1.864E+0	3.087E+2	1.271E+0			
					Pin 29, Absorption						
0	4.587E+1	8.794E+0	9.950E–1	2.914E+1	1.546E+2	2.063E+2	1.388E+2	2.858E+1	1.687E+5	5.291E+3	0.000E+0
10	4.321E+1	7.896E+0	9.944E–1	2.761E+1	1.352E+2	1.588E+2	1.260E+2	2.858E+1	1.579E+5	4.931E+3	4.219E+0
20	4.273E+1	7.364E+0	9.971E–1	2.747E+1	1.285E+2	1.215E+2	1.222E+2	2.814E+1	1.570E+5	4.876E+3	3.874E+0
30	4.328E+1	7.022E+0	1.001E+0	2.798E+1	1.269E+2	1.017E+2	1.223E+2	2.716E+1	1.607E+5	4.967E+3	3.673E+0
40	4.433E+1	6.799E+0	1.006E+0	2.882E+1	1.279E+2	9.057E+1	1.243E+2	2.583E+1	1.668E+5	5.129E+3	3.518E+0
50	4.558E+1	6.659E+0	1.012E+0	2.978E+1	1.301E+2	8.397E+1	1.273E+2	2.435E+1	1.738E+5	5.323E+3	3.375E+0
60	4.682E+1	6.579E+0	1.017E+0	3.073E+1	1.326E+2	7.999E+1	1.304E+2	2.291E+1	1.806E+5	5.514E+3	3.223E+0
					Pin 29, Production						
0	9.110E+1	7.997E–1	2.906E–1	6.828E+0	2.806E+2	1.921E+0	2.960E+2	1.260E+0			
10	8.555E+1	7.850E–1	2.966E–1	6.751E+0	2.467E+2	1.924E+0	2.694E+2	1.281E+0			
20	8.453E+1	7.751E–1	2.996E–1	6.764E+0	2.352E+2	1.916E+0	2.616E+2	1.291E+0			
30	8.564E+1	7.680E–1	3.012E–1	6.817E+0	2.329E+2	1.910E+0	2.620E+2	1.295E+0			
40	8.780E+1	7.630E–1	3.020E–1	6.889E+0	2.352E+2	1.905E+0	2.665E+2	1.297E+0			
50	9.040E+1	7.596E–1	3.025E–1	6.970E+0	2.396E+2	1.901E+0	2.730E+2	1.296E+0			
60	9.298E+1	7.577E–1	3.029E–1	7.046E+0	2.446E+2	1.898E+0	2.798E+2	1.296E+0			

Table 4.146. (continued)

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{38}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 72, Absorption						
0	4.821E+1	8.898E+0	1.006E+0	3.080E+1	1.611E+2	2.087E+2	1.456E+2	2.882E+1	1.805E+5	5.640E+3	0.000E+0
10	4.579E+1	7.987E+0	1.006E+0	2.945E+1	1.426E+2	1.609E+2	1.336E+2	2.882E+1	1.710E+5	5.317E+3	4.326E+0
20	4.548E+1	7.450E+0	1.009E+0	2.943E+1	1.364E+2	1.236E+2	1.303E+2	2.838E+1	1.709E+5	5.285E+3	3.976E+0
30	4.623E+1	7.106E+0	1.014E+0	3.008E+1	1.354E+2	1.040E+2	1.309E+2	2.741E+1	1.756E+5	5.403E+3	3.770E+0
40	4.747E+1	6.882E+0	1.020E+0	3.106E+1	1.369E+2	9.292E+1	1.335E+2	2.608E+1	1.826E+5	5.592E+3	3.607E+0
50	4.888E+1	6.741E+0	1.026E+0	3.214E+1	1.395E+2	8.644E+1	1.369E+2	2.460E+1	1.904E+5	5.808E+3	3.454E+0
60	5.022E+1	6.662E+0	1.031E+0	3.315E+1	1.423E+2	8.256E+1	1.403E+2	2.316E+1	1.977E+5	6.011E+3	3.286E+0
					Pin 72, Production						
0	9.590E+1	7.972E–1	2.877E–1	6.945E+0	2.928E+2	1.904E+0	3.106E+2	1.247E+0			
10	9.087E+1	7.817E–1	2.935E–1	6.881E+0	2.605E+2	1.906E+0	2.856E+2	1.268E+0			
20	9.021E+1	7.712E–1	2.962E–1	6.902E+0	2.500E+2	1.897E+0	2.789E+2	1.277E+0			
30	9.173E+1	7.635E–1	2.975E–1	6.965E+0	2.488E+2	1.889E+0	2.805E+2	1.280E+0			
40	9.429E+1	7.579E–1	2.981E–1	7.047E+0	2.520E+2	1.882E+0	2.862E+2	1.280E+0			
50	9.722E+1	7.541E–1	2.984E–1	7.136E+0	2.572E+2	1.877E+0	2.936E+2	1.279E+0			
60	1.000E+2	7.519E–1	2.985E–1	7.217E+0	2.628E+2	1.873E+0	3.010E+2	1.277E+0			

Table 4.147. Absorption and production microscopic cross sections (b) of main isotopes, Variant 11, State 2

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 1, Absorption						
0	4.559E+1	8.812E+0	9.950E–1	2.912E+1	1.507E+2	1.996E+2	1.365E+2	2.801E+1	1.683E+5	5.242E+3	0.000E+0
10	4.392E+1	7.891E+0	9.954E–1	2.826E+1	1.358E+2	1.539E+2	1.274E+2	2.792E+1	1.625E+5	5.036E+3	4.167E+0
20	4.363E+1	7.362E+0	9.986E–1	2.823E+1	1.302E+2	1.184E+2	1.243E+2	2.750E+1	1.623E+5	5.002E+3	3.834E+0
30	4.425E+1	7.024E+0	1.003E+0	2.877E+1	1.291E+2	9.962E+1	1.247E+2	2.657E+1	1.661E+5	5.096E+3	3.628E+0
40	4.524E+1	6.803E+0	1.008E+0	2.956E+1	1.301E+2	8.903E+1	1.267E+2	2.529E+1	1.717E+5	5.244E+3	3.470E+0
50	4.638E+1	6.667E+0	1.013E+0	3.043E+1	1.321E+2	8.280E+1	1.293E+2	2.388E+1	1.779E+5	5.414E+3	3.311E+0
60	4.747E+1	6.591E+0	1.018E+0	3.125E+1	1.343E+2	7.906E+1	1.321E+2	2.250E+1	1.838E+5	5.577E+3	3.118E+0
					Pin 1, Production						
0	9.053E+1	8.044E–1	2.926E–1	6.847E+0	2.740E+2	1.931E+0	2.913E+2	1.270E+0			
10	8.705E+1	7.875E–1	2.977E–1	6.815E+0	2.481E+2	1.929E+0	2.724E+2	1.288E+0			
20	8.643E+1	7.770E–1	3.004E–1	6.834E+0	2.386E+2	1.920E+0	2.663E+2	1.296E+0			
30	8.767E+1	7.695E–1	3.017E–1	6.887E+0	2.372E+2	1.914E+0	2.674E+2	1.299E+0			
40	8.971E+1	7.643E–1	3.025E–1	6.956E+0	2.394E+2	1.909E+0	2.717E+2	1.300E+0			
50	9.207E+1	7.610E–1	3.029E–1	7.028E+0	2.435E+2	1.904E+0	2.775E+2	1.300E+0			
60	9.432E+1	7.593E–1	3.033E–1	7.095E+0	2.478E+2	1.901E+0	2.834E+2	1.299E+0			
					Pin 29, Absorption						
0	3.838E+1	8.444E+0	9.601E–1	2.412E+1	1.282E+2	1.860E+2	1.145E+2	2.661E+1	1.327E+5	4.174E+3	0.000E+0
10	3.640E+1	7.570E+0	9.599E–1	2.302E+1	1.128E+2	1.426E+2	1.047E+2	2.655E+1	1.252E+5	3.918E+3	3.766E+0
20	3.597E+1	7.061E+0	9.623E–1	2.288E+1	1.071E+2	1.087E+2	1.014E+2	2.612E+1	1.242E+5	3.868E+3	3.469E+0
30	3.634E+1	6.737E+0	9.660E–1	2.323E+1	1.056E+2	9.073E+1	1.012E+2	2.522E+1	1.268E+5	3.928E+3	3.290E+0
40	3.708E+1	6.528E+0	9.702E–1	2.382E+1	1.060E+2	8.056E+1	1.026E+2	2.400E+1	1.311E+5	4.042E+3	3.148E+0
50	3.798E+1	6.398E+0	9.747E–1	2.452E+1	1.075E+2	7.451E+1	1.046E+2	2.264E+1	1.361E+5	4.180E+3	3.016E+0
60	3.887E+1	6.325E+0	9.790E–1	2.519E+1	1.093E+2	7.084E+1	1.068E+2	2.132E+1	1.410E+5	4.315E+3	2.877E+0
					Pin 29, Production						
0	7.567E+1	8.076E–1	2.997E–1	6.501E+0	2.323E+2	1.972E+0	2.443E+2	1.303E+0			
10	7.157E+1	7.922E–1	3.050E–1	6.452E+0	2.054E+2	1.973E+0	2.238E+2	1.322E+0			
20	7.064E+1	7.826E–1	3.078E–1	6.461E+0	1.956E+2	1.966E+0	2.171E+2	1.331E+0			
30	7.137E+1	7.761E–1	3.094E–1	6.501E+0	1.933E+2	1.962E+0	2.169E+2	1.335E+0			
40	7.289E+1	7.717E–1	3.104E–1	6.555E+0	1.946E+2	1.958E+0	2.199E+2	1.337E+0			
50	7.475E+1	7.691E–1	3.111E–1	6.614E+0	1.976E+2	1.956E+0	2.244E+2	1.338E+0			
60	7.660E+1	7.678E–1	3.117E–1	6.671E+0	2.011E+2	1.954E+0	2.292E+2	1.338E+0			

Table 4.147. (continued)

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 72, Absorption						
0	3.126E+1	8.019E+0	9.259E–1	1.939E+1	1.027E+2	1.633E+2	9.140E+1	2.423E+1	9.933E+4	3.138E+3	0.000E+0
10	2.957E+1	7.206E+0	9.265E–1	1.843E+1	8.999E+1	1.249E+2	8.318E+1	2.419E+1	9.259E+4	2.912E+3	3.273E+0
20	2.927E+1	6.729E+0	9.290E–1	1.833E+1	8.560E+1	9.486E+1	8.072E+1	2.379E+1	9.200E+4	2.878E+3	3.032E+0
30	2.955E+1	6.429E+0	9.326E–1	1.860E+1	8.445E+1	7.901E+1	8.059E+1	2.299E+1	9.395E+4	2.924E+3	2.876E+0
40	3.011E+1	6.237E+0	9.366E–1	1.903E+1	8.481E+1	7.003E+1	8.157E+1	2.189E+1	9.709E+4	3.007E+3	2.746E+0
50	3.076E+1	6.120E+0	9.406E–1	1.952E+1	8.587E+1	6.469E+1	8.303E+1	2.067E+1	1.006E+5	3.104E+3	2.625E+0
60	3.137E+1	6.055E+0	9.444E–1	1.999E+1	8.711E+1	6.143E+1	8.454E+1	1.948E+1	1.040E+5	3.196E+3	2.493E+0
					Pin 72, Production						
0	6.106E+1	8.091E–1	3.071E–1	6.196E+0	1.856E+2	2.009E+0	1.951E+2	1.335E+0			
10	5.753E+1	7.939E–1	3.116E–1	6.151E+0	1.635E+2	2.008E+0	1.780E+2	1.350E+0			
20	5.687E+1	7.845E–1	3.141E–1	6.161E+0	1.560E+2	2.001E+0	1.730E+2	1.358E+0			
30	5.743E+1	7.784E–1	3.156E–1	6.193E+0	1.542E+2	1.996E+0	1.728E+2	1.362E+0			
40	5.856E+1	7.745E–1	3.166E–1	6.234E+0	1.552E+2	1.994E+0	1.750E+2	1.363E+0			
50	5.989E+1	7.724E–1	3.174E–1	6.277E+0	1.573E+2	1.992E+0	1.782E+2	1.365E+0			
60	6.116E+1	7.716E–1	3.181E–1	6.317E+0	1.597E+2	1.991E+0	1.815E+2	1.366E+0			

Table 4.148. Absorption and production reaction rates, Variant 11, State 1

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 1, Absorption						
0	6.185E–1	0.000E+0	2.702E–1	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	2.537E–2	5.803E–3	0.000E+0
10	4.336E–1	4.480E–3	2.657E–1	4.370E–5	1.369E–1	2.016E–2	5.846E–3	8.268E–5	2.376E–2	5.395E–3	2.649E–2
20	3.160E–1	7.298E–3	2.654E–1	2.600E–4	1.941E–1	4.025E–2	2.160E–2	7.118E–4	2.230E–2	4.983E–3	4.821E–2
30	2.295E–1	9.176E–3	2.668E–1	7.583E–4	2.222E–1	5.466E–2	3.882E–2	2.082E–3	2.112E–2	4.638E–3	6.821E–2
40	1.621E–1	1.039E–2	2.684E–1	1.612E–3	2.364E–1	6.536E–2	5.388E–2	4.013E–3	2.003E–2	4.328E–3	8.694E–2
50	1.097E–1	1.107E–2	2.698E–1	2.828E–3	2.432E–1	7.326E–2	6.561E–2	6.219E–3	1.902E–2	4.054E–3	1.037E–1
60	7.058E–2	1.134E–2	2.707E–1	4.322E–3	2.459E–1	7.888E–2	7.396E–2	8.454E–3	1.816E–2	3.826E–3	1.172E–1
					Pin 1, Production						
0	1.232E+0	0.000E+0	7.628E–2	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0			
10	8.615E–1	4.340E–4	7.649E–2	9.954E–6	2.503E–1	2.358E–4	1.250E–2	3.602E–6			
20	6.275E–1	7.474E–4	7.689E–2	5.946E–5	3.559E–1	6.082E–4	4.625E–2	3.170E–5			
30	4.559E–1	9.752E–4	7.725E–2	1.714E–4	4.084E–1	9.767E–4	8.320E–2	9.621E–5			
40	3.223E–1	1.132E–3	7.753E–2	3.581E–4	4.354E–1	1.302E–3	1.155E–1	1.950E–4			
50	2.184E–1	1.226E–3	7.759E–2	6.161E–4	4.486E–1	1.563E–3	1.408E–1	3.200E–4			
60	1.406E–1	1.267E–3	7.752E–2	9.248E–4	4.541E–1	1.759E–3	1.587E–1	4.616E–4			
					Pin 29, Absorption						
0	6.08E–01	0.00E+00	2.83E–01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.41E–02	5.72E–03	0.00E+00
10	4.33E–01	4.36E–03	2.77E–01	3.81E–05	1.34E–01	1.93E–02	5.15E–03	7.13E–05	2.28E–02	5.38E–03	2.49E–02
20	3.21E–01	7.14E–03	2.75E–01	2.22E–04	1.92E–01	3.88E–02	1.94E–02	6.20E–04	2.16E–02	5.01E–03	4.53E–02
30	2.39E–01	9.00E–03	2.74E–01	6.45E–04	2.21E–01	5.30E–02	3.56E–02	1.84E–03	2.07E–02	4.70E–03	6.42E–02
40	1.74E–01	1.03E–02	2.73E–01	1.38E–03	2.37E–01	6.37E–02	5.04E–02	3.59E–03	1.99E–02	4.42E–03	8.20E–02
50	1.23E–01	1.10E–02	2.73E–01	2.44E–03	2.44E–01	7.19E–02	6.25E–02	5.64E–03	1.90E–02	4.16E–03	9.84E–02
60	8.24E–02	1.14E–02	2.72E–01	3.80E–03	2.47E–01	7.78E–02	7.16E–02	7.78E–03	1.82E–02	3.93E–03	1.13E–01
					Pin 29, Production						
0	1.21E+00	0.00E+00	8.26E–02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
10	8.57E–01	4.34E–04	8.27E–02	9.30E–06	2.44E–01	2.34E–04	1.10E–02	3.19E–06			
20	6.36E–01	7.51E–04	8.25E–02	5.47E–05	3.51E–01	6.12E–04	4.15E–02	2.85E–05			
30	4.73E–01	9.85E–04	8.23E–02	1.57E–04	4.06E–01	9.95E–04	7.62E–02	8.75E–05			
40	3.45E–01	1.15E–03	8.20E–02	3.29E–04	4.35E–01	1.34E–03	1.08E–01	1.80E–04			
50	2.43E–01	1.26E–03	8.16E–02	5.72E–04	4.49E–01	1.63E–03	1.34E–01	3.00E–04			
60	1.64E–01	1.31E–03	8.12E–02	8.71E–04	4.55E–01	1.85E–03	1.54E–01	4.40E–04			

Table 4.148. (continued)

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 72, Absorption						
0	6.144E–1	0.000E+0	2.751E–1	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	2.487E–2	5.768E–3	0.000E+0
10	4.338E–1	4.423E–3	2.696E–1	4.130E–5	1.357E–1	1.981E–2	5.570E–3	7.807E–5	2.342E–2	5.391E–3	2.584E–2
20	3.187E–1	7.213E–3	2.683E–1	2.445E–4	1.932E–1	3.964E–2	2.074E–2	6.750E–4	2.210E–2	4.998E–3	4.705E–2
30	2.338E–1	9.080E–3	2.686E–1	7.132E–4	2.218E–1	5.396E–2	3.761E–2	1.984E–3	2.103E–2	4.665E–3	6.667E–2
40	1.672E–1	1.030E–2	2.694E–1	1.523E–3	2.364E–1	6.471E–2	5.267E–2	3.849E–3	2.004E–2	4.365E–3	8.497E–2
50	1.148E–1	1.101E–2	2.702E–1	2.690E–3	2.434E–1	7.274E–2	6.463E–2	6.003E–3	1.909E–2	4.094E–3	1.017E–1
60	7.488E–2	1.131E–2	2.706E–1	4.140E–3	2.459E–1	7.847E–2	7.322E–2	8.209E–3	1.822E–2	3.859E–3	1.162E–1
					Pin 72, Production						
0	1.222E+0	0.000E+0	7.867E–2	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0			
10	8.609E–1	4.329E–4	7.865E–2	9.652E–6	2.479E–1	2.346E–4	1.191E–2	3.434E–6			
20	6.322E–1	7.467E–4	7.875E–2	5.733E–5	3.541E–1	6.081E–4	4.441E–2	3.036E–5			
30	4.639E–1	9.756E–4	7.878E–2	1.651E–4	4.075E–1	9.805E–4	8.060E–2	9.263E–5			
40	3.321E–1	1.134E–3	7.874E–2	3.457E–4	4.353E–1	1.311E–3	1.129E–1	1.889E–4			
50	2.282E–1	1.232E–3	7.858E–2	5.973E–4	4.488E–1	1.579E–3	1.387E–1	3.119E–4			
60	1.491E–1	1.276E–3	7.834E–2	9.013E–4	4.539E–1	1.780E–3	1.571E–1	4.527E–4			

Table 4.149. Absorption and production reaction rates, Variant 11, State 2

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 1, Absorption						
0	6.070E–1	0.000E+0	2.842E–1	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	2.425E–2	5.550E–3	0.000E+0
10	4.268E–1	4.654E–3	2.766E–1	4.287E–5	1.343E–1	2.032E–2	5.726E–3	8.473E–5	2.291E–2	5.205E–3	2.667E–2
20	3.108E–1	7.572E–3	2.760E–1	2.548E–4	1.902E–1	4.047E–2	2.114E–2	7.284E–4	2.149E–2	4.804E–3	4.856E–2
30	2.255E–1	9.518E–3	2.772E–1	7.421E–4	2.175E–1	5.489E–2	3.796E–2	2.130E–3	2.032E–2	4.465E–3	6.868E–2
40	1.590E–1	1.078E–2	2.788E–1	1.575E–3	2.313E–1	6.558E–2	5.260E–2	4.107E–3	1.924E–2	4.160E–3	8.750E–2
50	1.074E–1	1.149E–2	2.802E–1	2.758E–3	2.376E–1	7.347E–2	6.396E–2	6.369E–3	1.824E–2	3.890E–3	1.043E–1
60	6.901E–2	1.178E–2	2.811E–1	4.207E–3	2.400E–1	7.907E–2	7.199E–2	8.663E–3	1.738E–2	3.664E–3	1.179E–1
					Pin 1, Production						
0	1.205E+0	0.000E+0	8.357E–2	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0			
10	8.460E–1	4.645E–4	8.273E–2	1.034E–5	2.453E–1	2.548E–4	1.225E–2	3.908E–6			
20	6.157E–1	7.991E–4	8.301E–2	6.169E–5	3.486E–1	6.566E–4	4.527E–2	3.433E–5			
30	4.467E–1	1.043E–3	8.336E–2	1.776E–4	3.997E–1	1.054E–3	8.135E–2	1.041E–4			
40	3.153E–1	1.211E–3	8.367E–2	3.707E–4	4.256E–1	1.406E–3	1.128E–1	2.111E–4			
50	2.133E–1	1.312E–3	8.378E–2	6.370E–4	4.379E–1	1.690E–3	1.372E–1	3.467E–4			
60	1.371E–1	1.357E–3	8.375E–2	9.552E–4	4.427E–1	1.902E–3	1.545E–1	5.003E–4			
					Pin 29, Absorption						
0	5.83E–01	0.00E+00	3.13E–01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.18E–02	5.17E–03	0.00E+00
10	4.15E–01	4.77E–03	3.05E–01	3.62E–05	1.27E–01	1.98E–02	4.88E–03	7.54E–05	2.06E–02	4.87E–03	2.53E–02
20	3.08E–01	7.79E–03	3.02E–01	2.11E–04	1.82E–01	3.95E–02	1.83E–02	6.55E–04	1.95E–02	4.52E–03	4.62E–02
30	2.28E–01	9.83E–03	3.00E–01	6.09E–04	2.10E–01	5.38E–02	3.35E–02	1.94E–03	1.86E–02	4.23E–03	6.54E–02
40	1.66E–01	1.12E–02	3.00E–01	1.30E–03	2.23E–01	6.45E–02	4.73E–02	3.79E–03	1.78E–02	3.96E–03	8.35E–02
50	1.16E–01	1.20E–02	2.99E–01	2.29E–03	2.30E–01	7.26E–02	5.85E–02	5.97E–03	1.70E–02	3.72E–03	1.00E–01
60	7.79E–02	1.24E–02	2.99E–01	3.54E–03	2.31E–01	7.84E–02	6.68E–02	8.25E–03	1.62E–02	3.50E–03	1.15E–01
					Pin 29, Production						
0	1.150E+0	0.000E+0	9.772E–2	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0			
10	8.167E–1	4.990E–4	9.686E–2	1.013E–5	2.319E–1	2.736E–4	1.043E–2	3.754E–6			
20	6.046E–1	8.630E–4	9.649E–2	5.947E–5	3.327E–1	7.147E–4	3.922E–2	3.336E–5			
30	4.485E–1	1.132E–3	9.617E–2	1.704E–4	3.836E–1	1.162E–3	7.179E–2	1.026E–4			
40	3.259E–1	1.324E–3	9.587E–2	3.564E–4	4.097E–1	1.568E–3	1.014E–1	2.113E–4			
50	2.287E–1	1.447E–3	9.552E–2	6.178E–4	4.218E–1	1.905E–3	1.255E–1	3.529E–4			
60	1.535E–1	1.510E–3	9.511E–2	9.384E–4	4.256E–1	2.163E–3	1.433E–1	5.176E–4			

Table 4.149. (continued)

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 72, Absorption						
0	5.521E–1	0.000E+0	3.508E–1	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	1.896E–2	4.448E–3	0.000E+0
10	3.874E–1	5.518E–3	3.433E–1	3.574E–5	1.184E–1	2.126E–2	4.796E–3	9.060E–5	1.753E–2	4.084E–3	2.703E–2
20	2.826E–1	8.976E–3	3.403E–1	2.098E–4	1.670E–1	4.191E–2	1.771E–2	7.796E–4	1.639E–2	3.749E–3	4.943E–2
30	2.055E–1	1.130E–2	3.395E–1	6.062E–4	1.902E–1	5.639E–2	3.184E–2	2.288E–3	1.546E–2	3.471E–3	6.993E–2
40	1.456E–1	1.282E–2	3.396E–1	1.282E–3	2.011E–1	6.696E–2	4.419E–2	4.435E–3	1.462E–2	3.222E–3	8.883E–2
50	9.901E–2	1.371E–2	3.397E–1	2.241E–3	2.054E–1	7.464E–2	5.376E–2	6.916E–3	1.383E–2	3.000E–3	1.060E–1
60	6.406E–2	1.408E–2	3.394E–1	3.418E–3	2.061E–1	7.995E–2	6.043E–2	9.453E–3	1.312E–2	2.810E–3	1.207E–1
					Pin 72, Production						
0	1.078E+0	0.000E+0	1.164E–1	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0			
10	7.538E–1	6.080E–4	1.155E–1	1.193E–5	2.151E–1	3.418E–4	1.026E–2	5.058E–6			
20	5.491E–1	1.047E–3	1.150E–1	7.051E–5	3.044E–1	8.838E–4	3.795E–2	4.449E–5			
30	3.994E–1	1.368E–3	1.149E–1	2.019E–4	3.474E–1	1.425E–3	6.828E–2	1.355E–4			
40	2.832E–1	1.592E–3	1.148E–1	4.198E–4	3.679E–1	1.906E–3	9.482E–2	2.763E–4			
50	1.928E–1	1.730E–3	1.146E–1	7.205E–4	3.763E–1	2.299E–3	1.154E–1	4.565E–4			
60	1.249E–1	1.794E–3	1.143E–1	1.080E–3	3.778E–1	2.592E–3	1.298E–1	6.627E–4			

Table 4.150. Absorption and production reaction rates, Variant 12, State 1

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 1, Absorption						
0	1.490E–2	0.000E+0	2.400E–1	0.000E+0	6.122E–1	5.220E–2	6.905E–3	0.000E+0	1.941E–2	5.313E–3	0.000E+0
10	1.319E–2	1.715E–4	2.434E–1	1.816E–5	5.086E–1	8.845E–2	3.719E–2	1.039E–3	1.918E–2	4.978E–3	2.754E–2
20	1.146E–2	3.188E–4	2.489E–1	1.064E–4	4.232E–1	1.071E–1	7.073E–2	3.480E–3	1.881E–2	4.661E–3	4.984E–2
30	9.527E–3	4.390E–4	2.547E–1	3.258E–4	3.539E–1	1.164E–1	9.833E–2	6.823E–3	1.840E–2	4.405E–3	6.989E–2
40	7.471E–3	5.266E–4	2.589E–1	7.131E–4	3.041E–1	1.184E–1	1.145E–1	1.031E–2	1.793E–2	4.173E–3	9.032E–2
50	5.472E–3	5.775E–4	2.604E–1	1.234E–3	2.720E–1	1.149E–1	1.186E–1	1.333E–2	1.735E–2	3.946E–3	1.134E–1
60	3.812E–3	6.006E–4	2.623E–1	1.823E–3	2.565E–1	1.100E–1	1.161E–1	1.579E–2	1.700E–2	3.783E–3	1.269E–1
					Pin 1, Production						
0	2.873E–2	0.000E+0	7.675E–2	0.000E+0	1.134E+0	1.078E–3	1.486E–2	0.000E+0			
10	2.556E–2	1.590E–5	7.708E–2	5.608E–6	9.407E–1	2.632E–3	8.004E–2	4.747E–5			
20	2.232E–2	2.989E–5	7.782E–2	3.077E–5	7.819E–1	3.561E–3	1.521E–1	1.688E–4			
30	1.866E–2	4.153E–5	7.859E–2	8.857E–5	6.534E–1	3.976E–3	2.114E–1	3.595E–4			
40	1.469E–2	5.011E–5	7.883E–2	1.835E–4	5.612E–1	3.983E–3	2.461E–1	5.934E–4			
50	1.080E–2	5.521E–5	7.834E–2	3.039E–4	5.019E–1	3.731E–3	2.547E–1	8.323E–4			
60	7.543E–3	5.764E–5	7.804E–2	4.318E–4	4.735E–1	3.409E–3	2.493E–1	1.056E–3			
					Pin 29, Absorption						
0	1.471E–2	0.000E+0	2.607E–1	0.000E+0	5.907E–1	5.595E–2	6.694E–3	0.000E+0	1.733E–2	5.162E–3	0.000E+0
10	1.304E–2	1.686E–4	2.602E–1	1.615E–5	5.085E–1	8.598E–2	3.328E–2	9.254E–4	1.774E–2	4.975E–3	2.558E–2
20	1.138E–2	3.100E–4	2.601E–1	9.150E–5	4.363E–1	1.031E–1	6.258E–2	3.005E–3	1.784E–2	4.709E–3	4.631E–2
30	9.615E–3	4.240E–4	2.608E–1	2.752E–4	3.727E–1	1.130E–1	8.860E–2	5.858E–3	1.777E–2	4.474E–3	6.581E–2
40	7.779E–3	5.094E–4	2.613E–1	6.056E–4	3.219E–1	1.170E–1	1.070E–1	8.971E–3	1.755E–2	4.256E–3	8.485E–2
50	5.989E–3	5.669E–4	2.622E–1	1.080E–3	2.865E–1	1.165E–1	1.161E–1	1.195E–2	1.724E–2	4.059E–3	1.020E–1
60	4.368E–3	5.960E–4	2.624E–1	1.640E–3	2.643E–1	1.127E–1	1.170E–1	1.452E–2	1.686E–2	3.878E–3	1.187E–1
					Pin 29, Production						
0	2.813E–2	0.000E+0	8.593E–2	0.000E+0	1.093E+0	1.208E–3	1.441E–2	0.000E+0			
10	2.506E–2	1.602E–5	8.520E–2	5.553E–6	9.392E–1	2.706E–3	7.163E–2	4.346E–5			
20	2.201E–2	2.985E–5	8.434E–2	2.946E–5	8.051E–1	3.669E–3	1.346E–1	1.503E–4			
30	1.870E–2	4.125E–5	8.365E–2	8.310E–5	6.871E–1	4.168E–3	1.906E–1	3.192E–4			
40	1.520E–2	4.990E–5	8.282E–2	1.722E–4	5.934E–1	4.273E–3	2.300E–1	5.351E–4			
50	1.175E–2	5.582E–5	8.216E–2	2.918E–4	5.280E–1	4.114E–3	2.495E–1	7.753E–4			
60	8.600E–3	5.894E–5	8.137E–2	4.247E–4	4.873E–1	3.801E–3	2.513E–1	1.010E–3			

Table 4.150. (continued)

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{42}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 72, Absorption						
0	1.484E–2	0.000E+0	2.483E–1	0.000E+0	6.034E–1	5.383E–2	6.824E–3	0.000E+0	1.857E–2	5.251E–3	0.000E+0
10	1.315E–2	1.698E–4	2.496E–1	1.729E–5	5.093E–1	8.730E–2	3.556E–2	9.908E–4	1.867E–2	4.982E–3	2.671E–2
20	1.145E–2	3.140E–4	2.524E–1	1.002E–4	4.294E–1	1.054E–1	6.744E–2	3.277E–3	1.852E–2	4.686E–3	4.836E–2
30	9.300E–3	4.191E–4	2.490E–1	2.956E–4	3.509E–1	1.111E–1	9.155E–2	6.232E–3	1.766E–2	4.301E–3	9.456E–2
40	7.439E–3	5.050E–4	2.526E–1	6.529E–4	3.036E–1	1.148E–1	1.089E–1	9.498E–3	1.740E–2	4.103E–3	1.092E–1
50	5.551E–3	5.574E–4	2.539E–1	1.144E–3	2.701E–1	1.129E–1	1.149E–1	1.244E–2	1.690E–2	3.886E–3	1.299E–1
60	3.973E–3	5.853E–4	2.566E–1	1.728E–3	2.544E–1	1.093E–1	1.149E–1	1.498E–2	1.671E–2	3.751E–3	1.383E–1
					Pin 72, Production						
0	2.851E–2	0.000E+0	8.038E–2	0.000E+0	1.117E+0	1.130E–3	1.469E–2	0.000E+0			
10	2.540E–2	1.591E–5	8.007E–2	5.562E–6	9.417E–1	2.657E–3	7.654E–2	4.571E–5			
20	2.226E–2	2.975E–5	7.998E–2	3.009E–5	7.932E–1	3.595E–3	1.451E–1	1.607E–4			
30	1.817E–2	4.012E–5	7.799E–2	8.350E–5	6.476E–1	3.938E–3	1.969E–1	3.327E–4			
40	1.460E–2	4.861E–5	7.804E–2	1.737E–4	5.602E–1	4.000E–3	2.340E–1	5.538E–4			
50	1.094E–2	5.390E–5	7.746E–2	2.902E–4	4.982E–1	3.786E–3	2.468E–1	7.874E–4			
60	7.854E–3	5.679E–5	7.731E–2	4.193E–4	4.696E–1	3.485E–3	2.468E–1	1.015E–3			

Table 4.151. Absorption and production reaction rates, Variant 12, State 2

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 1, Absorption						
0	1.484E–2	0.000E+0	2.484E–1	0.000E+0	6.047E–1	5.216E–2	6.831E–3	0.000E+0	1.887E–2	5.167E–3	0.000E+0
10	1.311E–2	1.755E–4	2.512E–1	1.801E–5	5.023E–1	8.812E–2	3.677E–2	1.050E–3	1.869E–2	4.854E–3	2.769E–2
20	1.136E–2	3.266E–4	2.569E–1	1.053E–4	4.172E–1	1.067E–1	6.976E–2	3.520E–3	1.828E–2	4.534E–3	5.015E–2
30	9.423E–3	4.504E–4	2.630E–1	3.213E–4	3.483E–1	1.160E–1	9.675E–2	6.913E–3	1.785E–2	4.273E–3	7.034E–2
40	7.371E–3	5.411E–4	2.675E–1	7.012E–4	2.987E–1	1.180E–1	1.124E–1	1.047E–2	1.733E–2	4.038E–3	9.085E–2
50	5.387E–3	5.945E–4	2.692E–1	1.210E–3	2.667E–1	1.146E–1	1.162E–1	1.356E–2	1.674E–2	3.809E–3	1.139E–1
60	3.744E–3	6.193E–4	2.714E–1	1.784E–3	2.511E–1	1.098E–1	1.135E–1	1.609E–2	1.636E–2	3.642E–3	1.275E–1
					Pin 1, Production						
0	2.853E–2	0.000E+0	8.162E–2	0.000E+0	1.120E+0	1.147E–3	1.471E–2	0.000E+0			
10	2.535E–2	1.671E–5	8.182E–2	5.823E–6	9.288E–1	2.798E–3	7.916E–2	5.055E–5			
20	2.209E–2	3.147E–5	8.272E–2	3.191E–5	7.706E–1	3.791E–3	1.501E–1	1.800E–4			
30	1.841E–2	4.378E–5	8.367E–2	9.175E–5	6.427E–1	4.240E–3	2.081E–1	3.840E–4			
40	1.446E–2	5.294E–5	8.410E–2	1.899E–4	5.509E–1	4.256E–3	2.417E–1	6.352E–4			
50	1.060E–2	5.844E–5	8.375E–2	3.143E–4	4.919E–1	3.995E–3	2.496E–1	8.927E–4			
60	7.390E–3	6.113E–5	8.359E–2	4.462E–4	4.633E–1	3.658E–3	2.438E–1	1.135E–3			
					Pin 29, Absorption						
0	1.453E–2	0.000E+0	2.835E–1	0.000E+0	5.703E–1	5.606E–2	6.487E–3	0.000E+0	1.585E–2	4.739E–3	0.000E+0
10	1.280E–2	1.797E–4	2.829E–1	1.570E–5	4.891E–1	8.604E–2	3.208E–2	9.568E–4	1.617E–2	4.550E–3	2.603E–2
20	1.110E–2	3.315E–4	2.832E–1	8.834E–5	4.179E–1	1.031E–1	5.997E–2	3.118E–3	1.618E–2	4.286E–3	4.728E–2
30	9.320E–3	4.549E–4	2.841E–1	2.638E–4	3.554E–1	1.129E–1	8.441E–2	6.099E–3	1.605E–2	4.053E–3	6.723E–2
40	7.493E–3	5.483E–4	2.850E–1	5.767E–4	3.057E–1	1.169E–1	1.014E–1	9.372E–3	1.578E–2	3.837E–3	8.658E–2
50	5.737E–3	6.117E–4	2.861E–1	1.023E–3	2.710E–1	1.164E–1	1.095E–1	1.252E–2	1.544E–2	3.645E–3	1.039E–1
60	4.163E–3	6.451E–4	2.867E–1	1.544E–3	2.491E–1	1.126E–1	1.098E–1	1.525E–2	1.504E–2	3.467E–3	1.206E–1
					Pin 29, Production						
0	2.757E–2	0.000E+0	9.777E–2	0.000E+0	1.054E+0	1.375E–3	1.398E–2	0.000E+0			
10	2.442E–2	1.792E–5	9.709E–2	6.080E–6	9.022E–1	3.089E–3	6.913E–2	4.969E–5			
20	2.130E–2	3.350E–5	9.642E–2	3.219E–5	7.699E–1	4.202E–3	1.291E–1	1.724E–4			
30	1.798E–2	4.646E–5	9.593E–2	9.060E–5	6.541E–1	4.789E–3	1.817E–1	3.674E–4			
40	1.453E–2	5.641E–5	9.533E–2	1.873E–4	5.624E–1	4.928E–3	2.181E–1	6.181E–4			
50	1.117E–2	6.328E–5	9.483E–2	3.165E–4	4.984E–1	4.757E–3	2.354E–1	8.981E–4			
60	8.130E–3	6.705E–5	9.426E–2	4.598E–4	4.582E–1	4.410E–3	2.360E–1	1.174E–3			

Table 4.151. (continued)

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 72, Absorption						
0	1.428E–2	0.000E+0	3.139E–1	0.000E+0	5.434E–1	5.585E–2	6.211E–3	0.000E+0	1.410E–2	4.055E–3	0.000E+0
10	1.239E–2	2.043E–4	3.153E–1	1.577E–5	4.516E–1	8.951E–2	3.173E–2	1.111E–3	1.395E–2	3.781E–3	2.830E–2
20	1.058E–2	3.790E–4	3.182E–1	8.953E–5	3.760E–1	1.069E–1	5.914E–2	3.685E–3	1.371E–2	3.519E–3	5.150E–2
30	8.442E–3	5.075E–4	3.133E–1	2.592E–4	3.037E–1	1.118E–1	7.904E–2	7.029E–3	1.296E–2	3.199E–3	9.849E–2
40	6.643E–3	6.137E–4	3.175E–1	5.628E–4	2.601E–1	1.149E–1	9.273E–2	1.075E–2	1.268E–2	3.027E–3	1.137E–1
50	4.897E–3	6.802E–4	3.189E–1	9.735E–4	2.297E–1	1.127E–1	9.687E–2	1.414E–2	1.225E–2	2.850E–3	1.334E–1
60	3.461E–3	7.163E–4	3.218E–1	1.452E–3	2.147E–1	1.089E–1	9.592E–2	1.707E–2	1.204E–2	2.733E–3	1.425E–1
					Pin 72, Production						
0	2.682E–2	0.000E+0	1.132E–1	0.000E+0	1.002E+0	1.589E–3	1.341E–2	0.000E+0			
10	2.338E–2	2.146E–5	1.130E–1	7.075E–6	8.311E–1	3.752E–3	6.847E–2	6.477E–5			
20	2.009E–2	4.028E–5	1.132E–1	3.790E–5	6.908E–1	5.094E–3	1.275E–1	2.283E–4			
30	1.611E–2	5.450E–5	1.108E–1	1.042E–4	5.574E–1	5.598E–3	1.703E–1	4.743E–4			
40	1.274E–2	6.631E–5	1.113E–1	2.147E–4	4.771E–1	5.709E–3	1.997E–1	7.926E–4			
50	9.428E–3	7.387E–5	1.110E–1	3.562E–4	4.211E–1	5.427E–3	2.084E–1	1.132E–3			
60	6.687E–3	7.811E–5	1.112E–1	5.104E–4	3.937E–1	5.011E–3	2.063E–1	1.465E–3			

Table 4.152. Absorption and production microscopic cross sections (b) of main isotopes, Variant 12, State 1

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 1, Absorption						
0	3.026E+1	9.433E+0	9.888E–1	1.882E+1	7.245E+1	9.615E+1	7.663E+1	3.039E+1	9.332E+4	2.910E+3	0.000E+0
10	3.239E+1	9.206E+0	9.947E–1	2.042E+1	8.062E+1	6.581E+1	8.375E+1	2.940E+1	1.050E+5	3.252E+3	5.095E+0
20	3.500E+1	9.006E+0	1.001E+0	2.231E+1	9.020E+1	5.837E+1	9.211E+1	2.751E+1	1.186E+5	3.654E+3	4.560E+0
30	3.771E+1	8.839E+0	1.008E+0	2.425E+1	1.000E+2	5.640E+1	1.007E+2	2.515E+1	1.327E+5	4.069E+3	4.204E+0
40	4.038E+1	8.709E+0	1.015E+0	2.615E+1	1.093E+2	5.688E+1	1.091E+2	2.287E+1	1.465E+5	4.475E+3	4.034E+0
50	4.274E+1	8.604E+0	1.021E+0	2.783E+1	1.173E+2	5.864E+1	1.165E+2	2.094E+1	1.587E+5	4.836E+3	4.047E+0
60	4.496E+1	8.516E+0	1.028E+0	2.943E+1	1.244E+2	6.116E+1	1.233E+2	1.945E+1	1.703E+5	5.175E+3	3.751E+0
					Pin 1, Production						
0	5.833E+1	8.623E–1	3.163E–1	6.181E+0	1.342E+2	1.985E+0	1.650E+2	1.349E+0			
10	6.276E+1	8.537E–1	3.150E–1	6.308E+0	1.491E+2	1.958E+0	1.802E+2	1.343E+0			
20	6.820E+1	8.445E–1	3.130E–1	6.449E+0	1.667E+2	1.941E+0	1.981E+2	1.335E+0			
30	7.386E+1	8.362E–1	3.110E–1	6.592E+0	1.846E+2	1.926E+0	2.166E+2	1.325E+0			
40	7.942E+1	8.287E–1	3.090E–1	6.731E+0	2.018E+2	1.913E+0	2.345E+2	1.316E+0			
50	8.433E+1	8.226E–1	3.073E–1	6.854E+0	2.166E+2	1.903E+0	2.503E+2	1.308E+0			
60	8.896E+1	8.172E–1	3.057E–1	6.971E+0	2.297E+2	1.895E+0	2.648E+2	1.300E+0			
					Pin 29, Absorption						
0	2.698E+1	9.240E+0	9.703E–1	1.653E+1	6.314E+1	9.309E+1	6.710E+1	3.005E+1	7.707E+4	2.428E+3	0.000E+0
10	2.864E+1	9.012E+0	9.747E–1	1.780E+1	6.976E+1	6.310E+1	7.278E+1	2.904E+1	8.645E+4	2.705E+3	4.875E+0
20	3.084E+1	8.812E+0	9.800E–1	1.939E+1	7.792E+1	5.541E+1	7.986E+1	2.714E+1	9.812E+4	3.051E+3	4.378E+0
30	3.323E+1	8.644E+0	9.858E–1	2.110E+1	8.659E+1	5.312E+1	8.748E+1	2.477E+1	1.106E+5	3.423E+3	4.106E+0
40	3.570E+1	8.515E+0	9.923E–1	2.286E+1	9.532E+1	5.334E+1	9.533E+1	2.250E+1	1.235E+5	3.806E+3	3.935E+0
50	3.802E+1	8.409E+0	9.985E–1	2.451E+1	1.032E+2	5.492E+1	1.026E+2	2.057E+1	1.356E+5	4.163E+3	3.743E+0
60	4.007E+1	8.322E+0	1.004E+0	2.598E+1	1.100E+2	5.725E+1	1.090E+2	1.908E+1	1.463E+5	4.479E+3	3.604E+0
					Pin 29, Production						
0	5.159E+1	8.640E–1	3.199E–1	6.018E+0	1.168E+2	2.009E+0	1.445E+2	1.367E+0			
10	5.506E+1	8.565E–1	3.192E–1	6.121E+0	1.289E+2	1.986E+0	1.567E+2	1.364E+0			
20	5.964E+1	8.485E–1	3.178E–1	6.242E+0	1.438E+2	1.972E+0	1.718E+2	1.357E+0			
30	6.462E+1	8.410E–1	3.162E–1	6.370E+0	1.597E+2	1.960E+0	1.881E+2	1.350E+0			
40	6.978E+1	8.342E–1	3.145E–1	6.500E+0	1.757E+2	1.949E+0	2.049E+2	1.342E+0			
50	7.462E+1	8.281E–1	3.129E–1	6.621E+0	1.903E+2	1.939E+0	2.205E+2	1.334E+0			
60	7.888E+1	8.230E–1	3.115E–1	6.727E+0	2.027E+2	1.931E+0	2.341E+2	1.327E+0			

Table 4.152. (continued)

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 72, Absorption						
0	2.887E+1	9.348E+0	9.804E–1	1.785E+1	6.841E+1	9.500E+1	7.256E+1	3.029E+1	8.649E+4	2.709E+3	0.000E+0
10	3.089E+1	9.119E+0	9.858E–1	1.938E+1	7.616E+1	6.470E+1	7.932E+1	2.930E+1	9.768E+4	3.038E+3	5.009E+0
20	3.344E+1	8.919E+0	9.921E–1	2.122E+1	8.547E+1	5.722E+1	8.748E+1	2.739E+1	1.111E+5	3.435E+3	4.495E+0
30	3.597E+1	8.746E+0	9.982E–1	2.303E+1	9.473E+1	5.470E+1	9.561E+1	2.500E+1	1.244E+5	3.830E+3	5.950E+0
40	3.872E+1	8.617E+0	1.005E+0	2.499E+1	1.043E+2	5.528E+1	1.043E+2	2.272E+1	1.387E+5	4.252E+3	5.088E+0
50	4.111E+1	8.514E+0	1.012E+0	2.669E+1	1.125E+2	5.709E+1	1.118E+2	2.080E+1	1.510E+5	4.618E+3	4.819E+0
60	4.355E+1	8.424E+0	1.019E+0	2.844E+1	1.202E+2	5.976E+1	1.192E+2	1.931E+1	1.638E+5	4.991E+3	4.226E+0
					Pin 72, Production						
0	5.547E+1	8.624E–1	3.174E–1	6.110E+0	1.267E+2	1.995E+0	1.562E+2	1.356E+0			
10	5.967E+1	8.541E–1	3.163E–1	6.232E+0	1.408E+2	1.969E+0	1.707E+2	1.352E+0			
20	6.499E+1	8.451E–1	3.144E–1	6.370E+0	1.579E+2	1.952E+0	1.882E+2	1.343E+0			
30	7.027E+1	8.371E–1	3.127E–1	6.506E+0	1.748E+2	1.939E+0	2.056E+2	1.335E+0			
40	7.601E+1	8.296E–1	3.106E–1	6.649E+0	1.924E+2	1.926E+0	2.241E+2	1.325E+0			
50	8.099E+1	8.233E–1	3.088E–1	6.772E+0	2.075E+2	1.915E+0	2.402E+2	1.317E+0			
60	8.607E+1	8.174E–1	3.070E–1	6.899E+0	2.218E+2	1.905E+0	2.561E+2	1.308E+0			

Table 4.153. Absorption and production microscopic cross sections (b) of main isotopes, Variant 12, State 2

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 1, Absorption						
0	2.863E+1	9.206E+0	9.728E–1	1.776E+1	6.801E+1	9.130E+1	7.204E+1	2.927E+1	8.619E+4	2.689E+3	0.000E+0
10	3.068E+1	8.977E+0	9.778E–1	1.930E+1	7.586E+1	6.247E+1	7.888E+1	2.830E+1	9.746E+4	3.021E+3	4.881E+0
20	3.305E+1	8.786E+0	9.838E–1	2.101E+1	8.468E+1	5.539E+1	8.650E+1	2.649E+1	1.098E+5	3.384E+3	4.369E+0
30	3.549E+1	8.627E+0	9.900E–1	2.275E+1	9.364E+1	5.349E+1	9.430E+1	2.424E+1	1.224E+5	3.756E+3	4.025E+0
40	3.786E+1	8.505E+0	9.964E–1	2.444E+1	1.021E+2	5.390E+1	1.018E+2	2.206E+1	1.347E+5	4.115E+3	3.857E+0
50	3.993E+1	8.407E+0	1.002E+0	2.591E+1	1.092E+2	5.552E+1	1.083E+2	2.022E+1	1.453E+5	4.430E+3	3.857E+0
60	4.186E+1	8.324E+0	1.008E+0	2.730E+1	1.155E+2	5.787E+1	1.143E+2	1.879E+1	1.554E+5	4.724E+3	3.572E+0
					Pin 1, Production						
0	5.505E+1	8.631E–1	3.196E–1	6.118E+0	1.260E+2	2.008E+0	1.551E+2	1.368E+0			
10	5.931E+1	8.549E–1	3.186E–1	6.240E+0	1.403E+2	1.983E+0	1.698E+2	1.363E+0			
20	6.424E+1	8.464E–1	3.168E–1	6.368E+0	1.564E+2	1.967E+0	1.861E+2	1.355E+0			
30	6.934E+1	8.386E–1	3.150E–1	6.497E+0	1.728E+2	1.954E+0	2.028E+2	1.347E+0			
40	7.428E+1	8.320E–1	3.133E–1	6.620E+0	1.883E+2	1.943E+0	2.188E+2	1.339E+0			
50	7.859E+1	8.264E–1	3.118E–1	6.728E+0	2.015E+2	1.934E+0	2.328E+2	1.331E+0			
60	8.263E+1	8.216E–1	3.105E–1	6.829E+0	2.131E+2	1.927E+0	2.455E+2	1.325E+0			
					Pin 29, Absorption						
0	2.376E+1	8.771E+0	9.409E–1	1.442E+1	5.436E+1	8.317E+1	5.798E+1	2.766E+1	6.285E+4	1.987E+3	0.000E+0
10	2.506E+1	8.561E+0	9.444E–1	1.542E+1	5.979E+1	5.626E+1	6.251E+1	2.676E+1	7.022E+4	2.205E+3	4.421E+0
20	2.676E+1	8.382E+0	9.488E–1	1.665E+1	6.637E+1	4.929E+1	6.806E+1	2.504E+1	7.917E+4	2.470E+3	3.976E+0
30	2.859E+1	8.234E+0	9.537E–1	1.795E+1	7.331E+1	4.714E+1	7.399E+1	2.290E+1	8.872E+4	2.753E+3	3.724E+0
40	3.048E+1	8.121E+0	9.591E–1	1.929E+1	8.019E+1	4.723E+1	8.002E+1	2.083E+1	9.843E+4	3.040E+3	3.558E+0
50	3.224E+1	8.030E+0	9.644E–1	2.054E+1	8.641E+1	4.854E+1	8.561E+1	1.907E+1	1.075E+5	3.309E+3	3.375E+0
60	3.373E+1	7.957E+0	9.693E–1	2.160E+1	9.154E+1	5.053E+1	9.034E+1	1.771E+1	1.152E+5	3.537E+3	3.235E+0
					Pin 29, Production						
0	4.508E+1	8.601E–1	3.245E–1	5.890E+0	1.004E+2	2.039E+0	1.250E+2	1.392E+0			
10	4.780E+1	8.537E–1	3.241E–1	5.973E+0	1.103E+2	2.020E+0	1.347E+2	1.390E+0			
20	5.134E+1	8.470E–1	3.231E–1	6.067E+0	1.223E+2	2.008E+0	1.466E+2	1.385E+0			
30	5.517E+1	8.409E–1	3.220E–1	6.165E+0	1.349E+2	1.999E+0	1.593E+2	1.379E+0			
40	5.908E+1	8.355E–1	3.208E–1	6.264E+0	1.475E+2	1.991E+0	1.721E+2	1.374E+0			
50	6.275E+1	8.308E–1	3.196E–1	6.355E+0	1.589E+2	1.984E+0	1.841E+2	1.368E+0			
60	6.587E+1	8.270E–1	3.187E–1	6.433E+0	1.684E+2	1.979E+0	1.942E+2	1.363E+0			

Table 4.153. (continued)

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
					Pin 72, Absorption						
0	2.041E+1	8.224E+0	9.102E–1	1.223E+1	4.525E+1	7.240E+1	4.850E+1	2.485E+1	4.824E+4	1.536E+3	0.000E+0
10	2.137E+1	8.053E+0	9.141E–1	1.297E+1	4.958E+1	4.870E+1	5.195E+1	2.411E+1	5.359E+4	1.693E+3	3.896E+0
20	2.269E+1	7.904E+0	9.185E–1	1.392E+1	5.494E+1	4.264E+1	5.632E+1	2.261E+1	6.039E+4	1.894E+3	3.514E+0
30	2.398E+1	7.777E+0	9.225E–1	1.483E+1	6.021E+1	4.041E+1	6.061E+1	2.071E+1	6.706E+4	2.092E+3	4.551E+0
40	2.538E+1	7.688E+0	9.275E–1	1.581E+1	6.560E+1	4.060E+1	6.519E+1	1.888E+1	7.416E+4	2.302E+3	3.889E+0
50	2.659E+1	7.618E+0	9.321E–1	1.666E+1	7.016E+1	4.179E+1	6.913E+1	1.733E+1	8.026E+4	2.484E+3	3.629E+0
60	2.781E+1	7.559E+0	9.368E–1	1.752E+1	7.435E+1	4.365E+1	7.296E+1	1.613E+1	8.647E+4	2.667E+3	3.192E+0
					Pin 72, Production						
0	3.832E+1	8.513E–1	3.282E–1	5.757E+0	8.345E+1	2.059E+0	1.047E+2	1.408E+0			
10	4.032E+1	8.457E–1	3.277E–1	5.819E+0	9.123E+1	2.041E+0	1.121E+2	1.406E+0			
20	4.306E+1	8.400E–1	3.268E–1	5.891E+0	1.010E+2	2.031E+0	1.215E+2	1.401E+0			
30	4.575E+1	8.351E–1	3.261E–1	5.961E+0	1.105E+2	2.024E+0	1.306E+2	1.397E+0			
40	4.868E+1	8.307E–1	3.251E–1	6.033E+0	1.203E+2	2.017E+0	1.404E+2	1.392E+0			
50	5.119E+1	8.274E–1	3.244E–1	6.095E+0	1.286E+2	2.013E+0	1.487E+2	1.388E+0			
60	5.373E+1	8.243E–1	3.236E–1	6.157E+0	1.363E+2	2.009E+0	1.569E+2	1.384E+0			

Table 4.154. Nuclide concentration [atoms/(b·cm)] vs burnup, Variant 1

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{241}Am	^{242m}Am	^{243}Am	^{242}Cm	^{243}Cm	^{244}Cm	^{135}Xe	^{149}Sm	Fission product
0.0	8.737E–4	0.000E+0	1.874E–2	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	9.508E–9	7.377E–8	0.000E+0
2.0	8.271E–4	8.707E–6	1.872E–2	2.514E–9	1.826E–5	5.731E–7	4.739E–8	5.290E–10	7.218E–11	1.547E–13	3.724E–12	1.341E–12	1.132E–15	3.516E–14	9.759E–9	7.631E–8	8.281E–5
4.0	7.831E–4	1.686E–5	1.870E–2	1.213E–8	3.509E–5	2.055E–6	3.436E–7	7.901E–9	1.074E–9	4.318E–12	1.168E–10	3.962E–11	6.950E–14	2.298E–12	9.855E–9	7.721E–8	1.655E–4
6.0	7.415E–4	2.451E–5	1.867E–2	3.197E–8	4.961E–5	4.074E–6	9.937E–7	3.524E–8	4.751E–9	2.691E–11	8.157E–10	2.606E–10	7.088E–13	2.481E–11	9.906E–9	7.767E–8	2.479E–4
8.0	7.020E–4	3.171E–5	1.865E–2	6.485E–8	6.223E–5	6.425E–6	1.995E–6	9.698E–8	1.291E–8	9.174E–11	3.104E–9	9.354E–10	3.493E–12	1.291E–10	9.927E–9	7.784E–8	3.300E–4
10.0	6.645E–4	3.849E–5	1.862E–2	1.134E–7	7.328E–5	8.989E–6	3.300E–6	2.059E–7	2.696E–8	2.259E–10	8.499E–9	2.421E–9	1.160E–11	4.522E–10	9.925E–9	7.780E–8	4.119E–4
12.0	6.286E–4	4.489E–5	1.859E–2	1.798E–7	8.299E–5	1.169E–5	4.849E–6	3.721E–7	4.784E–8	4.545E–10	1.895E–8	5.109E–9	3.008E–11	1.236E–9	9.904E–9	7.758E–8	4.936E–4
14.0	5.944E–4	5.092E–5	1.857E–2	2.664E–7	9.154E–5	1.449E–5	6.585E–6	6.031E–7	7.598E–8	7.968E–10	3.671E–8	9.382E–9	6.583E–11	2.851E–9	9.869E–9	7.723E–8	5.752E–4
16.0	5.617E–4	5.660E–5	1.854E–2	3.751E–7	9.907E–5	1.734E–5	8.456E–6	9.042E–7	1.114E–7	1.265E–9	6.423E–8	1.558E–8	1.274E–10	5.813E–9	9.821E–9	7.676E–8	6.567E–4
18.0	5.305E–4	6.195E–5	1.851E–2	5.076E–7	1.057E–4	2.022E–5	1.042E–5	1.279E–6	1.539E–7	1.866E–9	1.041E–7	2.400E–8	2.246E–10	1.079E–8	9.764E–9	7.621E–8	7.380E–4
20.0	5.007E–4	6.698E–5	1.848E–2	6.655E–7	1.116E–4	2.311E–5	1.243E–5	1.728E–6	2.030E–7	2.597E–9	1.587E–7	3.484E–8	3.681E–10	1.863E–8	9.698E–9	7.557E–8	8.192E–4
22.0	4.721E–4	7.171E–5	1.846E–2	8.503E–7	1.167E–4	2.599E–5	1.447E–5	2.253E–6	2.579E–7	3.452E–9	2.307E–7	4.827E–8	5.689E–10	3.030E–8	9.625E–9	7.487E–8	9.003E–4
24.0	4.449E–4	7.614E–5	1.843E–2	1.063E–6	1.213E–4	2.884E–5	1.651E–5	2.853E–6	3.179E–7	4.422E–9	3.223E–7	6.434E–8	8.380E–10	4.697E–8	9.546E–9	7.412E–8	9.814E–4
26.0	4.188E–4	8.028E–5	1.840E–2	1.305E–6	1.253E–4	3.166E–5	1.853E–5	3.525E–6	3.822E–7	5.491E–9	4.356E–7	8.308E–8	1.186E–9	6.992E–8	9.462E–9	7.333E–8	1.062E–3
28.0	3.939E–4	8.414E–5	1.837E–2	1.576E–6	1.288E–4	3.444E–5	2.051E–5	4.269E–6	4.498E–7	6.645E–9	5.725E–7	1.044E–7	1.622E–9	1.006E–7	9.374E–9	7.250E–8	1.143E–3
30.0	3.702E–4	8.774E–5	1.834E–2	1.878E–6	1.318E–4	3.716E–5	2.244E–5	5.082E–6	5.199E–7	7.865E–9	7.346E–7	1.283E–7	2.155E–9	1.405E–7	9.283E–9	7.165E–8	1.224E–3
32.0	3.476E–4	9.108E–5	1.831E–2	2.209E–6	1.345E–4	3.981E–5	2.432E–5	5.960E–6	5.916E–7	9.136E–9	9.232E–7	1.545E–7	2.792E–9	1.913E–7	9.189E–9	7.077E–8	1.305E–3
34.0	3.260E–4	9.416E–5	1.828E–2	2.572E–6	1.368E–4	4.240E–5	2.612E–5	6.901E–6	6.641E–7	1.044E–8	1.140E–6	1.830E–7	3.538E–9	2.547E–7	9.094E–9	6.989E–8	1.385E–3
36.0	3.054E–4	9.700E–5	1.825E–2	2.964E–6	1.388E–4	4.492E–5	2.785E–5	7.901E–6	7.366E–7	1.176E–8	1.384E–6	2.134E–7	4.397E–9	3.324E–7	8.997E–9	6.899E–8	1.466E–3
38.0	2.859E–4	9.961E–5	1.821E–2	3.387E–6	1.405E–4	4.736E–5	2.951E–5	8.956E–6	8.085E–7	1.308E–8	1.657E–6	2.455E–7	5.371E–9	4.264E–7	8.899E–9	6.809E–8	1.547E–3
40.0	2.673E–4	1.020E–4	1.818E–2	3.839E–6	1.419E–4	4.971E–5	3.108E–5	1.006E–5	8.791E–7	1.438E–8	1.960E–6	2.791E–7	6.458E–9	5.384E–7	8.803E–9	6.723E–8	1.627E–3
42.0	2.497E–4	1.041E–4	1.815E–2	4.319E–6	1.432E–4	5.198E–5	3.257E–5	1.122E–5	9.479E–7	1.566E–8	2.291E–6	3.140E–7	7.658E–9	6.702E–7	8.707E–9	6.635E–8	1.708E–3
44.0	2.329E–4	1.061E–4	1.812E–2	4.826E–6	1.442E–4	5.416E–5	3.399E–5	1.242E–5	1.014E–6	1.691E–8	2.650E–6	3.498E–7	8.967E–9	8.237E–7	8.611E–9	6.548E–8	1.788E–3
46.0	2.171E–4	1.078E–4	1.808E–2	5.359E–6	1.451E–4	5.625E–5	3.532E–5	1.365E–5	1.078E–6	1.810E–8	3.038E–6	3.862E–7	1.038E–8	1.001E–6	8.516E–9	6.463E–8	1.869E–3
48.0	2.021E–4	1.093E–4	1.805E–2	5.916E–6	1.458E–4	5.825E–5	3.657E–5	1.493E–5	1.139E–6	1.924E–8	3.452E–6	4.231E–7	1.189E–8	1.202E–6	8.422E–9	6.380E–8	1.950E–3
50.0	1.880E–4	1.107E–4	1.801E–2	6.496E–6	1.463E–4	6.015E–5	3.774E–5	1.623E–5	1.196E–6	2.032E–8	3.892E–6	4.602E–7	1.348E–8	1.431E–6	8.331E–9	6.298E–8	2.030E–3
52.0	1.746E–4	1.118E–4	1.798E–2	7.097E–6	1.468E–4	6.197E–5	3.883E–5	1.757E–5	1.250E–6	2.134E–8	4.357E–6	4.972E–7	1.516E–8	1.687E–6	8.241E–9	6.219E–8	2.111E–3
54.0	1.620E–4	1.128E–4	1.794E–2	7.717E–6	1.471E–4	6.369E–5	3.985E–5	1.893E–5	1.300E–6	2.228E–8	4.845E–6	5.339E–7	1.690E–8	1.973E–6	8.154E–9	6.142E–8	2.192E–3
56.0	1.502E–4	1.136E–4	1.791E–2	8.353E–6	1.473E–4	6.532E–5	4.080E–5	2.031E–5	1.347E–6	2.316E–8	5.356E–6	5.701E–7	1.870E–8	2.290E–6	8.070E–9	6.068E–8	2.272E–3
58.0	1.391E–4	1.142E–4	1.787E–2	9.004E–6	1.475E–4	6.686E–5	4.168E–5	2.171E–5	1.390E–6	2.397E–8	5.886E–6	6.056E–7	2.054E–8	2.638E–6	7.988E–9	5.997E–8	2.353E–3
60.0	1.286E–4	1.147E–4	1.783E–2	9.668E–6	1.475E–4	6.832E–5	4.249E–5	2.312E–5	1.429E–6	2.471E–8	6.435E–6	6.401E–7	2.242E–8	3.018E–6	7.910E–9	5.930E–8	2.434E–3

Table 4.155. Nuclide concentration [atoms/(b·cm)] vs burnup, Variant 2

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{241}Am	^{224m}Am	^{243}Am	^{242}Cm	^{243}Cm	^{244}Cm	^{135}Xe	^{149}Sm	Fission product
0.0	3.839E–5	0.000E+0	1.892E–2	0.000E+0	6.588E–4	4.232E–5	7.025E–6	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	1.599E–8	1.574E–7	0.000E+0
2.0	3.704E–5	2.976E–7	1.889E–2	2.522E–9	6.267E–4	5.505E–5	1.237E–5	2.236E–7	5.856E–8	1.807E–10	4.171E–9	1.529E–9	2.596E–12	7.761E–11	1.597E–8	1.576E–7	7.841E–5
4.0	3.569E–5	5.886E–7	1.886E–2	1.065E–8	5.973E–4	6.677E–5	1.796E–5	5.782E–7	1.457E–7	7.889E–10	2.012E–8	6.923E–9	2.293E–11	7.184E–10	1.565E–8	1.526E–7	1.570E–4
6.0	3.435E–5	8.718E–7	1.884E–2	2.536E–8	5.691E–4	7.753E–5	2.364E–5	1.070E–6	2.597E–7	1.894E–9	5.313E–8	1.722E–8	8.386E–11	2.764E–9	1.533E–8	1.478E–7	2.356E–4
8.0	3.303E–5	1.147E–6	1.881E–2	4.776E–8	5.420E–4	8.739E–5	2.931E–5	1.703E–6	3.982E–7	3.529E–9	1.084E–7	3.324E–8	2.125E–10	7.366E–9	1.502E–8	1.432E–7	3.143E–4
10.0	3.173E–5	1.413E–6	1.878E–2	7.904E–8	5.162E–4	9.638E–5	3.488E–5	2.479E–6	5.584E–7	5.696E–9	1.910E–7	5.559E–8	4.390E–10	1.598E–8	1.471E–8	1.388E–7	3.930E–4
12.0	3.045E–5	1.670E–6	1.875E–2	1.204E–7	4.915E–4	1.046E–4	4.030E–5	3.397E–6	7.368E–7	8.372E–9	3.056E–7	8.468E–8	7.946E–10	3.034E–8	1.441E–8	1.346E–7	4.717E–4
14.0	2.919E–5	1.918E–6	1.872E–2	1.732E–7	4.680E–4	1.119E–4	4.550E–5	4.454E–6	9.302E–7	1.151E–8	4.563E–7	1.207E–7	1.311E–9	5.245E–8	1.411E–8	1.306E–7	5.504E–4
16.0	2.795E–5	2.157E–6	1.869E–2	2.384E–7	4.457E–4	1.186E–4	5.045E–5	5.648E–6	1.135E–6	1.505E–8	6.469E–7	1.637E–7	2.018E–9	8.456E–8	1.383E–8	1.268E–7	6.291E–4
18.0	2.673E–5	2.385E–6	1.866E–2	3.173E–7	4.246E–4	1.245E–4	5.511E–5	6.973E–6	1.348E–6	1.891E–8	8.801E–7	2.135E–7	2.944E–9	1.291E–7	1.354E–8	1.231E–7	7.079E–4
20.0	2.554E–5	2.604E–6	1.863E–2	4.107E–7	4.047E–4	1.297E–4	5.946E–5	8.424E–6	1.565E–6	2.302E–8	1.158E–6	2.697E–7	4.114E–9	1.886E–7	1.327E–8	1.196E–7	7.867E–4
22.0	2.438E–5	2.813E–6	1.860E–2	5.195E–7	3.859E–4	1.342E–4	6.348E–5	9.994E–6	1.783E–6	2.730E–8	1.483E–6	3.320E–7	5.549E–9	2.658E–7	1.300E–8	1.163E–7	8.656E–4
24.0	2.324E–5	3.012E–6	1.857E–2	6.445E–7	3.682E–4	1.381E–4	6.716E–5	1.168E–5	2.000E–6	3.167E–8	1.856E–6	3.998E–7	7.263E–9	3.635E–7	1.274E–8	1.132E–7	9.445E–4
26.0	2.213E–5	3.201E–6	1.854E–2	7.859E–7	3.517E–4	1.414E–4	7.049E–5	1.346E–5	2.212E–6	3.605E–8	2.276E–6	4.725E–7	9.267E–9	4.845E–7	1.249E–8	1.101E–7	1.023E–3
28.0	2.104E–5	3.380E–6	1.851E–2	9.441E–7	3.362E–4	1.442E–4	7.347E–5	1.534E–5	2.417E–6	4.036E–8	2.744E–6	5.492E–7	1.157E–8	6.315E–7	1.224E–8	1.072E–7	1.102E–3
30.0	1.999E–5	3.548E–6	1.848E–2	1.119E–6	3.218E–4	1.464E–4	7.610E–5	1.731E–5	2.612E–6	4.455E–8	3.258E–6	6.292E–7	1.416E–8	8.071E–7	1.200E–8	1.045E–7	1.181E–3
32.0	1.897E–5	3.707E–6	1.844E–2	1.311E–6	3.084E–4	1.481E–4	7.839E–5	1.935E–5	2.797E–6	4.855E–8	3.818E–6	7.117E–7	1.704E–8	1.014E–6	1.177E–8	1.018E–7	1.260E–3
34.0	1.798E–5	3.855E–6	1.841E–2	1.519E–6	2.959E–4	1.493E–4	8.035E–5	2.146E–5	2.968E–6	5.232E–8	4.419E–6	7.958E–7	2.019E–8	1.255E–6	1.154E–8	9.921E–8	1.339E–3
36.0	1.702E–5	3.993E–6	1.838E–2	1.742E–6	2.843E–4	1.502E–4	8.200E–5	2.362E–5	3.125E–6	5.582E–8	5.059E–6	8.808E–7	2.358E–8	1.533E–6	1.133E–8	9.684E–8	1.419E–3
38.0	1.610E–5	4.121E–6	1.834E–2	1.980E–6	2.736E–4	1.506E–4	8.334E–5	2.584E–5	3.267E–6	5.901E–8	5.737E–6	9.656E–7	2.722E–8	1.848E–6	1.113E–8	9.457E–8	1.498E–3
40.0	1.521E–5	4.239E–6	1.831E–2	2.232E–6	2.637E–4	1.507E–4	8.438E–5	2.809E–5	3.394E–6	6.188E–8	6.451E–6	1.050E–6	3.105E–8	2.203E–6	1.093E–8	9.241E–8	1.577E–3
42.0	1.435E–5	4.348E–6	1.827E–2	2.497E–6	2.546E–4	1.504E–4	8.516E–5	3.037E–5	3.505E–6	6.441E–8	7.197E–6	1.132E–6	3.507E–8	2.600E–6	1.074E–8	9.035E–8	1.656E–3
44.0	1.352E–5	4.446E–6	1.824E–2	2.773E–6	2.463E–4	1.499E–4	8.567E–5	3.266E–5	3.600E–6	6.660E–8	7.972E–6	1.211E–6	3.922E–8	3.039E–6	1.056E–8	8.838E–8	1.736E–3
46.0	1.273E–5	4.536E–6	1.820E–2	3.059E–6	2.387E–4	1.491E–4	8.596E–5	3.496E–5	3.678E–6	6.844E–8	8.773E–6	1.288E–6	4.348E–8	3.522E–6	1.039E–8	8.651E–8	1.815E–3
48.0	1.197E–5	4.616E–6	1.817E–2	3.353E–6	2.317E–4	1.481E–4	8.603E–5	3.726E–5	3.742E–6	6.994E–8	9.595E–6	1.360E–6	4.780E–8	4.049E–6	1.022E–8	8.473E–8	1.895E–3
50.0	1.124E–5	4.687E–6	1.813E–2	3.655E–6	2.253E–4	1.469E–4	8.592E–5	3.954E–5	3.790E–6	7.111E–8	1.044E–5	1.429E–6	5.214E–8	4.622E–6	1.007E–8	8.303E–8	1.975E–3
52.0	1.055E–5	4.749E–6	1.810E–2	3.961E–6	2.195E–4	1.456E–4	8.563E–5	4.181E–5	3.824E–6	7.196E–8	1.129E–5	1.493E–6	5.647E–8	5.240E–6	9.912E–9	8.141E–8	2.055E–3
54.0	9.883E–6	4.803E–6	1.806E–2	4.270E–6	2.141E–4	1.441E–4	8.520E–5	4.406E–5	3.844E–6	7.252E–8	1.216E–5	1.552E–6	6.075E–8	5.903E–6	9.767E–9	7.986E–8	2.134E–3
56.0	9.253E–6	4.849E–6	1.802E–2	4.581E–6	2.093E–4	1.425E–4	8.464E–5	4.627E–5	3.852E–6	7.280E–8	1.303E–5	1.605E–6	6.494E–8	6.611E–6	9.628E–9	7.839E–8	2.214E–3
58.0	8.654E–6	4.887E–6	1.799E–2	4.892E–6	2.048E–4	1.408E–4	8.396E–5	4.844E–5	3.849E–6	7.282E–8	1.391E–5	1.653E–6	6.900E–8	7.363E–6	9.494E–9	7.699E–8	2.294E–3
60.0	8.085E–6	4.917E–6	1.795E–2	5.202E–6	2.007E–4	1.391E–4	8.319E–5	5.057E–5	3.835E–6	7.261E–8	1.479E–5	1.696E–6	7.291E–8	8.159E–6	9.367E–9	7.565E–8	2.375E–3

Table 4.156. Nuclide concentration [atoms/(b·cm)] vs burnup, Variant 10

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{241}Am	^{242m}Am	^{243}Am	^{242}Cm	^{243}Cm	^{244}Cm	^{135}Xe	^{149}Sm	Fission product
0.0	5.000E–5	0.000E+0	2.210E–2	3.000E–5	1.160E–3	4.900E–4	1.900E–4	1.050E–4	2.500E–5	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	2.454E–8	4.655E–7	0.000E+0
2.0	4.873E–5	3.299E–7	2.207E–2	2.965E–5	1.133E–3	4.911E–4	1.957E–4	1.055E–4	2.504E–5	1.195E–7	2.380E–6	9.392E–7	2.751E–9	6.076E–8	2.473E–8	4.809E–7	9.837E–5
4.0	4.748E–5	6.495E–7	2.203E–2	2.951E–5	1.108E–3	4.919E–4	2.010E–4	1.060E–4	2.511E–5	2.203E–7	4.663E–6	1.673E–6	9.986E–9	2.376E–7	2.465E–8	4.763E–7	1.968E–4
6.0	4.625E–5	9.586E–7	2.200E–2	2.954E–5	1.083E–3	4.925E–4	2.059E–4	1.067E–4	2.521E–5	3.052E–7	6.854E–6	2.250E–6	2.044E–8	5.225E–7	2.455E–8	4.710E–7	2.953E–4
8.0	4.505E–5	1.257E–6	2.197E–2	2.969E–5	1.060E–3	4.928E–4	2.106E–4	1.074E–4	2.533E–5	3.767E–7	8.956E–6	2.705E–6	3.314E–8	9.081E–7	2.445E–8	4.656E–7	3.938E–4
10.0	4.386E–5	1.546E–6	2.193E–2	2.995E–5	1.037E–3	4.928E–4	2.149E–4	1.082E–4	2.546E–5	4.370E–7	1.098E–5	3.068E–6	4.735E–8	1.387E–6	2.434E–8	4.601E–7	4.923E–4
12.0	4.270E–5	1.825E–6	2.190E–2	3.029E–5	1.014E–3	4.927E–4	2.189E–4	1.090E–4	2.561E–5	4.878E–7	1.291E–5	3.361E–6	6.252E–8	1.953E–6	2.424E–8	4.545E–7	5.909E–4
14.0	4.156E–5	2.093E–6	2.186E–2	3.068E–5	9.925E–4	4.922E–4	2.226E–4	1.099E–4	2.577E–5	5.307E–7	1.478E–5	3.600E–6	7.825E–8	2.600E–6	2.413E–8	4.489E–7	6.895E–4
16.0	4.044E–5	2.353E–6	2.183E–2	3.113E–5	9.713E–4	4.916E–4	2.261E–4	1.109E–4	2.593E–5	5.668E–7	1.658E–5	3.798E–6	9.422E–8	3.323E–6	2.402E–8	4.433E–7	7.882E–4
18.0	3.934E–5	2.602E–6	2.179E–2	3.161E–5	9.506E–4	4.907E–4	2.292E–4	1.120E–4	2.610E–5	5.974E–7	1.830E–5	3.965E–6	1.102E–7	4.115E–6	2.391E–8	4.377E–7	8.869E–4
20.0	3.826E–5	2.843E–6	2.176E–2	3.213E–5	9.306E–4	4.896E–4	2.321E–4	1.131E–4	2.626E–5	6.232E–7	1.997E–5	4.108E–6	1.261E–7	4.973E–6	2.380E–8	4.320E–7	9.857E–4
22.0	3.720E–5	3.074E–6	2.172E–2	3.267E–5	9.111E–4	4.883E–4	2.348E–4	1.143E–4	2.643E–5	6.450E–7	2.157E–5	4.233E–6	1.417E–7	5.890E–6	2.369E–8	4.264E–7	1.085E–3
24.0	3.616E–5	3.296E–6	2.169E–2	3.324E–5	8.922E–4	4.868E–4	2.371E–4	1.155E–4	2.659E–5	6.635E–7	2.312E–5	4.345E–6	1.569E–7	6.864E–6	2.358E–8	4.208E–7	1.184E–3
26.0	3.514E–5	3.510E–6	2.165E–2	3.382E–5	8.738E–4	4.851E–4	2.393E–4	1.167E–4	2.675E–5	6.792E–7	2.462E–5	4.446E–6	1.718E–7	7.890E–6	2.346E–8	4.152E–7	1.283E–3
28.0	3.414E–5	3.715E–6	2.162E–2	3.441E–5	8.559E–4	4.832E–4	2.412E–4	1.180E–4	2.690E–5	6.925E–7	2.606E–5	4.538E–6	1.863E–7	8.964E–6	2.335E–8	4.096E–7	1.382E–3
30.0	3.316E–5	3.911E–6	2.158E–2	3.502E–5	8.385E–4	4.812E–4	2.429E–4	1.194E–4	2.704E–5	7.037E–7	2.746E–5	4.625E–6	2.003E–7	1.008E–5	2.323E–8	4.041E–7	1.481E–3
32.0	3.220E–5	4.099E–6	2.155E–2	3.564E–5	8.216E–4	4.789E–4	2.444E–4	1.208E–4	2.717E–5	7.131E–7	2.881E–5	4.706E–6	2.139E–7	1.124E–5	2.311E–8	3.986E–7	1.580E–3
34.0	3.125E–5	4.279E–6	2.151E–2	3.627E–5	8.053E–4	4.765E–4	2.456E–4	1.222E–4	2.729E–5	7.211E–7	3.012E–5	4.783E–6	2.271E–7	1.244E–5	2.300E–8	3.932E–7	1.680E–3
36.0	3.033E–5	4.450E–6	2.147E–2	3.690E–5	7.894E–4	4.739E–4	2.467E–4	1.236E–4	2.740E–5	7.277E–7	3.139E–5	4.856E–6	2.398E–7	1.368E–5	2.288E–8	3.878E–7	1.779E–3
38.0	2.943E–5	4.614E–6	2.144E–2	3.754E–5	7.739E–4	4.712E–4	2.476E–4	1.251E–4	2.749E–5	7.331E–7	3.262E–5	4.927E–6	2.520E–7	1.494E–5	2.275E–8	3.818E–7	1.879E–3
40.0	2.855E–5	4.770E–6	2.140E–2	3.819E–5	7.589E–4	4.683E–4	2.483E–4	1.266E–4	2.756E–5	7.375E–7	3.381E–5	4.994E–6	2.639E–7	1.624E–5	2.264E–8	3.771E–7	1.979E–3
42.0	2.768E–5	4.918E–6	2.136E–2	3.884E–5	7.444E–4	4.652E–4	2.488E–4	1.281E–4	2.763E–5	7.409E–7	3.496E–5	5.059E–6	2.753E–7	1.756E–5	2.252E–8	3.719E–7	2.078E–3
44.0	2.683E–5	5.059E–6	2.132E–2	3.949E–5	7.303E–4	4.621E–4	2.491E–4	1.297E–4	2.767E–5	7.435E–7	3.608E–5	5.122E–6	2.863E–7	1.891E–5	2.240E–8	3.667E–7	2.178E–3
46.0	2.600E–5	5.193E–6	2.129E–2	4.014E–5	7.166E–4	4.588E–4	2.493E–4	1.313E–4	2.770E–5	7.453E–7	3.717E–5	5.182E–6	2.969E–7	2.028E–5	2.228E–8	3.616E–7	2.278E–3
48.0	2.519E–5	5.319E–6	2.125E–2	4.080E–5	7.033E–4	4.553E–4	2.493E–4	1.329E–4	2.771E–5	7.464E–7	3.823E–5	5.240E–6	3.071E–7	2.168E–5	2.215E–8	3.565E–7	2.379E–3
50.0	2.440E–5	5.438E–6	2.121E–2	4.145E–5	6.905E–4	4.518E–4	2.492E–4	1.345E–4	2.770E–5	7.468E–7	3.926E–5	5.294E–6	3.170E–7	2.309E–5	2.203E–8	3.515E–7	2.479E–3
52.0	2.363E–5	5.551E–6	2.117E–2	4.211E–5	6.780E–4	4.481E–4	2.489E–4	1.361E–4	2.768E–5	7.465E–7	4.026E–5	5.347E–6	3.265E–7	2.452E–5	2.191E–8	3.465E–7	2.579E–3
54.0	2.287E–5	5.657E–6	2.113E–2	4.276E–5	6.659E–4	4.444E–4	2.485E–4	1.377E–4	2.764E–5	7.456E–7	4.123E–5	5.396E–6	3.355E–7	2.596E–5	2.179E–8	3.416E–7	2.680E–3
56.0	2.213E–5	5.756E–6	2.110E–2	4.341E–5	6.542E–4	4.405E–4	2.480E–4	1.393E–4	2.758E–5	7.441E–7	4.217E–5	5.443E–6	3.443E–7	2.742E–5	2.166E–8	3.368E–7	2.781E–3
58.0	2.141E–5	5.848E–6	2.106E–2	4.405E–5	6.428E–4	4.365E–4	2.473E–4	1.409E–4	2.751E–5	7.420E–7	4.309E–5	5.487E–6	3.526E–7	2.889E–5	2.154E–8	3.320E–7	2.882E–3
60.0	2.070E–5	5.935E–6	2.102E–2	4.469E–5	6.318E–4	4.325E–4	2.465E–4	1.426E–4	2.741E–5	7.393E–7	4.398E–5	5.528E–6	3.606E–7	3.038E–5	2.142E–8	3.273E–7	2.983E–3

Table 4.157. Nuclide concentration [atoms/(b·cm)] in fuel pin 1 vs burnup, Variant 11

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
0.0	8.737E–4	0.000E+0	1.874E–2	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	9.455E–9	6.948E–8	0.000E+0
2.0	8.244E–4	8.921E–6	1.872E–2	2.212E–9	1.679E–5	5.445E–7	4.174E–8	4.897E–10	9.598E–9	7.075E–8	8.710E–5
4.0	7.778E–4	1.729E–5	1.870E–2	1.073E–8	3.223E–5	1.984E–6	3.071E–7	7.488E–9	9.613E–9	7.082E–8	1.739E–4
6.0	7.336E–4	2.515E–5	1.868E–2	2.844E–8	4.536E–5	3.972E–6	8.970E–7	3.397E–8	9.586E–9	7.053E–8	2.603E–4
8.0	6.916E–4	3.256E–5	1.865E–2	5.797E–8	5.662E–5	6.303E–6	1.813E–6	9.474E–8	9.530E–9	7.000E–8	3.463E–4
10.0	6.515E–4	3.954E–5	1.863E–2	1.017E–7	6.629E–5	8.855E–6	3.014E–6	2.034E–7	9.452E–9	6.930E–8	4.319E–4
12.0	6.133E–4	4.613E–5	1.861E–2	1.619E–7	7.463E–5	1.155E–5	4.441E–6	3.712E–7	9.357E–9	6.847E–8	5.172E–4
14.0	5.768E–4	5.234E–5	1.858E–2	2.405E–7	8.180E–5	1.434E–5	6.040E–6	6.068E–7	9.249E–9	6.753E–8	6.021E–4
16.0	5.420E–4	5.819E–5	1.856E–2	3.394E–7	8.798E–5	1.717E–5	7.758E–6	9.165E–7	9.130E–9	6.651E–8	6.867E–4
18.0	5.087E–4	6.369E–5	1.853E–2	4.602E–7	9.329E–5	2.003E–5	9.551E–6	1.305E–6	9.002E–9	6.543E–8	7.709E–4
20.0	4.769E–4	6.886E–5	1.850E–2	6.044E–7	9.784E–5	2.289E–5	1.138E–5	1.773E–6	8.867E–9	6.430E–8	8.549E–4
22.0	4.466E–4	7.371E–5	1.848E–2	7.733E–7	1.017E–4	2.573E–5	1.322E–5	2.324E–6	8.726E–9	6.313E–8	9.386E–4
24.0	4.176E–4	7.824E–5	1.845E–2	9.680E–7	1.050E–4	2.854E–5	1.504E–5	2.956E–6	8.581E–9	6.193E–8	1.022E–3
26.0	3.900E–4	8.248E–5	1.842E–2	1.189E–6	1.078E–4	3.130E–5	1.683E–5	3.669E–6	8.433E–9	6.071E–8	1.105E–3
28.0	3.637E–4	8.642E–5	1.840E–2	1.438E–6	1.101E–4	3.400E–5	1.856E–5	4.461E–6	8.282E–9	5.948E–8	1.188E–3
30.0	3.387E–4	9.007E–5	1.837E–2	1.714E–6	1.120E–4	3.663E–5	2.023E–5	5.329E–6	8.130E–9	5.824E–8	1.271E–3
32.0	3.149E–4	9.345E–5	1.834E–2	2.019E–6	1.136E–4	3.918E–5	2.182E–5	6.270E–6	7.978E–9	5.701E–8	1.353E–3
34.0	2.923E–4	9.655E–5	1.831E–2	2.351E–6	1.148E–4	4.165E–5	2.333E–5	7.281E–6	7.826E–9	5.580E–8	1.435E–3
36.0	2.709E–4	9.940E–5	1.828E–2	2.711E–6	1.158E–4	4.403E–5	2.476E–5	8.358E–6	7.675E–9	5.459E–8	1.517E–3
38.0	2.506E–4	1.020E–4	1.825E–2	3.097E–6	1.165E–4	4.632E–5	2.610E–5	9.498E–6	7.525E–9	5.341E–8	1.599E–3
40.0	2.315E–4	1.043E–4	1.822E–2	3.510E–6	1.171E–4	4.851E–5	2.734E–5	1.070E–5	7.378E–9	5.224E–8	1.680E–3
42.0	2.134E–4	1.064E–4	1.819E–2	3.947E–6	1.174E–4	5.060E–5	2.850E–5	1.195E–5	7.234E–9	5.111E–8	1.762E–3
44.0	1.964E–4	1.083E–4	1.816E–2	4.408E–6	1.176E–4	5.258E–5	2.958E–5	1.325E–5	7.092E–9	5.001E–8	1.843E–3
46.0	1.803E–4	1.099E–4	1.812E–2	4.892E–6	1.177E–4	5.447E–5	3.056E–5	1.460E–5	6.955E–9	4.893E–8	1.924E–3
48.0	1.653E–4	1.113E–4	1.809E–2	5.395E–6	1.176E–4	5.625E–5	3.146E–5	1.599E–5	6.821E–9	4.790E–8	2.005E–3
50.0	1.512E–4	1.125E–4	1.806E–2	5.917E–6	1.174E–4	5.792E–5	3.228E–5	1.741E–5	6.692E–9	4.690E–8	2.086E–3
52.0	1.381E–4	1.136E–4	1.802E–2	6.455E–6	1.172E–4	5.949E–5	3.302E–5	1.887E–5	6.568E–9	4.595E–8	2.167E–3
54.0	1.259E–4	1.144E–4	1.799E–2	7.006E–6	1.169E–4	6.096E–5	3.369E–5	2.036E–5	6.448E–9	4.504E–8	2.248E–3
56.0	1.145E–4	1.150E–4	1.795E–2	7.569E–6	1.165E–4	6.233E–5	3.429E–5	2.186E–5	6.334E–9	4.416E–8	2.329E–3
58.0	1.039E–4	1.154E–4	1.792E–2	8.140E–6	1.161E–4	6.359E–5	3.483E–5	2.339E–5	6.225E–9	4.333E–8	2.410E–3
60.0	9.414E–5	1.157E–4	1.788E–2	8.717E–6	1.157E–4	6.476E–5	3.530E–5	2.494E–5	6.121E–9	4.255E–8	2.491E–3

Table 4.158. Nuclide concentration [atoms/(b·cm)] in fuel pin 29 vs burnup, Variant 11

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
0.0	8.737E–4	0.000E+0	1.874E–2	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	9.436E–9	7.120E–8	0.000E+0
2.0	8.286E–4	8.274E–6	1.872E–2	2.082E–9	1.635E–5	4.938E–7	3.702E–8	3.984E–10	9.627E–9	7.308E–8	7.976E–5
4.0	7.859E–4	1.606E–5	1.870E–2	9.940E–9	3.159E–5	1.803E–6	2.737E–7	6.088E–9	9.681E–9	7.348E–8	1.594E–4
6.0	7.453E–4	2.341E–5	1.868E–2	2.607E–8	4.476E–5	3.620E–6	8.037E–7	2.767E–8	9.695E–9	7.352E–8	2.388E–4
8.0	7.065E–4	3.036E–5	1.866E–2	5.277E–8	5.622E–5	5.767E–6	1.635E–6	7.738E–8	9.681E–9	7.330E–8	3.180E–4
10.0	6.694E–4	3.695E–5	1.863E–2	9.214E–8	6.623E–5	8.134E–6	2.734E–6	1.667E–7	9.645E–9	7.288E–8	3.972E–4
12.0	6.338E–4	4.320E–5	1.861E–2	1.462E–7	7.499E–5	1.065E–5	4.055E–6	3.052E–7	9.591E–9	7.231E–8	4.762E–4
14.0	5.997E–4	4.913E–5	1.859E–2	2.167E–7	8.267E–5	1.328E–5	5.550E–6	5.007E–7	9.523E–9	7.162E–8	5.553E–4
16.0	5.670E–4	5.475E–5	1.856E–2	3.054E–7	8.939E–5	1.597E–5	7.175E–6	7.590E–7	9.443E–9	7.083E–8	6.343E–4
18.0	5.355E–4	6.007E–5	1.854E–2	4.138E–7	9.527E–5	1.871E–5	8.891E–6	1.085E–6	9.353E–9	6.996E–8	7.132E–4
20.0	5.053E–4	6.511E–5	1.851E–2	5.434E–7	1.004E–4	2.146E–5	1.067E–5	1.480E–6	9.254E–9	6.902E–8	7.922E–4
22.0	4.763E–4	6.987E–5	1.849E–2	6.955E–7	1.049E–4	2.423E–5	1.247E–5	1.948E–6	9.147E–9	6.801E–8	8.712E–4
24.0	4.484E–4	7.436E–5	1.846E–2	8.713E–7	1.087E–4	2.698E–5	1.428E–5	2.489E–6	9.034E–9	6.697E–8	9.502E–4
26.0	4.217E–4	7.858E–5	1.843E–2	1.072E–6	1.121E–4	2.970E–5	1.608E–5	3.102E–6	8.915E–9	6.588E–8	1.029E–3
28.0	3.961E–4	8.255E–5	1.841E–2	1.298E–6	1.149E–4	3.239E–5	1.784E–5	3.788E–6	8.792E–9	6.476E–8	1.108E–3
30.0	3.715E–4	8.627E–5	1.838E–2	1.550E–6	1.173E–4	3.504E–5	1.956E–5	4.545E–6	8.665E–9	6.363E–8	1.187E–3
32.0	3.480E–4	8.974E–5	1.835E–2	1.828E–6	1.194E–4	3.762E–5	2.123E–5	5.372E–6	8.535E–9	6.247E–8	1.266E–3
34.0	3.255E–4	9.297E–5	1.832E–2	2.134E–6	1.210E–4	4.015E–5	2.284E–5	6.267E–6	8.403E–9	6.131E–8	1.346E–3
36.0	3.040E–4	9.597E–5	1.829E–2	2.466E–6	1.224E–4	4.260E–5	2.438E–5	7.227E–6	8.269E–9	6.015E–8	1.425E–3
38.0	2.835E–4	9.874E–5	1.826E–2	2.825E–6	1.235E–4	4.498E–5	2.584E–5	8.250E–6	8.134E–9	5.899E–8	1.504E–3
40.0	2.640E–4	1.013E–4	1.823E–2	3.210E–6	1.243E–4	4.728E–5	2.723E–5	9.333E–6	7.999E–9	5.783E–8	1.583E–3
42.0	2.454E–4	1.036E–4	1.820E–2	3.621E–6	1.250E–4	4.948E–5	2.853E–5	1.047E–5	7.864E–9	5.669E–8	1.663E–3
44.0	2.277E–4	1.057E–4	1.817E–2	4.057E–6	1.254E–4	5.160E–5	2.976E–5	1.167E–5	7.730E–9	5.557E–8	1.742E–3
46.0	2.110E–4	1.076E–4	1.814E–2	4.516E–6	1.256E–4	5.362E–5	3.090E–5	1.291E–5	7.598E–9	5.447E–8	1.822E–3
48.0	1.951E–4	1.093E–4	1.811E–2	4.997E–6	1.257E–4	5.555E–5	3.196E–5	1.420E–5	7.467E–9	5.339E–8	1.901E–3
50.0	1.802E–4	1.108E–4	1.808E–2	5.500E–6	1.257E–4	5.737E–5	3.293E–5	1.553E–5	7.339E–9	5.234E–8	1.981E–3
52.0	1.660E–4	1.121E–4	1.804E–2	6.021E–6	1.256E–4	5.910E–5	3.383E–5	1.691E–5	7.213E–9	5.131E–8	2.061E–3
54.0	1.527E–4	1.132E–4	1.801E–2	6.560E–6	1.254E–4	6.072E–5	3.465E–5	1.831E–5	7.090E–9	5.033E–8	2.141E–3
56.0	1.402E–4	1.141E–4	1.798E–2	7.113E–6	1.250E–4	6.224E–5	3.540E–5	1.975E–5	6.971E–9	4.937E–8	2.221E–3
58.0	1.286E–4	1.148E–4	1.794E–2	7.679E–6	1.247E–4	6.366E–5	3.608E–5	2.122E–5	6.856E–9	4.846E–8	2.301E–3
60.0	1.176E–4	1.154E–4	1.791E–2	8.256E–6	1.242E–4	6.499E–5	3.668E–5	2.271E–5	6.746E–9	4.758E–8	2.381E–3

Table 4.159. Nuclide concentration [atoms/(b·cm)] in fuel pin 72 vs burnup, Variant 11

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
0.0	8.737E–4	0.000E+0	1.874E–2	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	9.444E–9	7.011E–8	0.000E+0
2.0	8.262E–4	8.640E–6	1.872E–2	2.148E–9	1.658E–5	5.222E–7	3.969E–8	4.494E–10	9.607E–9	7.153E–8	8.393E–5
4.0	7.812E–4	1.678E–5	1.870E–2	1.037E–8	3.191E–5	1.908E–6	2.932E–7	6.898E–9	9.637E–9	7.172E–8	1.679E–4
6.0	7.384E–4	2.444E–5	1.868E–2	2.738E–8	4.504E–5	3.826E–6	8.586E–7	3.135E–8	9.625E–9	7.154E–8	2.515E–4
8.0	6.976E–4	3.167E–5	1.865E–2	5.567E–8	5.636E–5	6.082E–6	1.740E–6	8.757E–8	9.583E–9	7.111E–8	3.349E–4
10.0	6.587E–4	3.850E–5	1.863E–2	9.752E–8	6.614E–5	8.560E–6	2.899E–6	1.883E–7	9.520E–9	7.050E–8	4.179E–4
12.0	6.215E–4	4.496E–5	1.861E–2	1.550E–7	7.463E–5	1.118E–5	4.283E–6	3.442E–7	9.440E–9	6.975E–8	5.008E–4
14.0	5.858E–4	5.107E–5	1.858E–2	2.302E–7	8.198E–5	1.391E–5	5.840E–6	5.636E–7	9.345E–9	6.889E–8	5.835E–4
16.0	5.518E–4	5.683E–5	1.856E–2	3.247E–7	8.835E–5	1.669E–5	7.519E–6	8.527E–7	9.240E–9	6.794E–8	6.660E–4
18.0	5.191E–4	6.228E–5	1.853E–2	4.402E–7	9.386E–5	1.950E–5	9.281E–6	1.216E–6	9.124E–9	6.691E–8	7.483E–4
20.0	4.879E–4	6.740E–5	1.851E–2	5.783E–7	9.860E–5	2.232E–5	1.109E–5	1.656E–6	9.001E–9	6.583E–8	8.304E–4
22.0	4.580E–4	7.223E–5	1.848E–2	7.401E–7	1.027E–4	2.514E–5	1.291E–5	2.174E–6	8.870E–9	6.470E–8	9.124E–4
24.0	4.294E–4	7.676E–5	1.845E–2	9.268E–7	1.062E–4	2.793E–5	1.472E–5	2.770E–6	8.735E–9	6.353E–8	9.942E–4
26.0	4.020E–4	8.100E–5	1.843E–2	1.139E–6	1.091E–4	3.068E–5	1.651E–5	3.445E–6	8.595E–9	6.234E–8	1.076E–3
28.0	3.759E–4	8.497E–5	1.840E–2	1.379E–6	1.116E–4	3.338E–5	1.825E–5	4.196E–6	8.452E–9	6.113E–8	1.157E–3
30.0	3.509E–4	8.866E–5	1.837E–2	1.645E–6	1.136E–4	3.602E–5	1.994E–5	5.023E–6	8.306E–9	5.991E–8	1.239E–3
32.0	3.271E–4	9.209E–5	1.834E–2	1.939E–6	1.153E–4	3.859E–5	2.155E–5	5.922E–6	8.159E–9	5.868E–8	1.320E–3
34.0	3.045E–4	9.526E–5	1.832E–2	2.260E–6	1.167E–4	4.108E–5	2.309E–5	6.890E–6	8.011E–9	5.746E–8	1.401E–3
36.0	2.829E–4	9.817E–5	1.829E–2	2.608E–6	1.178E–4	4.350E–5	2.456E–5	7.926E–6	7.863E–9	5.624E–8	1.482E–3
38.0	2.624E–4	1.008E–4	1.826E–2	2.983E–6	1.186E–4	4.582E–5	2.593E–5	9.024E–6	7.716E–9	5.504E–8	1.563E–3
40.0	2.430E–4	1.033E–4	1.823E–2	3.384E–6	1.192E–4	4.805E–5	2.723E–5	1.018E–5	7.569E–9	5.386E–8	1.644E–3
42.0	2.247E–4	1.055E–4	1.819E–2	3.811E–6	1.196E–4	5.019E–5	2.843E–5	1.140E–5	7.425E–9	5.270E–8	1.725E–3
44.0	2.073E–4	1.074E–4	1.816E–2	4.261E–6	1.198E–4	5.223E–5	2.955E–5	1.266E–5	7.282E–9	5.156E–8	1.806E–3
46.0	1.909E–4	1.092E–4	1.813E–2	4.734E–6	1.199E–4	5.416E–5	3.058E–5	1.398E–5	7.143E–9	5.046E–8	1.887E–3
48.0	1.755E–4	1.107E–4	1.810E–2	5.229E–6	1.198E–4	5.599E–5	3.152E–5	1.534E–5	7.007E–9	4.939E–8	1.968E–3
50.0	1.610E–4	1.120E–4	1.807E–2	5.742E–6	1.197E–4	5.772E–5	3.239E–5	1.674E–5	6.875E–9	4.835E–8	2.048E–3
52.0	1.474E–4	1.132E–4	1.803E–2	6.272E–6	1.194E–4	5.934E–5	3.317E–5	1.817E–5	6.747E–9	4.735E–8	2.129E–3
54.0	1.348E–4	1.141E–4	1.800E–2	6.817E–6	1.191E–4	6.086E–5	3.388E–5	1.963E–5	6.623E–9	4.639E–8	2.210E–3
56.0	1.229E–4	1.148E–4	1.796E–2	7.374E–6	1.187E–4	6.228E–5	3.452E–5	2.112E–5	6.504E–9	4.547E–8	2.291E–3
58.0	1.119E–4	1.154E–4	1.793E–2	7.941E–6	1.183E–4	6.359E–5	3.509E–5	2.264E–5	6.390E–9	4.460E–8	2.372E–3
60.0	1.017E–4	1.158E–4	1.789E–2	8.515E–6	1.178E–4	6.480E–5	3.559E–5	2.417E–5	6.282E–9	4.377E–8	2.452E–3

Table 4.160. Nuclide concentration [atoms/(b·cm)] in fuel pin 1 vs burnup, Variant 12

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
0.0	3.839E–5	0.000E+0	1.892E–2	0.000E+0	6.588E–4	4.232E–5	7.025E–6	0.000E+0	1.622E–8	1.423E–7	0.000E+0
2.0	3.695E–5	2.995E–7	1.889E–2	2.176E–9	6.196E–4	5.693E–5	1.208E–5	2.412E–7	1.598E–8	1.398E–7	8.468E–5
4.0	3.552E–5	5.931E–7	1.887E–2	9.185E–9	5.834E–4	7.025E–5	1.748E–5	6.233E–7	1.548E–8	1.339E–7	1.691E–4
6.0	3.409E–5	8.798E–7	1.884E–2	2.187E–8	5.488E–4	8.237E–5	2.305E–5	1.158E–6	1.498E–8	1.281E–7	2.531E–4
8.0	3.268E–5	1.159E–6	1.882E–2	4.121E–8	5.158E–4	9.333E–5	2.862E–5	1.853E–6	1.450E–8	1.227E–7	3.367E–4
10.0	3.128E–5	1.431E–6	1.879E–2	6.828E–8	4.845E–4	1.032E–4	3.411E–5	2.713E–6	1.403E–8	1.176E–7	4.199E–4
12.0	2.990E–5	1.694E–6	1.877E–2	1.042E–7	4.547E–4	1.120E–4	3.941E–5	3.742E–6	1.358E–8	1.127E–7	5.027E–4
14.0	2.853E–5	1.948E–6	1.874E–2	1.501E–7	4.266E–4	1.199E–4	4.446E–5	4.937E–6	1.313E–8	1.081E–7	5.852E–4
16.0	2.719E–5	2.194E–6	1.871E–2	2.070E–7	4.001E–4	1.267E–4	4.921E–5	6.298E–6	1.271E–8	1.038E–7	6.673E–4
18.0	2.587E–5	2.430E–6	1.869E–2	2.761E–7	3.753E–4	1.327E–4	5.361E–5	7.819E–6	1.229E–8	9.964E–8	7.491E–4
20.0	2.457E–5	2.657E–6	1.866E–2	3.581E–7	3.521E–4	1.377E–4	5.763E–5	9.494E–6	1.190E–8	9.574E–8	8.305E–4
22.0	2.330E–5	2.873E–6	1.863E–2	4.540E–7	3.305E–4	1.419E–4	6.125E–5	1.132E–5	1.152E–8	9.205E–8	9.117E–4
24.0	2.205E–5	3.080E–6	1.860E–2	5.642E–7	3.104E–4	1.453E–4	6.444E–5	1.328E–5	1.115E–8	8.856E–8	9.926E–4
26.0	2.084E–5	3.276E–6	1.857E–2	6.893E–7	2.919E–4	1.480E–4	6.722E–5	1.536E–5	1.080E–8	8.529E–8	1.073E–3
28.0	1.965E–5	3.462E–6	1.854E–2	8.292E–7	2.748E–4	1.499E–4	6.957E–5	1.757E–5	1.047E–8	8.220E–8	1.154E–3
30.0	1.850E–5	3.638E–6	1.851E–2	9.841E–7	2.592E–4	1.512E–4	7.150E–5	1.987E–5	1.016E–8	7.929E–8	1.234E–3
32.0	1.739E–5	3.802E–6	1.848E–2	1.154E–6	2.449E–4	1.519E–4	7.303E–5	2.227E–5	9.855E–9	7.654E–8	1.314E–3
34.0	1.631E–5	3.956E–6	1.845E–2	1.337E–6	2.320E–4	1.520E–4	7.416E–5	2.474E–5	9.569E–9	7.396E–8	1.395E–3
36.0	1.527E–5	4.098E–6	1.842E–2	1.534E–6	2.202E–4	1.517E–4	7.493E–5	2.727E–5	9.298E–9	7.152E–8	1.474E–3
38.0	1.427E–5	4.229E–6	1.838E–2	1.742E–6	2.096E–4	1.509E–4	7.536E–5	2.984E–5	9.041E–9	6.923E–8	1.554E–3
40.0	1.331E–5	4.349E–6	1.835E–2	1.961E–6	2.000E–4	1.497E–4	7.548E–5	3.244E–5	8.799E–9	6.708E–8	1.634E–3
42.0	1.239E–5	4.458E–6	1.832E–2	2.190E–6	1.914E–4	1.482E–4	7.532E–5	3.506E–5	8.571E–9	6.505E–8	1.714E–3
44.0	1.151E–5	4.557E–6	1.829E–2	2.426E–6	1.837E–4	1.464E–4	7.492E–5	3.768E–5	8.363E–9	6.323E–8	1.794E–3
46.0	1.068E–5	4.644E–6	1.825E–2	2.668E–6	1.769E–4	1.444E–4	7.432E–5	4.027E–5	8.163E–9	6.145E–8	1.873E–3
48.0	9.882E–6	4.720E–6	1.822E–2	2.914E–6	1.708E–4	1.422E–4	7.352E–5	4.285E–5	7.974E–9	5.978E–8	1.953E–3
50.0	9.131E–6	4.786E–6	1.818E–2	3.162E–6	1.653E–4	1.398E–4	7.257E–5	4.539E–5	7.795E–9	5.819E–8	2.033E–3
52.0	8.421E–6	4.843E–6	1.815E–2	3.410E–6	1.604E–4	1.373E–4	7.149E–5	4.788E–5	7.625E–9	5.670E–8	2.112E–3
54.0	7.751E–6	4.889E–6	1.811E–2	3.657E–6	1.560E–4	1.348E–4	7.031E–5	5.033E–5	7.466E–9	5.530E–8	2.192E–3
56.0	7.122E–6	4.927E–6	1.807E–2	3.900E–6	1.521E–4	1.322E–4	6.905E–5	5.271E–5	7.318E–9	5.400E–8	2.272E–3
58.0	6.532E–6	4.955E–6	1.804E–2	4.138E–6	1.485E–4	1.295E–4	6.774E–5	5.502E–5	7.177E–9	5.275E–8	2.353E–3
60.0	5.979E–6	4.974E–6	1.800E–2	4.369E–6	1.454E–4	1.269E–4	6.639E–5	5.726E–5	7.039E–9	5.155E–8	2.433E–3

Table 4.161. Nuclide concentration [atoms/(b·cm)] in fuel pin 29 vs burnup, Variant 12

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
0.0	3.839E–5	0.000E+0	1.892E–2	0.000E+0	6.588E–4	4.232E–5	7.025E–6	0.000E+0	1.603E–8	1.448E–7	0.000E+0
2.0	3.702E–5	2.883E–7	1.889E–2	2.117E–9	6.227E–4	5.592E–5	1.197E–5	2.264E–7	1.588E–8	1.430E–7	8.010E–5
4.0	3.566E–5	5.715E–7	1.887E–2	8.934E–9	5.892E–4	6.847E–5	1.721E–5	5.823E–7	1.546E–8	1.374E–7	1.603E–4
6.0	3.429E–5	8.487E–7	1.885E–2	2.126E–8	5.570E–4	8.000E–5	2.258E–5	1.077E–6	1.503E–8	1.319E–7	2.405E–4
8.0	3.294E–5	1.119E–6	1.882E–2	4.003E–8	5.261E–4	9.055E–5	2.797E–5	1.718E–6	1.460E–8	1.267E–7	3.205E–4
10.0	3.160E–5	1.383E–6	1.880E–2	6.626E–8	4.965E–4	1.002E–4	3.328E–5	2.511E–6	1.419E–8	1.217E–7	4.005E–4
12.0	3.027E–5	1.639E–6	1.877E–2	1.010E–7	4.681E–4	1.089E–4	3.845E–5	3.457E–6	1.378E–8	1.170E–7	4.804E–4
14.0	2.896E–5	1.887E–6	1.874E–2	1.454E–7	4.412E–4	1.167E–4	4.340E–5	4.558E–6	1.338E–8	1.124E–7	5.602E–4
16.0	2.766E–5	2.127E–6	1.872E–2	2.004E–7	4.156E–4	1.236E–4	4.810E–5	5.814E–6	1.298E–8	1.081E–7	6.399E–4
18.0	2.638E–5	2.359E–6	1.869E–2	2.672E–7	3.914E–4	1.298E–4	5.249E–5	7.221E–6	1.260E–8	1.040E–7	7.196E–4
20.0	2.512E–5	2.582E–6	1.866E–2	3.465E–7	3.685E–4	1.351E–4	5.655E–5	8.775E–6	1.223E–8	1.001E–7	7.992E–4
22.0	2.389E–5	2.797E–6	1.863E–2	4.392E–7	3.471E–4	1.396E–4	6.025E–5	1.047E–5	1.186E–8	9.633E–8	8.787E–4
24.0	2.267E–5	3.002E–6	1.860E–2	5.459E–7	3.270E–4	1.434E–4	6.358E–5	1.231E–5	1.151E–8	9.277E–8	9.582E–4
26.0	2.148E–5	3.197E–6	1.858E–2	6.671E–7	3.082E–4	1.465E–4	6.651E–5	1.427E–5	1.117E–8	8.952E–8	1.038E–3
28.0	2.032E–5	3.382E–6	1.855E–2	8.027E–7	2.909E–4	1.490E–4	6.899E–5	1.634E–5	1.085E–8	8.639E–8	1.117E–3
30.0	1.920E–5	3.558E–6	1.852E–2	9.529E–7	2.750E–4	1.508E–4	7.109E–5	1.850E–5	1.054E–8	8.338E–8	1.196E–3
32.0	1.810E–5	3.723E–6	1.849E–2	1.118E–6	2.603E–4	1.520E–4	7.282E–5	2.077E–5	1.024E–8	8.052E–8	1.275E–3
34.0	1.703E–5	3.878E–6	1.846E–2	1.296E–6	2.468E–4	1.527E–4	7.419E–5	2.312E–5	9.953E–9	7.780E–8	1.354E–3
36.0	1.600E–5	4.023E–6	1.842E–2	1.488E–6	2.344E–4	1.528E–4	7.522E–5	2.554E–5	9.679E–9	7.524E–8	1.433E–3
38.0	1.500E–5	4.157E–6	1.839E–2	1.693E–6	2.230E–4	1.525E–4	7.591E–5	2.801E–5	9.417E–9	7.281E–8	1.512E–3
40.0	1.404E–5	4.282E–6	1.836E–2	1.909E–6	2.127E–4	1.518E–4	7.630E–5	3.054E–5	9.168E–9	7.052E–8	1.591E–3
42.0	1.311E–5	4.396E–6	1.833E–2	2.135E–6	2.033E–4	1.507E–4	7.640E–5	3.309E–5	8.931E–9	6.835E–8	1.670E–3
44.0	1.222E–5	4.499E–6	1.829E–2	2.369E–6	1.948E–4	1.492E–4	7.624E–5	3.567E–5	8.707E–9	6.632E–8	1.750E–3
46.0	1.137E–5	4.592E–6	1.826E–2	2.611E–6	1.872E–4	1.475E–4	7.586E–5	3.825E–5	8.495E–9	6.441E–8	1.829E–3
48.0	1.056E–5	4.675E–6	1.823E–2	2.858E–6	1.803E–4	1.456E–4	7.527E–5	4.083E–5	8.299E–9	6.265E–8	1.909E–3
50.0	9.793E–6	4.748E–6	1.819E–2	3.108E–6	1.741E–4	1.434E–4	7.452E–5	4.337E–5	8.114E–9	6.101E–8	1.988E–3
52.0	9.064E–6	4.811E–6	1.816E–2	3.360E–6	1.686E–4	1.410E–4	7.363E–5	4.589E–5	7.933E–9	5.938E–8	2.067E–3
54.0	8.373E–6	4.864E–6	1.812E–2	3.612E–6	1.636E–4	1.386E–4	7.259E–5	4.837E–5	7.763E–9	5.787E–8	2.147E–3
56.0	7.721E–6	4.908E–6	1.809E–2	3.862E–6	1.591E–4	1.361E–4	7.145E–5	5.080E–5	7.605E–9	5.645E–8	2.227E–3
58.0	7.105E–6	4.943E–6	1.805E–2	4.107E–6	1.551E–4	1.335E–4	7.023E–5	5.318E–5	7.452E–9	5.509E–8	2.307E–3
60.0	6.527E–6	4.970E–6	1.801E–2	4.347E–6	1.515E–4	1.308E–4	6.895E–5	5.550E–5	7.300E–9	5.376E–8	2.387E–3

Table 4.162. Nuclide concentration [atoms/(b·cm)] in fuel pin 72 vs burnup, Variant 12

Burnup (MWd/kg)	^{235}U	^{236}U	^{238}U	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{135}Xe	^{149}Sm	Fission product
0.0	3.839E–5	0.000E+0	1.892E–2	0.000E+0	6.588E–4	4.232E–5	7.025E–6	0.000E+0	1.603E–8	1.448E–7	0.000E+0
2.0	3.702E–5	2.883E–7	1.889E–2	2.117E–9	6.227E–4	5.592E–5	1.197E–5	2.264E–7	1.588E–8	1.430E–7	8.010E–5
4.0	3.566E–5	5.715E–7	1.887E–2	8.934E–9	5.892E–4	6.847E–5	1.721E–5	5.823E–7	1.546E–8	1.374E–7	1.603E–4
6.0	3.429E–5	8.487E–7	1.885E–2	2.126E–8	5.570E–4	8.000E–5	2.258E–5	1.077E–6	1.503E–8	1.319E–7	2.405E–4
8.0	3.294E–5	1.119E–6	1.882E–2	4.003E–8	5.261E–4	9.055E–5	2.797E–5	1.718E–6	1.460E–8	1.267E–7	3.205E–4
10.0	3.160E–5	1.383E–6	1.880E–2	6.626E–8	4.965E–4	1.002E–4	3.328E–5	2.511E–6	1.419E–8	1.217E–7	4.005E–4
12.0	3.027E–5	1.639E–6	1.877E–2	1.010E–7	4.681E–4	1.089E–4	3.845E–5	3.457E–6	1.378E–8	1.170E–7	4.804E–4
14.0	2.896E–5	1.887E–6	1.874E–2	1.454E–7	4.412E–4	1.167E–4	4.340E–5	4.558E–6	1.338E–8	1.124E–7	5.602E–4
16.0	2.766E–5	2.127E–6	1.872E–2	2.004E–7	4.156E–4	1.236E–4	4.810E–5	5.814E–6	1.298E–8	1.081E–7	6.399E–4
18.0	2.638E–5	2.359E–6	1.869E–2	2.672E–7	3.914E–4	1.298E–4	5.249E–5	7.221E–6	1.260E–8	1.040E–7	7.196E–4
20.0	2.512E–5	2.582E–6	1.866E–2	3.465E–7	3.685E–4	1.351E–4	5.655E–5	8.775E–6	1.223E–8	1.001E–7	7.992E–4
22.0	2.389E–5	2.797E–6	1.863E–2	4.392E–7	3.471E–4	1.396E–4	6.025E–5	1.047E–5	1.186E–8	9.633E–8	8.787E–4
24.0	2.267E–5	3.002E–6	1.860E–2	5.459E–7	3.270E–4	1.434E–4	6.358E–5	1.231E–5	1.151E–8	9.277E–8	9.582E–4
26.0	2.148E–5	3.197E–6	1.858E–2	6.671E–7	3.082E–4	1.465E–4	6.651E–5	1.427E–5	1.117E–8	8.952E–8	1.038E–3
28.0	2.032E–5	3.382E–6	1.855E–2	8.027E–7	2.909E–4	1.490E–4	6.899E–5	1.634E–5	1.085E–8	8.639E–8	1.117E–3
30.0	1.920E–5	3.558E–6	1.852E–2	9.529E–7	2.750E–4	1.508E–4	7.109E–5	1.850E–5	1.054E–8	8.338E–8	1.196E–3
32.0	1.810E–5	3.723E–6	1.849E–2	1.118E–6	2.603E–4	1.520E–4	7.282E–5	2.077E–5	1.024E–8	8.052E–8	1.275E–3
34.0	1.703E–5	3.878E–6	1.846E–2	1.296E–6	2.468E–4	1.527E–4	7.419E–5	2.312E–5	9.953E–9	7.780E–8	1.354E–3
36.0	1.600E–5	4.023E–6	1.842E–2	1.488E–6	2.344E–4	1.528E–4	7.522E–5	2.554E–5	9.679E–9	7.524E–8	1.433E–3
38.0	1.500E–5	4.157E–6	1.839E–2	1.693E–6	2.230E–4	1.525E–4	7.591E–5	2.801E–5	9.417E–9	7.281E–8	1.512E–3
40.0	1.404E–5	4.282E–6	1.836E–2	1.909E–6	2.127E–4	1.518E–4	7.630E–5	3.054E–5	9.168E–9	7.052E–8	1.591E–3
42.0	1.311E–5	4.396E–6	1.833E–2	2.135E–6	2.033E–4	1.507E–4	7.640E–5	3.309E–5	8.931E–9	6.835E–8	1.670E–3
44.0	1.222E–5	4.499E–6	1.829E–2	2.369E–6	1.948E–4	1.492E–4	7.624E–5	3.567E–5	8.707E–9	6.632E–8	1.750E–3
46.0	1.137E–5	4.592E–6	1.826E–2	2.611E–6	1.872E–4	1.475E–4	7.586E–5	3.825E–5	8.495E–9	6.441E–8	1.829E–3
48.0	1.056E–5	4.675E–6	1.823E–2	2.858E–6	1.803E–4	1.456E–4	7.527E–5	4.083E–5	8.299E–9	6.265E–8	1.909E–3
50.0	9.793E–6	4.748E–6	1.819E–2	3.108E–6	1.741E–4	1.434E–4	7.452E–5	4.337E–5	8.114E–9	6.101E–8	1.988E–3
52.0	9.064E–6	4.811E–6	1.816E–2	3.360E–6	1.686E–4	1.410E–4	7.363E–5	4.589E–5	7.933E–9	5.938E–8	2.067E–3
54.0	8.373E–6	4.864E–6	1.812E–2	3.612E–6	1.636E–4	1.386E–4	7.259E–5	4.837E–5	7.763E–9	5.787E–8	2.147E–3
56.0	7.721E–6	4.908E–6	1.809E–2	3.862E–6	1.591E–4	1.361E–4	7.145E–5	5.080E–5	7.605E–9	5.645E–8	2.227E–3
58.0	7.105E–6	4.943E–6	1.805E–2	4.107E–6	1.551E–4	1.335E–4	7.023E–5	5.318E–5	7.452E–9	5.509E–8	2.307E–3
60.0	6.527E–6	4.970E–6	1.801E–2	4.347E–6	1.515E–4	1.308E–4	6.895E–5	5.550E–5	7.300E–9	5.376E–8	2.387E–3

Table 4.163. Burnup-dependent physics parameters for Variant V13, State S1

Burnup (MWd/MT)	k_{eff}	k_0	Buckling (cm^{-2})	Migration area (cm^2)
0.000	1.057605	1.258261	3.00000E-03	63.740
2.000	1.040187	1.237529	3.00000E-03	63.740
4.000	1.023579	1.217773	3.00000E-03	63.744
6.000	1.007093	1.198198	3.00000E-03	63.756
8.000	0.991185	1.179325	3.00000E-03	63.774
10.000	0.975983	1.161311	3.00000E-03	63.800
12.000	0.961472	1.144136	3.00000E-03	63.833
14.000	0.947613	1.127743	3.00000E-03	63.869
16.000	0.934307	1.112024	3.00000E-03	63.910
18.000	0.921507	1.096907	3.00000E-03	63.954
20.000	0.909131	1.082305	3.00000E-03	64.003
22.000	0.897156	1.068176	3.00000E-03	64.052
24.000	0.885525	1.054461	3.00000E-03	64.103
26.000	0.874195	1.041107	3.00000E-03	64.157
28.000	0.863154	1.028102	3.00000E-03	64.213
30.000	0.852387	1.015417	3.00000E-03	64.269
32.000	0.841869	1.003031	3.00000E-03	64.327
34.000	0.831602	0.990941	3.00000E-03	64.385
36.000	0.821566	0.979126	3.00000E-03	64.445
38.000	0.811765	0.967589	3.00000E-03	64.505
40.000	0.802196	0.956325	3.00000E-03	64.565
42.000	0.792850	0.945329	3.00000E-03	64.627
44.000	0.783762	0.934627	3.00000E-03	64.686
46.000	0.774885	0.924182	3.00000E-03	64.747
48.000	0.766245	0.914015	3.00000E-03	64.808
50.000	0.757857	0.904140	3.00000E-03	64.868
52.000	0.749682	0.894527	3.00000E-03	64.930
54.000	0.741781	0.885225	3.00000E-03	64.987
56.000	0.734110	0.876199	3.00000E-03	65.047
58.000	0.726684	0.867460	3.00000E-03	65.105
60.000	0.719500	0.859012	3.00000E-03	65.164

Table 4.164. Burnup-dependent physics parameters for Variant V13, State S4

Burnup (MWd/MT)	k_{eff}	k_0	Buckling (cm^{-2})	Migration area (cm^2)
0.000	1.097090	1.305556	3.00000E-03	63.836
10.000	1.011790	1.204201	3.00000E-03	63.892
20.000	0.941704	1.121333	3.00000E-03	64.090
30.000	0.882183	1.051153	3.00000E-03	64.359
40.000	0.829505	0.989105	3.00000E-03	64.655
50.000	0.782901	0.934237	3.00000E-03	64.959
60.000	0.742565	0.886757	3.00000E-03	65.256

Table 4.165. Burnup-dependent physics parameters for Variant V13, State S6

Burnup (MWd/MT)	k_{eff}	k_0	Buckling (cm^{-2})	Migration area (cm^2)
0.000	1.213490	1.361397	3.00000E-03	40.832
10.000	1.126030	1.263600	3.00000E-03	40.933
20.000	1.051020	1.179918	3.00000E-03	41.092
30.000	0.984043	1.105266	3.00000E-03	41.278
40.000	0.922633	1.036834	3.00000E-03	41.474
50.000	0.866990	0.974813	3.00000E-03	41.670
60.000	0.818050	0.920249	3.00000E-03	41.859

```
                                   67   -  cell number
                                   26.  -  cell type

                                68    56
                                50.   25.

                             69    57    46
                             50.   50.   25.

                          70    58    47    37
                          50.   50.   50.   25.

                       71    59    48    38    29
                       50.   50.   50.   50.   25.

                    72    60    49    39    30    22
                    50.   50.   50.   50.   50.   25.

                 73    61    50    40    31    23    16
                 29.   50.   50.   50.   50.   50.   25.

              74    62    51    41    32    24    17    11
              50.   50.   50.   50.   50.   50.   50.   25.

           75    63    52    42    33    25    18    12     7
           50.   50.   50.   29.   50.   50.   50.   50.   25.

        76    64    53    43    34    26    19    13     8     4
        50.   29.   50.   50.   50.   50.   50.   50.   50.   25.

     77    65    54    44    35    27    20    14     9     5     2
     50.   50.   50.   50.   50.   50.   50.   50.   50.   50.   25.

78    66    55    45    36    28    21    15    10     6     3     1
27.   50.   50.   50.   50.   29.   50.   50.   50.   50.   50.   26.
```

Note: 50.—fuel cell (G1)
26.—corner water cell
25.—side water cell
27.—central tube cell (G2)
29.—guide tube cell (G4)

Fig. 4.7. Positions and numbers of cells in fuel assembly (60° symmetry angle).

```
                    67
                 0.000

               68    56
             1.056 0.000

            69    57    46
          0.993 1.035 0.000

         70    58    47    37
       0.963 0.980 1.027 0.000

      71    59    48    38    29
    0.958 0.959 0.976 1.025 0.000

   72    60    49    39    30    22
 0.993 0.964 0.960 0.976 1.024 0.000

73    61    50    40    31    23    16
0.000 1.002 0.972 0.965 0.977 1.024 0.000

74    62    51    41    32    24    17    11
1.023 1.020 1.010 0.996 0.969 0.977 1.024 0.000

75    63    52    42    33    25    18    12     7
1.030 1.029 1.023 0.000 0.995 0.965 0.976 1.025 0.000

76    64    53    43    34    26    19    13     8     4
1.038 0.000 1.027 1.020 1.009 0.971 0.960 0.976 1.027 0.000

77    65    54    44    35    27    20    14     9     5     2
1.045 1.040 1.032 1.007 1.017 1.002 0.964 0.959 0.980 1.035 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 1.045 1.038 1.030 1.023 0.000 0.993 0.958 0.963 0.993 1.056 0.000
```

Fig. 4.8. Pin-by-pin power distribution, Variant 11, State 1, at burnup = 0.0 MWd/kg (U + Pu).

```
                    67
                 0.000

              68    56
           1.046 0.000

          69    57    46
       0.994 1.029 0.000

     70    58    47    37
  0.966 0.982 1.022 0.000

   71    59    48    38    29
0.962 0.962 0.978 1.019 0.000

 72    60    49    39    30    22
0.992 0.967 0.964 0.978 1.018 0.000

 73    61    50    40    31    23    16
0.000 1.001 0.975 0.968 0.979 1.018 0.000

 74    62    51    41    32    24    17    11
1.023 1.019 1.009 0.995 0.972 0.979 1.018 0.000

 75    63    52    42    33    25    18    12     7
1.031 1.029 1.022 0.000 0.995 0.968 0.978 1.019 0.000

 76    64    53    43    34    26    19    13     8     4
1.040 0.000 1.028 1.020 1.008 0.974 0.963 0.978 1.022 0.000

 77    65    54    44    35    27    20    14     9     5     2
1.047 1.042 1.034 1.012 1.016 1.001 0.967 0.962 0.982 1.029 0.000

 78    66    55    45    36    28    21    15    10     6     3     1
0.000 1.047 1.040 1.031 1.023 0.000 0.992 0.962 0.966 0.994 1.046 0.000
```

Fig. 4.9. Pin-by-pin power distribution, Variant 11, State 1, at burnup = 10.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
             1.035 0.000

            69    57    46
          0.996 1.022 0.000

         70    58    47    37
       0.973 0.986 1.016 0.000

      71    59    48    38    29
    0.969 0.969 0.983 1.014 0.000

   72    60    49    39    30    22
 0.993 0.974 0.971 0.982 1.013 0.000

73    61    50    40    31    23    16
0.000 1.001 0.980 0.975 0.983 1.013 0.000

74    62    51    41    32    24    17    11
1.019 1.016 1.007 0.995 0.977 0.983 1.013 0.000

75    63    52    42    33    25    18    12     7
1.026 1.024 1.018 0.000 0.995 0.975 0.982 1.014 0.000

76    64    53    43    34    26    19    13     8     4
1.034 0.000 1.024 1.016 1.006 0.979 0.971 0.982 1.016 0.000

77    65    54    44    35    27    20    14     9     5     2
1.040 1.035 1.029 1.011 1.013 1.000 0.974 0.969 0.986 1.022 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 1.040 1.034 1.026 1.019 0.000 0.993 0.969 0.973 0.996 1.035 0.000
```

Fig. 4.10. Pin-by-pin power distribution, Variant 11, State 1, at burnup = 20.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
            1.024 0.000

            69    57    46
         0.997 1.015 0.000

         70    58    47    37
      0.980 0.990 1.011 0.000

      71    59    48    38    29
   0.977 0.977 0.987 1.009 0.000

   72    60    49    39    30    22
0.994 0.981 0.978 0.987 1.008 0.000

73    61    50    40    31    23    16
0.000 1.000 0.985 0.981 0.988 1.008 0.000

74    62    51    41    32    24    17    11
1.015 1.012 1.005 0.996 0.983 0.988 1.008 0.000

75    63    52    42    33    25    18    12     7
1.021 1.019 1.014 0.000 0.996 0.981 0.987 1.009 0.000

76    64    53    43    34    26    19    13     8     4
1.027 0.000 1.018 1.012 1.004 0.985 0.978 0.987 1.011 0.000

77    65    54    44    35    27    20    14     9     5     2
1.031 1.028 1.023 1.010 1.010 1.000 0.980 0.977 0.990 1.015 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 1.031 1.027 1.021 1.015 0.000 0.994 0.977 0.980 0.997 1.024 0.000
```

Fig. 4.11. Pin-by-pin power distribution, Variant 11, State 1, at burnup = 30.0 MWd/kg (U + Pu).

```
                    67
                 0.000

              68    56
            1.014 0.000

           69    57    46
         0.998 1.009 0.000

        70    58    47    37
      0.987 0.993 1.006 0.000

     71    59    48    38    29
   0.984 0.985 0.992 1.005 0.000

  72    60    49    39    30    22
0.995 0.987 0.986 0.992 1.005 0.000

73    61    50    40    31    23    16
0.000 1.000 0.990 0.988 0.992 1.005 0.000

74    62    51    41    32    24    17    11
1.011 1.008 1.003 0.997 0.989 0.992 1.005 0.000

75    63    52    42    33    25    18    12     7
1.015 1.013 1.010 0.000 0.997 0.988 0.992 1.005 0.000

76    64    53    43    34    26    19    13     8     4
1.019 0.000 1.013 1.009 1.003 0.990 0.986 0.992 1.006 0.000

77    65    54    44    35    27    20    14     9     5     2
1.022 1.020 1.016 1.009 1.007 0.999 0.987 0.985 0.993 1.009 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 1.022 1.019 1.015 1.011 0.000 0.995 0.984 0.987 0.998 1.014 0.000
```

Fig. 4.12. Pin-by-pin power distribution, Variant 11, State 1, at burnup = 40.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
             1.007 0.000

            69    57    46
          0.999 1.005 0.000

         70    58    47    37
       0.992 0.996 1.003 0.000

      71    59    48    38    29
    0.991 0.991 0.995 1.002 0.000

   72    60    49    39    30    22
 0.997 0.992 0.991 0.995 1.002 0.000

73    61    50    40    31    23    16
0.000 0.999 0.994 0.993 0.995 1.002 0.000

74    62    51    41    32    24    17    11
1.007 1.005 1.002 0.998 0.994 0.995 1.002 0.000

75    63    52    42    33    25    18    12     7
1.010 1.008 1.006 0.000 0.998 0.993 0.995 1.002 0.000

76    64    53    43    34    26    19    13     8     4
1.013 0.000 1.009 1.005 1.001 0.994 0.991 0.995 1.003 0.000

77    65    54    44    35    27    20    14     9     5     2
1.014 1.013 1.011 1.007 1.004 0.999 0.992 0.991 0.996 1.005 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 1.014 1.013 1.010 1.007 0.000 0.997 0.991 0.992 0.999 1.007 0.000
```

Fig. 4.13. Pin-by-pin power distribution, Variant 11, State 1, at burnup = 50.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
            1.005 0.000

            69    57    46
         1.000 1.003 0.000

         70    58    47    37
      0.996 0.998 1.002 0.000

      71    59    48    38    29
   0.995 0.995 0.998 1.001 0.000

   72    60    49    39    30    22
0.998 0.996 0.995 0.997 1.001 0.000

73    61    50    40    31    23    16
0.000 0.999 0.997 0.996 0.998 1.001 0.000

74    62    51    41    32    24    17    11
1.004 1.003 1.001 0.998 0.996 0.998 1.001 0.000

75    63    52    42    33    25    18    12     7
1.005 1.005 1.003 0.000 0.998 0.996 0.997 1.001 0.000

76    64    53    43    34    26    19    13     8     4
1.007 0.000 1.004 1.003 1.000 0.997 0.995 0.998 1.002 0.000

77    65    54    44    35    27    20    14     9     5     2
1.008 1.007 1.003 1.004 1.002 0.999 0.996 0.995 0.998 1.003 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 1.008 1.007 1.005 1.004 0.000 0.998 0.995 0.996 1.000 1.005 0.000
```

Fig. 4.14. Pin-by-pin power distribution, Variant 11, State 1, at burnup = 60.0 MWd/kg (U + Pu).

```
                    67
                 0.000

              68    56
           1.282 0.000

           69    57    46
        1.193 1.250 0.000

        70    58    47    37
     1.118 1.162 1.231 0.000

     71    59    48    38    29
  1.032 1.084 1.140 1.217 0.000

  72    60    49    39    30    22
0.903 0.989 1.057 1.124 1.207 0.000

73    61    50    40    31    23    16
0.000 0.859 0.955 1.034 1.114 1.204 0.000

74    62    51    41    32    24    17    11
0.756 0.778 0.830 0.907 1.023 1.114 1.208 0.000

75    63    52    42    33    25    18    12     7
0.738 0.743 0.765 0.000 0.908 1.034 1.124 1.217 0.000

76    64    53    43    34    26    19    13     8     4
0.747 0.000 0.744 0.771 0.832 0.956 1.057 1.140 1.231 0.000

77    65    54    44    35    27    20    14     9     5     2
0.826 0.757 0.738 0.773 0.785 0.861 0.989 1.084 1.162 1.250 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 0.826 0.747 0.738 0.756 0.000 0.903 1.032 1.118 1.193 1.282 0.000
```

Fig. 4.15. Pin-by-pin power distribution, Variant 11, State 2, at burnup = 0.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
            1.282 0.000

            69    57    46
         1.203 1.254 0.000

         70    58    47    37
      1.128 1.172 1.235 0.000

      71    59    48    38    29
   1.038 1.092 1.149 1.220 0.000

   72    60    49    39    30    22
0.900 0.992 1.063 1.132 1.209 0.000

73    61    50    40    31    23    16
0.000 0.854 0.955 1.038 1.121 1.206 0.000

74    62    51    41    32    24    17    11
0.747 0.770 0.823 0.904 1.027 1.121 1.209 0.000

75    63    52    42    33    25    18    12     7
0.727 0.732 0.756 0.000 0.904 1.039 1.132 1.220 0.000

76    64    53    43    34    26    19    13     8     4
0.734 0.000 0.733 0.762 0.826 0.956 1.063 1.149 1.235 0.000

77    65    54    44    35    27    20    14     9     5     2
0.810 0.743 0.727 0.764 0.776 0.855 0.992 1.092 1.172 1.255 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 0.810 0.734 0.727 0.747 0.000 0.900 1.038 1.128 1.203 1.282 0.000
```

Fig. 4.16. Pin-by-pin power distribution, Variant 11, State 2, at burnup = 10.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
            1.269 0.000

            69    57    46
         1.206 1.247 0.000

         70    58    47    37
      1.136 1.177 1.229 0.000

      71    59    48    38    29
   1.045 1.100 1.155 1.214 0.000

   72    60    49    39    30    22
0.900 0.997 1.071 1.137 1.204 0.000

73    61    50    40    31    23    16
0.000 0.852 0.960 1.045 1.126 1.200 0.000

74    62    51    41    32    24    17    11
0.743 0.766 0.821 0.904 1.032 1.126 1.204 0.000

75    63    52    42    33    25    18    12     7
0.723 0.728 0.752 0.000 0.904 1.045 1.137 1.214 0.000

76    64    53    43    34    26    19    13     8     4
0.729 0.000 0.729 0.758 0.823 0.961 1.071 1.155 1.229 0.000

77    65    54    44    35    27    20    14     9     5     2
0.803 0.738 0.722 0.763 0.773 0.854 0.998 1.100 1.178 1.247 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 0.803 0.729 0.723 0.743 0.000 0.900 1.045 1.136 1.206 1.269 0.000
```

Fig. 4.17. Pin-by-pin power distribution, Variant 11, State 2, at burnup = 20.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
             1.256 0.000

            69    57    46
          1.209 1.239 0.000

         70    58    47    37
       1.145 1.183 1.223 0.000

      71    59    48    38    29
    1.053 1.109 1.161 1.209 0.000

   72    60    49    39    30    22
 0.900 1.003 1.079 1.143 1.199 0.000

73    61    50    40    31    23    16
0.000 0.851 0.964 1.052 1.131 1.196 0.000

74    62    51    41    32    24    17    11
0.738 0.762 0.818 0.904 1.038 1.131 1.199 0.000

75    63    52    42    33    25    18    12     7
0.717 0.722 0.748 0.000 0.904 1.052 1.143 1.209 0.000

76    64    53    43    34    26    19    13     8     4
0.722 0.000 0.724 0.754 0.821 0.965 1.079 1.161 1.223 0.000

77    65    54    44    35    27    20    14     9     5     2
0.793 0.731 0.716 0.760 0.769 0.853 1.004 1.110 1.183 1.239 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 0.793 0.722 0.717 0.738 0.000 0.900 1.053 1.145 1.209 1.256 0.000
```

Fig. 4.18. Pin-by-pin power distribution, Variant 11, State 2, at burnup = 30.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
            1.246 0.000

            69    57    46
         1.211 1.233 0.000

         70    58    47    37
      1.153 1.188 1.219 0.000

      71    59    48    38    29
   1.061 1.118 1.167 1.205 0.000

   72    60    49    39    30    22
0.901 1.009 1.087 1.148 1.196 0.000

73    61    50    40    31    23    16
0.000 0.850 0.968 1.058 1.137 1.192 0.000

74    62    51    41    32    24    17    11
0.733 0.758 0.815 0.904 1.044 1.137 1.196 0.000

75    63    52    42    33    25    18    12     7
0.711 0.716 0.743 0.000 0.905 1.058 1.149 1.206 0.000

76    64    53    43    34    26    19    13     8     4
0.714 0.000 0.718 0.750 0.818 0.969 1.087 1.167 1.219 0.000

77    65    54    44    35    27    20    14     9     5     2
0.783 0.723 0.709 0.756 0.766 0.852 1.010 1.118 1.188 1.233 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 0.783 0.714 0.711 0.733 0.000 0.901 1.061 1.153 1.211 1.246 0.000
```

Fig. 4.19. Pin-by-pin power distribution, Variant 11, State 2, at burnup = 40.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
            1.239 0.000

            69    57    46
         1.213 1.229 0.000

         70    58    47    37
      1.160 1.192 1.216 0.000

      71    59    48    38    29
   1.067 1.125 1.171 1.203 0.000

   72    60    49    39    30    22
0.902 1.014 1.093 1.152 1.193 0.000

73    61    50    40    31    23    16
0.000 0.849 0.971 1.063 1.140 1.189 0.000

74    62    51    41    32    24    17    11
0.729 0.754 0.814 0.904 1.048 1.140 1.193 0.000

75    63    52    42    33    25    18    12     7
0.705 0.711 0.739 0.000 0.905 1.063 1.153 1.203 0.000

76    64    53    43    34    26    19    13     8     4
0.707 0.000 0.713 0.746 0.817 0.972 1.093 1.171 1.216 0.000

77    65    54    44    35    27    20    14     9     5     2
0.774 0.716 0.704 0.752 0.762 0.851 1.014 1.125 1.192 1.229 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 0.774 0.707 0.705 0.729 0.000 0.902 1.067 1.160 1.213 1.239 0.000
```

Fig. 4.20. Pin-by-pin power distribution, Variant 11, State 2, at burnup = 50.0 MWd/kg (U + Pu).

```
                    67
                 0.000

              68    56
           1.236 0.000

           69    57    46
        1.214 1.228 0.000

        70    58    47    37
     1.164 1.195 1.215 0.000

     71    59    48    38    29
  1.071 1.129 1.174 1.202 0.000

  72    60    49    39    30    22
0.903 1.016 1.096 1.155 1.192 0.000

73    61    50    40    31    23    16
0.000 0.848 0.972 1.066 1.143 1.189 0.000

74    62    51    41    32    24    17    11
0.726 0.752 0.813 0.905 1.051 1.143 1.192 0.000

75    63    52    42    33    25    18    12     7
0.701 0.708 0.737 0.000 0.906 1.066 1.155 1.202 0.000

76    64    53    43    34    26    19    13     8     4
0.702 0.000 0.709 0.744 0.816 0.974 1.097 1.174 1.215 0.000

77    65    54    44    35    27    20    14     9     5     2
0.767 0.710 0.698 0.748 0.760 0.851 1.017 1.129 1.195 1.228 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 0.767 0.702 0.701 0.726 0.000 0.903 1.071 1.164 1.214 1.236 0.000
```

Fig. 4.21. Pin-by-pin power distribution, Variant 11, State 2, at burnup = 60.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
            1.087 0.000

            69    57    46
         0.987 1.054 0.000

         70    58    47    37
      0.943 0.968 1.043 0.000

      71    59    48    38    29
   0.938 0.938 0.963 1.040 0.000

   72    60    49    39    30    22
0.993 0.947 0.940 0.963 1.039 0.000

73    61    50    40    31    23    16
0.000 1.007 0.958 0.948 0.965 1.039 0.000

74    62    51    41    32    24    17    11
1.033 1.031 1.017 0.997 0.953 0.965 1.039 0.000

75    63    52    42    33    25    18    12     7
1.042 1.042 1.035 0.000 0.996 0.948 0.963 1.040 0.000

76    64    53    43    34    26    19    13     8     4
1.052 0.000 1.039 1.030 1.015 0.957 0.940 0.963 1.043 0.000

77    65    54    44    35    27    20    14     9     5     2
1.062 1.054 1.044 1.005 1.026 1.005 0.947 0.938 0.968 1.054 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 1.062 1.052 1.042 1.033 0.000 0.993 0.938 0.943 0.987 1.087 0.000
```

Fig. 4.22. Pin-by-pin power distribution, Variant 12, State 1, at burnup = 0.0 MWd/kg (U + Pu).

```
                    67
                 0.000

              68    56
           1.059 0.000

           69    57    46
        0.993 1.037 0.000

        70    58    47    37
     0.957 0.977 1.029 0.000

     71    59    48    38    29
  0.952 0.953 0.973 1.026 0.000

  72    60    49    39    30    22
0.992 0.960 0.955 0.973 1.025 0.000

73    61    50    40    31    23    16
0.000 1.003 0.969 0.961 0.974 1.025 0.000

74    62    51    41    32    24    17    11
1.027 1.024 1.012 0.995 0.965 0.974 1.025 0.000

75    63    52    42    33    25    18    12     7
1.036 1.034 1.027 0.000 0.995 0.961 0.973 1.026 0.000

76    64    53    43    34    26    19    13     8     4
1.045 0.000 1.032 1.024 1.010 0.968 0.954 0.973 1.029 0.000

77    65    54    44    35    27    20    14     9     5     2
1.053 1.047 1.038 1.011 1.020 1.002 0.959 0.953 0.977 1.037 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 1.053 1.045 1.036 1.027 0.000 0.992 0.952 0.957 0.993 1.059 0.000
```

Fig. 4.23. Pin-by-pin power distribution, Variant 12, State 1, at burnup = 10.0 MWd/kg (U + Pu).

```
                    67
                 0.000

              68    56
           1.036 0.000

          69    57    46
       0.997 1.023 0.000

      70    58    47    37
   0.971 0.986 1.017 0.000

     71    59    48    38    29
  0.966 0.967 0.982 1.015 0.000

    72    60    49    39    30    22
 0.992 0.972 0.968 0.982 1.014 0.000

   73    61    50    40    31    23    16
0.000 1.001 0.979 0.973 0.983 1.014 0.000

  74    62    51    41    32    24    17    11
1.020 1.017 1.007 0.995 0.976 0.983 1.014 0.000

  75    63    52    42    33    25    18    12     7
1.028 1.026 1.019 0.000 0.995 0.973 0.982 1.015 0.000

  76    64    53    43    34    26    19    13     8     4
1.036 0.000 1.025 1.017 1.006 0.978 0.968 0.982 1.017 0.000

  77    65    54    44    35    27    20    14     9     5     2
1.042 1.037 1.030 1.013 1.014 1.000 0.971 0.967 0.986 1.023 0.000

  78    66    55    45    36    28    21    15    10     6     3     1
0.000 1.042 1.036 1.028 1.020 0.000 0.992 0.966 0.971 0.997 1.036 0.000
```

Fig. 4.24. Pin-by-pin power distribution, Variant 12, State 1, at burnup = 20.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
            1.021 0.000

            69    57    46
         1.001 1.014 0.000

         70    58    47    37
      0.984 0.994 1.010 0.000

      71    59    48    38    29
   0.979 0.980 0.990 1.007 0.000

   72    60    49    39    30    22
0.993 0.982 0.981 0.990 1.006 0.000

73    61    50    40    31    23    16
0.000 0.999 0.987 0.984 0.990 1.006 0.000

74    62    51    41    32    24    17    11
1.009 1.009 1.003 0.995 0.986 0.990 1.006 0.000

75    63    52    42    33    25    18    12     7
1.019 1.016 1.011 0.000 0.995 0.984 0.990 1.007 0.000

76    64    53    43    34    26    19    13     8     4
1.026 0.000 1.016 1.010 1.002 0.987 0.981 0.990 1.010 0.000

77    65    54    44    35    27    20    14     9     5     2
1.030 1.027 1.021 1.010 1.005 0.998 0.982 0.980 0.993 1.014 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 1.030 1.026 1.019 1.009 0.000 0.993 0.979 0.984 1.001 1.021 0.000
```

Fig. 4.25. Pin-by-pin power distribution, Variant 12, State 1, at burnup = 30.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
             1.009 0.000

            69    57    46
          1.001 1.006 0.000

         70    58    47    37
       0.991 0.997 1.004 0.000

      71    59    48    38    29
    0.988 0.989 0.995 1.002 0.000

   72    60    49    39    30    22
 0.994 0.990 0.989 0.994 1.001 0.000

73    61    50    40    31    23    16
0.000 0.998 0.993 0.991 0.994 1.001 0.000

74    62    51    41    32    24    17    11
1.006 1.005 1.001 0.996 0.992 0.994 1.001 0.000

75    63    52    42    33    25    18    12     7
1.013 1.011 1.007 0.000 0.996 0.991 0.994 1.002 0.000

76    64    53    43    34    26    19    13     8     4
1.018 0.000 1.011 1.006 1.000 0.992 0.989 0.995 1.004 0.000

77    65    54    44    35    27    20    14     9     5     2
1.021 1.019 1.015 1.009 1.003 0.998 0.990 0.989 0.997 1.006 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 1.021 1.018 1.013 1.006 0.000 0.994 0.988 0.991 1.001 1.009 0.000
```

Fig. 4.26. Pin-by-pin power distribution, Variant 12, State 1, at burnup = 40.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
            1.004 0.000

            69    57    46
         1.001 1.003 0.000

         70    58    47    37
      0.995 0.999 1.001 0.000

      71    59    48    38    29
   0.993 0.994 0.997 1.001 0.000

   72    60    49    39    30    22
0.996 0.994 0.995 0.997 1.000 0.000

73    61    50    40    31    23    16
0.000 0.998 0.996 0.995 0.997 1.000 0.000

74    62    51    41    32    24    17    11
1.003 1.003 1.001 0.997 0.995 0.997 1.000 0.000

75    63    52    42    33    25    18    12     7
1.010 1.007 1.004 0.000 0.995 0.995 0.997 1.001 0.000

76    64    53    43    34    26    19    13     8     4
1.014 0.000 1.008 1.003 0.992 0.994 0.994 0.997 1.001 0.000

77    65    54    44    35    27    20    14     9     5     2
1.016 1.015 1.012 1.007 0.999 0.996 0.994 0.994 0.999 1.003 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 1.016 1.014 1.010 1.003 0.000 0.996 0.993 0.995 1.001 1.004 0.000
```

Fig. 4.27. Pin-by-pin power distribution, Variant 12, State 1, at burnup = 50.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
             1.002 0.000

            69    57    46
          1.000 1.002 0.000

         70    58    47    37
       0.997 0.999 1.001 0.000

      71    59    48    38    29
    0.997 0.997 0.999 1.001 0.000

   72    60    49    39    30    22
 0.998 0.994 0.996 0.999 1.000 0.000

73    61    50    40    31    23    16
0.000 0.999 0.997 0.998 0.999 0.999 0.000

74    62    51    41    32    24    17    11
1.005 1.004 1.001 0.998 0.997 0.997 0.997 0.000

75    63    52    42    33    25    18    12     7
1.008 1.006 1.005 0.000 0.997 0.994 0.987 0.997 0.000

76    64    53    43    34    26    19    13     8     4
1.009 0.000 1.007 1.004 0.998 0.996 0.995 0.996 1.000 0.000

77    65    54    44    35    27    20    14     9     5     2
1.009 1.010 1.008 1.007 1.002 1.000 0.996 0.997 0.999 1.002 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 1.009 1.009 1.008 1.005 0.000 0.998 0.997 0.997 1.000 1.002 0.000
```

Fig. 4.28. Pin-by-pin power distribution, Variant 12, State 1, at burnup = 60.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
            1.299 0.000

            69    57    46
         1.169 1.255 0.000

         70    58    47    37
      1.085 1.135 1.235 0.000

      71    59    48    38    29
   1.008 1.055 1.115 1.222 0.000

   72    60    49    39    30    22
0.900 0.972 1.032 1.101 1.214 0.000

73    61    50    40    31    23    16
0.000 0.865 0.945 1.013 1.093 1.211 0.000

74    62    51    41    32    24    17    11
0.783 0.800 0.842 0.905 1.005 1.093 1.214 0.000

75    63    52    42    33    25    18    12     7
0.770 0.772 0.790 0.000 0.905 1.014 1.102 1.222 0.000

76    64    53    43    34    26    19    13     8     4
0.783 0.000 0.774 0.795 0.844 0.946 1.032 1.115 1.235 0.000

77    65    54    44    35    27    20    14     9     5     2
0.878 0.795 0.771 0.799 0.806 0.866 0.973 1.055 1.135 1.255 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 0.878 0.783 0.770 0.783 0.000 0.900 1.008 1.085 1.169 1.299 0.000
```

Fig. 4.29. Pin-by-pin power distribution, Variant 12, State 2, at burnup = 0.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
             1.277 0.000

            69    57    46
          1.185 1.246 0.000

         70    58    47    37
       1.107 1.153 1.227 0.000

      71    59    48    38    29
    1.025 1.075 1.133 1.214 0.000

   72    60    49    39    30    22
 0.897 0.984 1.050 1.118 1.205 0.000

73    61    50    40    31    23    16
0.000 0.858 0.952 1.028 1.109 1.202 0.000

74    62    51    41    32    24    17    11
0.769 0.787 0.832 0.902 1.017 1.109 1.205 0.000

75    63    52    42    33    25    18    12     7
0.754 0.756 0.776 0.000 0.902 1.028 1.118 1.214 0.000

76    64    53    43    34    26    19    13     8     4
0.765 0.000 0.758 0.781 0.834 0.953 1.050 1.133 1.227 0.000

77    65    54    44    35    27    20    14     9     5     2
0.853 0.776 0.755 0.790 0.793 0.859 0.984 1.075 1.153 1.246 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 0.853 0.765 0.754 0.769 0.000 0.897 1.025 1.107 1.185 1.277 0.000
```

Fig. 4.30. Pin-by-pin power distribution, Variant 12, State 2, at burnup = 10.0 MWd/kg (U + Pu).

```
                    67
                 0.000

              68    56
           1.254 0.000

          69    57    46
       1.194 1.233 0.000

      70    58    47    37
   1.126 1.167 1.217 0.000

     71    59    48    38    29
  1.040 1.092 1.146 1.204 0.000

    72    60    49    39    30    22
 0.897 0.995 1.065 1.130 1.195 0.000

   73    61    50    40    31    23    16
0.000 0.854 0.960 1.041 1.120 1.192 0.000

  74    62    51    41    32    24    17    11
0.759 0.777 0.825 0.901 1.029 1.120 1.196 0.000

 75    63    52    42    33    25    18    12     7
0.742 0.745 0.766 0.000 0.901 1.041 1.130 1.204 0.000

 76    64    53    43    34    26    19    13     8     4
0.752 0.000 0.747 0.772 0.828 0.961 1.066 1.146 1.217 0.000

 77    65    54    44    35    27    20    14     9     5     2
0.835 0.762 0.743 0.785 0.785 0.856 0.995 1.093 1.167 1.233 0.000

 78    66    55    45    36    28    21    15    10     6     3     1
0.000 0.835 0.752 0.742 0.759 0.000 0.897 1.040 1.126 1.194 1.254 0.000
```

Fig. 4.31. Pin-by-pin power distribution, Variant 12, State 2, at burnup = 20.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
            1.238 0.000

            69    57    46
         1.201 1.225 0.000

         70    58    47    37
      1.142 1.178 1.211 0.000

      71    59    48    38    29
   1.053 1.108 1.158 1.198 0.000

   72    60    49    39    30    22
0.897 1.005 1.079 1.140 1.189 0.000

73    61    50    40    31    23    16
0.000 0.851 0.966 1.052 1.130 1.185 0.000

74    62    51    41    32    24    17    11
0.746 0.768 0.820 0.901 1.039 1.130 1.189 0.000

75    63    52    42    33    25    18    12     7
0.730 0.732 0.755 0.000 0.902 1.053 1.141 1.198 0.000

76    64    53    43    34    26    19    13     8     4
0.738 0.000 0.735 0.763 0.823 0.967 1.080 1.158 1.211 0.000

77    65    54    44    35    27    20    14     9     5     2
0.817 0.749 0.731 0.776 0.774 0.852 1.005 1.108 1.178 1.225 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 0.817 0.738 0.730 0.746 0.000 0.897 1.053 1.142 1.201 1.238 0.000
```

Fig. 4.32. Pin-by-pin power distribution, Variant 12, State 2, at burnup = 30.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
            1.229 0.000

            69    57    46
         1.205 1.220 0.000

         70    58    47    37
      1.152 1.185 1.207 0.000

      71    59    48    38    29
   1.062 1.119 1.164 1.195 0.000

   72    60    49    39    30    22
0.898 1.011 1.088 1.147 1.185 0.000

73    61    50    40    31    23    16
0.000 0.849 0.970 1.059 1.135 1.182 0.000

74    62    51    41    32    24    17    11
0.740 0.763 0.817 0.902 1.045 1.135 1.185 0.000

75    63    52    42    33    25    18    12     7
0.722 0.725 0.749 0.000 0.902 1.060 1.147 1.195 0.000

76    64    53    43    34    26    19    13     8     4
0.728 0.000 0.728 0.757 0.820 0.971 1.089 1.165 1.207 0.000

77    65    54    44    35    27    20    14     9     5     2
0.802 0.737 0.722 0.769 0.770 0.851 1.012 1.119 1.185 1.220 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 0.802 0.728 0.722 0.740 0.000 0.898 1.062 1.152 1.205 1.229 0.000
```

Fig. 4.33. Pin-by-pin power distribution, Variant 12, State 2, at burnup = 40.0 MWd/kg (U + Pu).

```
                    67
                 0.000

              68    56
           1.225 0.000

          69    57    46
       1.207 1.218 0.000

      70    58    47    37
   1.159 1.189 1.207 0.000

     71    59    48    38    29
  1.068 1.125 1.169 1.195 0.000

    72    60    49    39    30    22
 0.900 1.015 1.094 1.151 1.186 0.000

   73    61    50    40    31    23    16
0.000 0.849 0.973 1.064 1.139 1.182 0.000

  74    62    51    41    32    24    17    11
0.735 0.759 0.815 0.903 1.049 1.139 1.186 0.000

 75    63    52    42    33    25    18    12     7
0.715 0.719 0.745 0.000 0.902 1.064 1.151 1.195 0.000

 76    64    53    43    34    26    19    13     8     4
0.720 0.000 0.721 0.751 0.813 0.973 1.094 1.169 1.207 0.000

 77    65    54    44    35    27    20    14     9     5     2
0.791 0.729 0.715 0.763 0.765 0.850 1.015 1.125 1.189 1.219 0.000

 78    66    55    45    36    28    21    15    10     6     3     1
0.000 0.791 0.720 0.715 0.735 0.000 0.900 1.068 1.159 1.207 1.225 0.000
```

Fig. 4.34. Pin-by-pin power distribution, Variant 12, State 2, at burnup = 50.0 MWd/kg (U + Pu).

```
                    67
                 0.000

               68    56
            1.227 0.000

            69    57    46
         1.209 1.221 0.000

         70    58    47    37
      1.162 1.192 1.209 0.000

      71    59    48    38    29
   1.072 1.129 1.173 1.197 0.000

   72    60    49    39    30    22
0.901 1.014 1.097 1.154 1.187 0.000

73    61    50    40    31    23    16
0.000 0.849 0.972 1.067 1.142 1.183 0.000

74    62    51    41    32    24    17    11
0.734 0.757 0.815 0.904 1.050 1.140 1.185 0.000

75    63    52    42    33    25    18    12     7
0.711 0.716 0.743 0.000 0.904 1.063 1.141 1.194 0.000

76    64    53    43    34    26    19    13     8     4
0.714 0.000 0.718 0.750 0.816 0.974 1.095 1.170 1.207 0.000

77    65    54    44    35    27    20    14     9     5     2
0.781 0.722 0.709 0.759 0.765 0.852 1.017 1.129 1.191 1.220 0.000

78    66    55    45    36    28    21    15    10     6     3     1
0.000 0.781 0.714 0.711 0.734 0.000 0.901 1.072 1.162 1.209 1.227 0.000
```

Fig. 4.35. Pin-by-pin power distribution, Variant 12, State 2, at burnup = 60.0 MWd/kg (U + Pu).

67 - cell number
50. - cell type

																				79	68	56
																				50.	50.	50.
																		90	80	69	57	46
																		50.	50.	50.	50.	50.
																100	91	81	70	58	47	37
																50.	50.	50.	50.	50.	50.	50.
														109	101	92	82	71	59	48	38	29
														50.	50.	50.	50.	50.	50.	50.	50.	50.
												117	110	102	93	83	72	60	49	39	30	22
												50.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.
										124	118	111	103	94	84	73	61	50	40	31	23	16
										57.	25.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.
								130	125	119	112	104	95	85	74	62	51	41	32	24	17	11
								57.	57.	57.	25.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.
						135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7
						57.	57.	57.	57.	57.	25.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.
				139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4
				57.	57.	57.	57.	57.	57.	57.	25.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.
		142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2
		57.	57.	57.	57.	57.	57.	57.	57.	57.	25.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1
57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	57.	26.	25.	25.	25.	25.	25.	25.	25.	25.	25.	25.	26.

Note: 50.—fuel cell of type 1 (MOX)
57.—fuel cell of type 2 (UO_2)
26.—corner water cell
25.—side water cell
27.—central tube cell (G2)
29.—guide tube cell (G4)

Fig. 4.36. Positions and types of cells in multiassembly structure (30º symmetry angle).

																								67
																								0.984
																						79	68	56
																						0.984	0.984	0.984
																				90	80	69	57	46
																				0.985	0.984	0.984	0.985	0.985
																		100	91	81	70	58	47	37
																		0.985	0.985	0.985	0.985	0.986	0.986	0.987
																	109	101	92	82	71	59	48	38	29
																	0.980	0.984	0.985	0.986	0.987	0.987	0.988	0.989	0.991
																117	110	102	93	83	72	60	49	39	30	22
																0.965	0.973	0.981	0.986	0.988	0.989	0.990	0.991	0.993	0.994	0.997
														124	118	111	103	94	84	73	61	50	40	31	23	16
														1.184	0.000	0.966	0.976	0.985	0.990	0.993	0.995	0.997	0.998	1.000	1.003	1.007
												130	125	119	112	104	95	85	74	62	51	41	32	24	17	11
												0.900	0.982	1.186	0.000	0.972	0.982	0.992	0.999	1.003	1.005	1.007	1.009	1.012	1.016	1.024
										135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7
										0.847	0.865	0.901	0.985	1.194	0.000	0.983	0.995	1.007	1.015	1.020	1.023	1.026	1.028	1.032	1.039	1.051
								139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4
								0.834	0.839	0.848	0.867	0.906	0.993	1.210	0.000	1.004	1.019	1.035	1.046	1.052	1.055	1.059	1.062	1.068	1.077	1.096
			142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2	
			0.830	0.832	0.835	0.840	0.851	0.872	0.916	1.014	1.247	0.000	1.044	1.076	1.097	1.109	1.115	1.120	1.124	1.129	1.136	1.148	1.175	
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.829	0.829	0.830	0.833	0.836	0.844	0.857	0.885	0.943	1.069	1.355	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.37. Variant 13, pin-by-pin power distribution, burnup W = 0.0 MWd/kg, State S1.

															67									
															0.984									
														79	68	56								
														0.984	0.984	0.984								
												90	80	69	57	46								
												0.985	0.985	0.985	0.985	0.986								
										100	91	81	70	58	47	37								
										0.987	0.986	0.986	0.986	0.986	0.987	0.988								
								109	101	92	82	71	59	48	38	29								
								0.993	0.990	0.988	0.987	0.987	0.988	0.988	0.989	0.991								
							117	110	102	93	83	72	60	49	39	30	22							
							1.011	0.998	0.994	0.992	0.991	0.990	0.991	0.991	0.992	0.994	0.997							
						124	118	111	103	94	84	73	61	50	40	31	23	16						
						1.083	0.000	1.012	1.001	0.997	0.996	0.996	0.996	0.997	0.998	0.999	1.002	1.007						
					130	125	119	112	104	95	85	74	62	51	41	32	24	17	11					
					0.915	0.976	1.084	0.000	1.017	1.007	1.004	1.004	1.005	1.006	1.007	1.009	1.011	1.015	1.023					
				135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7				
				0.865	0.883	0.916	0.979	1.090	0.000	1.027	1.018	1.018	1.019	1.021	1.023	1.025	1.027	1.031	1.037	1.049				
			139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4			
			0.851	0.856	0.866	0.885	0.921	0.987	1.100	0.000	1.044	1.039	1.043	1.047	1.050	1.053	1.055	1.058	1.063	1.072	1.089			
		142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2		
		0.846	0.848	0.852	0.858	0.869	0.891	0.931	1.003	1.121	0.000	1.075	1.086	1.095	1.100	1.104	1.107	1.110	1.114	1.121	1.131	1.153		
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.845	0.846	0.847	0.849	0.854	0.862	0.876	0.904	0.954	1.039	1.165	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.38. Variant 13, pin-by-pin power distribution, burnup W = 10.0 MWd/kg, State S1.

															67									
															0.983									
													79	68	56									
													0.983	0.983	0.983									
											90	80	69	57	46									
											0.984	0.983	0.983	0.983	0.984									
									100	91	81	70	58	47	37									
									0.988	0.986	0.985	0.984	0.984	0.985	0.986									
							109	101	92	82	71	59	48	38	29									
							1.000	0.993	0.989	0.987	0.986	0.986	0.987	0.988	0.989									
						117	110	102	93	83	72	60	49	39	30	22								
						1.037	1.013	1.001	0.995	0.991	0.990	0.990	0.990	0.991	0.992	0.995								
					124	118	111	103	94	84	73	61	50	40	31	23	16							
					1.026	0.000	1.038	1.015	1.004	0.999	0.996	0.995	0.995	0.996	0.998	1.000	1.005							
				130	125	119	112	104	95	85	74	62	51	41	32	24	17	11						
				0.935	0.977	1.027	0.000	1.042	1.021	1.011	1.006	1.005	1.005	1.005	1.007	1.009	1.013	1.020						
			135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7					
			0.891	0.908	0.936	0.979	1.031	0.000	1.050	1.030	1.022	1.020	1.020	1.020	1.021	1.023	1.027	1.032	1.043					
		139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4				
		0.876	0.881	0.892	0.910	0.940	0.985	1.038	0.000	1.063	1.047	1.044	1.044	1.044	1.046	1.047	1.050	1.055	1.062	1.076				
	142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2			
	0.871	0.873	0.876	0.883	0.895	0.916	0.949	0.997	1.049	0.000	1.085	1.082	1.083	1.084	1.085	1.087	1.089	1.093	1.098	1.107	1.122			
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.869	0.870	0.871	0.874	0.879	0.887	0.902	0.927	0.967	1.018	1.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.39. Variant 13, pin-by-pin power distribution, burnup W = 20.0 MWd/kg, State S1.

																								67
																								0.983
																						79	68	56
																						0.983	0.983	0.983
																				90	80	69	57	46
																				0.985	0.984	0.983	0.983	0.984
																		100	91	81	70	58	47	37
																		0.990	0.987	0.985	0.985	0.984	0.985	0.986
																	109	101	92	82	71	59	48	38	29
																	1.005	0.996	0.991	0.988	0.987	0.986	0.987	0.988	0.989
																117	110	102	93	83	72	60	49	39	30	22
																1.050	1.022	1.006	0.998	0.993	0.991	0.990	0.990	0.991	0.992	0.995
														124	118	111	103	94	84	73	61	50	40	31	23	16
														0.993	0.000	1.051	1.024	1.009	1.001	0.997	0.996	0.995	0.996	0.997	1.000	1.004
												130	125	119	112	104	95	85	74	62	51	41	32	24	17	11
												0.950	0.976	0.994	0.000	1.054	1.028	1.015	1.008	1.005	1.004	1.004	1.005	1.007	1.011	1.017
										135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7
										0.914	0.929	0.951	0.978	0.996	0.000	1.060	1.036	1.025	1.020	1.018	1.018	1.018	1.020	1.023	1.028	1.037
							139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4	
							0.899	0.905	0.915	0.931	0.955	0.983	1.000	0.000	1.068	1.049	1.041	1.039	1.038	1.038	1.039	1.042	1.046	1.052	1.063	
		142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2		
		0.894	0.896	0.900	0.907	0.918	0.937	0.962	0.990	1.005	0.000	1.082	1.072	1.069	1.067	1.067	1.068	1.069	1.072	1.077	1.083	1.093		
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.892	0.893	0.894	0.897	0.902	0.911	0.925	0.946	0.974	1.000	1.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.40. Variant 13, pin-by-pin power distribution, burnup W = 30.0 MWd/kg, State S1.

																		67						
																		0.983						
																	79	68	56					
																	0.984	0.984	0.984					
																90	80	69	57	46				
																0.986	0.985	0.984	0.984	0.985				
															100	91	81	70	58	47	37			
															0.992	0.988	0.986	0.985	0.985	0.986	0.986			
														109	101	92	82	71	59	48	38	29		
														1.009	0.999	0.993	0.989	0.988	0.987	0.987	0.988	0.990		
													117	110	102	93	83	72	60	49	39	30	22	
													1.052	1.026	1.010	1.000	0.995	0.992	0.991	0.990	0.991	0.992	0.995	
												124	118	111	103	94	84	73	61	50	40	31	23	16
												0.978	0.000	1.053	1.027	1.012	1.003	0.999	0.996	0.996	0.996	0.997	0.999	1.002
											130	125	119	112	104	95	85	74	62	51	41	32	24	17	11
											0.964	0.977	0.979	0.000	1.055	1.031	1.016	1.009	1.005	1.004	1.003	1.004	1.006	1.009	1.014
										135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7
										0.937	0.949	0.965	0.978	0.980	0.000	1.059	1.036	1.024	1.018	1.015	1.014	1.015	1.016	1.018	1.022	1.029
									139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4
									0.923	0.929	0.938	0.951	0.967	0.982	0.983	0.000	1.064	1.045	1.036	1.032	1.030	1.030	1.031	1.032	1.035	1.040	1.048
								142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2
								0.918	0.920	0.924	0.930	0.941	0.955	0.973	0.986	0.984	0.000	1.070	1.059	1.053	1.050	1.049	1.049	1.050	1.052	1.055	1.060	1.066
							144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1
							0.916	0.917	0.918	0.921	0.926	0.934	0.946	0.963	0.980	0.989	0.981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Fig. 4.41. Variant 13, pin-by-pin power distribution, burnup W = 40.0 MWd/kg, State S1.

67
0.984

79 68 56
0.984 0.984 0.984

90 80 69 57 46
0.987 0.985 0.985 0.985 0.985

100 91 81 70 58 47 37
0.993 0.989 0.987 0.986 0.986 0.986 0.986

109 101 92 82 71 59 48 38 29
1.010 1.000 0.994 0.990 0.988 0.988 0.987 0.988 0.989

117 110 102 93 83 72 60 49 39 30 22
1.048 1.026 1.010 1.001 0.995 0.992 0.991 0.990 0.990 0.992 0.994

124 118 111 103 94 84 73 61 50 40 31 23 16
0.977 0.000 1.048 1.027 1.012 1.003 0.999 0.996 0.995 0.995 0.995 0.997 1.000

130 125 119 112 104 95 85 74 62 51 41 32 24 17 11
0.977 0.982 0.978 0.000 1.050 1.029 1.016 1.008 1.004 1.002 1.001 1.001 1.003 1.005 1.009

135 131 126 120 113 105 96 86 75 63 52 42 33 25 18 12 7
0.959 0.968 0.978 0.983 0.979 0.000 1.052 1.032 1.021 1.015 1.011 1.010 1.010 1.011 1.012 1.015 1.020

139 136 132 127 121 114 106 97 87 76 64 53 43 34 26 19 13 8 4
0.948 0.953 0.960 0.970 0.980 0.985 0.980 0.000 1.054 1.038 1.029 1.024 1.022 1.021 1.021 1.022 1.024 1.028 1.033

142 140 137 133 128 122 115 107 98 88 77 65 54 44 35 27 20 14 9 5 2
0.943 0.945 0.948 0.954 0.962 0.973 0.983 0.987 0.980 0.000 1.056 1.045 1.038 1.035 1.033 1.032 1.033 1.034 1.036 1.039 1.042

144 143 141 138 134 129 123 116 108 99 89 78 66 55 45 36 28 21 15 10 6 3 1
0.942 0.942 0.943 0.946 0.950 0.957 0.967 0.978 0.986 0.987 0.976 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

Fig. 4.42. Variant 13, pin-by-pin power distribution, burnup W = 50.0 MWd/kg, State S1.

																								67
																								0.984
																						79	68	56
																						0.984	0.984	0.984
																				90	80	69	57	46
																				0.987	0.985	0.984	0.984	0.984
																		100	91	81	70	58	47	37
																		0.993	0.989	0.987	0.986	0.985	0.985	0.986
																	109	101	92	82	71	59	48	38	29
																	1.009	0.999	0.994	0.990	0.988	0.987	0.987	0.987	0.988
																117	110	102	93	83	72	60	49	39	30	22
																1.040	1.022	1.009	1.000	0.995	0.992	0.990	0.989	0.989	0.990	0.991
														124	118	111	103	94	84	73	61	50	40	31	23	16
														0.985	0.000	1.041	1.023	1.010	1.002	0.997	0.994	0.993	0.993	0.993	0.994	0.997
												130	125	119	112	104	95	85	74	62	51	41	32	24	17	11
												0.990	0.991	0.985	0.000	1.041	1.024	1.013	1.005	1.001	0.999	0.998	0.998	0.999	1.000	1.003
										135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7
										0.980	0.986	0.991	0.992	0.986	0.000	1.042	1.026	1.016	1.010	1.007	1.005	1.004	1.004	1.006	1.008	1.011
								139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4
								0.971	0.975	0.980	0.987	0.992	0.993	0.986	0.000	1.042	1.029	1.021	1.016	1.013	1.012	1.012	1.012	1.014	1.016	1.019
				142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2		
				0.967	0.969	0.972	0.976	0.982	0.989	0.993	0.993	0.986	0.000	1.042	1.032	1.026	1.022	1.020	1.019	1.019	1.020	1.021	1.023	1.025		
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.966	0.967	0.968	0.970	0.973	0.979	0.985	0.991	0.995	0.992	0.983	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.43. Variant 13, pin-by-pin power distribution, burnup W = 60.0 MWd/kg, State S1.

																								67
																								0.987
																						79	68	56
																						0.987	0.987	0.987
																				90	80	69	57	46
																				0.987	0.987	0.987	0.988	0.988
																		100	91	81	70	58	47	37
																		0.986	0.987	0.988	0.988	0.989	0.989	0.991
																	109	101	92	82	71	59	48	38	29
																	0.980	0.985	0.987	0.989	0.989	0.990	0.991	0.992	0.994
																117	110	102	93	83	72	60	49	39	30	22
																0.962	0.972	0.981	0.987	0.990	0.992	0.993	0.994	0.996	0.998	1.001
														124	118	111	103	94	84	73	61	50	40	31	23	16
														1.180	0.000	0.963	0.975	0.985	0.992	0.995	0.998	1.000	1.001	1.003	1.006	1.011
												130	125	119	112	104	95	85	74	62	51	41	32	24	17	11
												0.895	0.978	1.182	0.000	0.969	0.982	0.993	1.001	1.005	1.008	1.010	1.013	1.016	1.020	1.028
										135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7
										0.839	0.858	0.896	0.981	1.190	0.000	0.981	0.995	1.008	1.017	1.023	1.026	1.029	1.032	1.036	1.043	1.055
								139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4
								0.825	0.830	0.840	0.860	0.901	0.990	1.207	0.000	1.002	1.019	1.037	1.048	1.054	1.059	1.062	1.066	1.071	1.081	1.100
				142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2		
				0.820	0.822	0.826	0.832	0.843	0.866	0.912	1.011	1.245	0.000	1.042	1.075	1.097	1.109	1.117	1.122	1.126	1.131	1.139	1.150	1.177		
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.819	0.820	0.821	0.823	0.828	0.835	0.850	0.879	0.939	1.068	1.352	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.44. Variant 13, pin-by-pin power distribution, burnup W = 0.0 MWd/kg, State S4.

67
0.986

79 68 56
0.986 0.986 0.987

90 80 69 57 46
0.987 0.987 0.987 0.987 0.988

100 91 81 70 58 47 37
0.989 0.988 0.988 0.988 0.988 0.989 0.990

109 101 92 82 71 59 48 38 29
0.993 0.991 0.990 0.989 0.989 0.990 0.991 0.992 0.994

117 110 102 93 83 72 60 49 39 30 22
1.008 0.998 0.994 0.993 0.992 0.992 0.993 0.994 0.995 0.997 1.000

124 118 111 103 94 84 73 61 50 40 31 23 16
1.079 0.000 1.010 1.000 0.998 0.997 0.998 0.998 0.999 1.000 1.002 1.005 1.010

130 125 119 112 104 95 85 74 62 51 41 32 24 17 11
0.911 0.973 1.081 0.000 1.015 1.006 1.005 1.006 1.007 1.008 1.010 1.012 1.014 1.018 1.026

135 131 126 120 113 105 96 86 75 63 52 42 33 25 18 12 7
0.860 0.878 0.912 0.976 1.086 0.000 1.025 1.018 1.019 1.021 1.023 1.025 1.027 1.030 1.034 1.040 1.052

139 136 132 127 121 114 106 97 87 76 64 53 43 34 26 19 13 8 4
0.844 0.850 0.861 0.880 0.917 0.984 1.097 0.000 1.042 1.039 1.044 1.049 1.052 1.055 1.058 1.061 1.066 1.075 1.092

142 140 137 133 128 122 115 107 98 88 77 65 54 44 35 27 20 14 9 5 2
0.839 0.841 0.845 0.852 0.864 0.886 0.928 1.001 1.118 0.000 1.073 1.084 1.094 1.100 1.104 1.107 1.111 1.115 1.122 1.132 1.153

144 143 141 138 134 129 123 116 108 99 89 78 66 55 45 36 28 21 15 10 6 3 1
0.838 0.838 0.839 0.842 0.847 0.856 0.871 0.900 0.951 1.038 1.161 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

Fig. 4.45. Variant 13, pin-by-pin power distribution, burnup W = 10.0 MWd/kg, State S4.

67
0.984

79 68 56
0.984 0.984 0.985

90 80 69 57 46
0.986 0.985 0.985 0.985 0.986

100 91 81 70 58 47 37
0.990 0.987 0.986 0.986 0.986 0.987 0.988

109 101 92 82 71 59 48 38 29
1.001 0.994 0.990 0.989 0.988 0.988 0.989 0.990 0.991

117 110 102 93 83 72 60 49 39 30 22
1.035 1.013 1.002 0.996 0.993 0.992 0.991 0.992 0.993 0.994 0.997

124 118 111 103 94 84 73 61 50 40 31 23 16
1.023 0.000 1.036 1.015 1.005 1.000 0.998 0.997 0.997 0.998 1.000 1.003 1.007

130 125 119 112 104 95 85 74 62 51 41 32 24 17 11
0.932 0.974 1.024 0.000 1.040 1.020 1.012 1.008 1.007 1.007 1.007 1.009 1.011 1.015 1.022

135 131 126 120 113 105 96 86 75 63 52 42 33 25 18 12 7
0.886 0.904 0.933 0.977 1.028 0.000 1.048 1.030 1.023 1.021 1.021 1.022 1.024 1.026 1.029 1.035 1.045

139 136 132 127 121 114 106 97 87 76 64 53 43 34 26 19 13 8 4
0.870 0.876 0.887 0.906 0.938 0.983 1.035 0.000 1.061 1.047 1.045 1.045 1.046 1.047 1.049 1.052 1.057 1.064 1.078

142 140 137 133 128 122 115 107 98 88 77 65 54 44 35 27 20 14 9 5 2
0.865 0.867 0.871 0.878 0.891 0.912 0.947 0.996 1.046 0.000 1.083 1.081 1.082 1.084 1.085 1.087 1.090 1.094 1.099 1.107 1.122

144 143 141 138 134 129 123 116 108 99 89 78 66 55 45 36 28 21 15 10 6 3 1
0.863 0.864 0.865 0.868 0.873 0.882 0.898 0.925 0.965 1.017 1.059 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

Fig. 4.46. Variant 13, pin-by-pin power distribution, burnup W = 20.0 MWd/kg, State S4.

																								67
																								0.984
																						79	68	56
																						0.984	0.984	0.984
																				90	80	69	57	46
																				0.986	0.985	0.985	0.985	0.985
																		100	91	81	70	58	47	37
																		0.992	0.988	0.987	0.986	0.986	0.986	0.987
																	109	101	92	82	71	59	48	38	29
																	1.006	0.997	0.992	0.990	0.988	0.988	0.988	0.989	0.991
																117	110	102	93	83	72	60	49	39	30	22
																1.047	1.022	1.007	0.999	0.995	0.992	0.992	0.992	0.992	0.994	0.997
														124	118	111	103	94	84	73	61	50	40	31	23	16
														0.990	0.000	1.049	1.024	1.010	1.003	0.999	0.997	0.997	0.998	0.999	1.002	1.006
												130	125	119	112	104	95	85	74	62	51	41	32	24	17	11
												0.948	0.974	0.991	0.000	1.052	1.028	1.016	1.010	1.007	1.006	1.006	1.007	1.009	1.013	1.019
										135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7
										0.911	0.927	0.949	0.976	0.993	0.000	1.058	1.036	1.025	1.021	1.020	1.019	1.020	1.022	1.025	1.030	1.039
							139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4
							0.895	0.901	0.912	0.929	0.953	0.981	0.997	0.000	1.066	1.048	1.042	1.039	1.039	1.039	1.041	1.043	1.047	1.053	1.064
		142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2		
		0.889	0.892	0.896	0.903	0.916	0.934	0.961	0.989	1.002	0.000	1.079	1.071	1.068	1.066	1.066	1.067	1.069	1.072	1.076	1.082	1.092		
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.888	0.888	0.890	0.893	0.898	0.908	0.922	0.945	0.973	0.998	1.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.47. Variant 13, pin-by-pin power distribution, burnup W = 30.0 MWd/kg, State S4.

																			67					
																			0.985					
																		79	68	56				
																		0.985	0.985	0.985				
																90	80	69	57	46				
																0.987	0.986	0.985	0.985	0.986				
														100	91	81	70	58	47	37				
														0.993	0.990	0.988	0.987	0.987	0.987	0.988				
												109	101	92	82	71	59	48	38	29				
												1.010	1.000	0.994	0.991	0.989	0.989	0.989	0.989	0.991				
											117	110	102	93	83	72	60	49	39	30	22			
											1.050	1.026	1.010	1.001	0.996	0.993	0.992	0.992	0.992	0.994	0.996			
										124	118	111	103	94	84	73	61	50	40	31	23	16		
										0.975	0.000	1.051	1.027	1.013	1.004	1.000	0.998	0.997	0.997	0.998	1.000	1.004		
									130	125	119	112	104	95	85	74	62	51	41	32	24	17	11	
									0.962	0.975	0.976	0.000	1.053	1.031	1.017	1.010	1.007	1.005	1.005	1.006	1.007	1.010	1.016	
								135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7
								0.935	0.948	0.963	0.977	0.977	0.000	1.057	1.036	1.025	1.019	1.017	1.016	1.016	1.017	1.020	1.024	1.031
						139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4
						0.920	0.926	0.936	0.950	0.966	0.980	0.980	0.000	1.062	1.045	1.036	1.032	1.031	1.031	1.031	1.033	1.036	1.041	1.048
		142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2		
		0.915	0.917	0.921	0.928	0.939	0.954	0.972	0.984	0.981	0.000	1.068	1.057	1.052	1.049	1.048	1.048	1.049	1.051	1.054	1.059	1.064		
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.913	0.914	0.915	0.918	0.923	0.932	0.945	0.962	0.979	0.987	0.978	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.48. Variant 13, pin-by-pin power distribution, burnup W = 40.0 MWd/kg, State S4.

															67									
															0.985									
														79	68	56								
														0.986	0.985	0.985								
												90	80	69	57	46								
												0.988	0.987	0.986	0.986	0.986								
											100	91	81	70	58	47	37							
											0.994	0.991	0.988	0.987	0.987	0.987	0.988							
										109	101	92	82	71	59	48	38	29						
										1.011	1.001	0.995	0.992	0.990	0.989	0.989	0.989	0.991						
									117	110	102	93	83	72	60	49	39	30	22					
									1.046	1.025	1.011	1.002	0.997	0.994	0.992	0.992	0.992	0.993	0.995					
								124	118	111	103	94	84	73	61	50	40	31	23	16				
								0.975	0.000	1.046	1.027	1.013	1.005	1.000	0.997	0.996	0.996	0.997	0.999	1.002				
							130	125	119	112	104	95	85	74	62	51	41	32	24	17	11			
							0.976	0.981	0.975	0.000	1.048	1.029	1.016	1.009	1.005	1.003	1.002	1.003	1.004	1.006	1.010			
						135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7		
						0.958	0.967	0.977	0.982	0.976	0.000	1.049	1.032	1.021	1.015	1.012	1.011	1.011	1.012	1.013	1.017	1.021		
				139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4		
				0.946	0.951	0.959	0.969	0.979	0.984	0.977	0.000	1.051	1.037	1.029	1.024	1.022	1.021	1.021	1.022	1.025	1.028	1.032		
		142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2		
		0.941	0.943	0.947	0.953	0.962	0.972	0.982	0.986	0.977	0.000	1.053	1.043	1.036	1.033	1.031	1.031	1.031	1.033	1.035	1.037	1.040		
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.940	0.940	0.941	0.944	0.949	0.956	0.966	0.977	0.986	0.986	0.973	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.49. Variant 13, pin-by-pin power distribution, burnup W = 50.0 MWd/kg, State S4.

															67									
															0.985									
														79	68	56								
														0.985	0.985	0.985								
													90	80	69	57	46							
													0.988	0.986	0.986	0.985	0.986							
												100	91	81	70	58	47	37						
												0.994	0.990	0.988	0.987	0.986	0.986	0.987						
											109	101	92	82	71	59	48	38	29					
											1.009	1.001	0.995	0.991	0.989	0.988	0.988	0.988	0.989					
										117	110	102	93	83	72	60	49	39	30	22				
										1.038	1.022	1.010	1.001	0.996	0.993	0.991	0.990	0.990	0.991	0.993				
									124	118	111	103	94	84	73	61	50	40	31	23	16			
									0.982	0.000	1.039	1.023	1.011	1.003	0.998	0.996	0.994	0.994	0.994	0.995	0.998			
								130	125	119	112	104	95	85	74	62	51	41	32	24	17	11		
								0.990	0.990	0.983	0.000	1.039	1.024	1.013	1.006	1.002	1.000	0.999	0.999	1.000	1.001	1.004		
							135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7	
							0.980	0.986	0.990	0.991	0.983	0.000	1.040	1.026	1.016	1.010	1.007	1.006	1.005	1.005	1.006	1.008	1.012	
						139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4
						0.971	0.975	0.981	0.987	0.992	0.992	0.984	0.000	1.040	1.028	1.020	1.016	1.013	1.012	1.012	1.012	1.013	1.016	1.018
				142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2
				0.967	0.969	0.972	0.976	0.982	0.989	0.993	0.992	0.983	0.000	1.039	1.030	1.024	1.020	1.018	1.017	1.017	1.018	1.019	1.021	1.022
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.966	0.966	0.967	0.970	0.973	0.979	0.985	0.992	0.994	0.991	0.980	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.50. Variant 13, pin-by-pin power distribution, burnup W = 60.0 MWd/kg, State S4.

																								67
																								0.986
																						79	68	56
																						0.986	0.986	0.986
																				90	80	69	57	46
																				0.985	0.985	0.986	0.986	0.986
																		100	91	81	70	58	47	37
																		0.985	0.984	0.985	0.985	0.986	0.986	0.987
																	109	101	92	82	71	59	48	38	29
																	0.989	0.986	0.985	0.985	0.985	0.986	0.986	0.987	0.988
																117	110	102	93	83	72	60	49	39	30	22
																1.032	0.998	0.990	0.987	0.986	0.986	0.987	0.987	0.988	0.989	0.990
														124	118	111	103	94	84	73	61	50	40	31	23	16
														1.137	0.000	1.033	1.000	0.992	0.990	0.989	0.990	0.990	0.991	0.992	0.993	0.996
												130	125	119	112	104	95	85	74	62	51	41	32	24	17	11
												0.881	0.948	1.138	0.000	1.037	1.004	0.997	0.996	0.996	0.997	0.998	0.999	1.000	1.003	1.009
										135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7
										0.845	0.856	0.882	0.949	1.143	0.000	1.046	1.015	1.010	1.011	1.012	1.013	1.014	1.016	1.018	1.023	1.035
								139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4
								0.838	0.841	0.846	0.857	0.884	0.954	1.154	0.000	1.066	1.041	1.044	1.047	1.049	1.051	1.053	1.055	1.058	1.067	1.090
				142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2		
				0.836	0.837	0.838	0.841	0.847	0.860	0.891	0.968	1.182	0.000	1.119	1.128	1.140	1.146	1.149	1.152	1.154	1.157	1.163	1.176	1.220		
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.836	0.836	0.836	0.837	0.839	0.843	0.851	0.868	0.910	1.013	1.280	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.51. Variant 13, pin-by-pin power distribution, burnup W = 0.0 MWd/kg, State S6.

67																								
0.991																								
79	68	56																						
0.991	0.991	0.991																						
90	80	69	57	46																				
0.989	0.990	0.991	0.991	0.991																				
100	91	81	70	58	47	37																		
0.988	0.988	0.989	0.990	0.991	0.991	0.992																		
109	101	92	82	71	59	48	38	29																
0.997	0.991	0.989	0.989	0.989	0.990	0.991	0.992	0.992																
117	110	102	93	83	72	60	49	39	30	22														
1.066	1.014	0.998	0.991	0.990	0.990	0.991	0.992	0.993	0.994	0.995														
124	118	111	103	94	84	73	61	50	40	31	23	16												
1.050	0.000	1.067	1.016	1.000	0.994	0.993	0.993	0.994	0.995	0.996	0.998	1.000												
130	125	119	112	104	95	85	74	62	51	41	32	24	17	11										
0.889	0.941	1.051	0.000	1.071	1.020	1.005	1.000	0.999	1.000	1.001	1.002	1.004	1.007	1.012										
135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7								
0.854	0.865	0.890	0.942	1.054	0.000	1.079	1.030	1.017	1.014	1.015	1.016	1.017	1.019	1.021	1.026	1.037								
139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4						
0.846	0.849	0.855	0.867	0.892	0.947	1.061	0.000	1.096	1.054	1.048	1.048	1.050	1.051	1.053	1.055	1.059	1.067	1.089						
142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2				
0.844	0.845	0.847	0.850	0.856	0.870	0.899	0.959	1.078	0.000	1.140	1.130	1.132	1.135	1.137	1.138	1.141	1.144	1.150	1.161	1.198				
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.843	0.844	0.844	0.845	0.848	0.852	0.860	0.878	0.916	0.990	1.122	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.52. Variant 13, pin-by-pin power distribution, burnup W = 10.0 MWd/kg, State S6.

67																								
0.993																								
79	68	56																						
0.993	0.993	0.993																						
90	80	69	57	46																				
0.991	0.992	0.993	0.993	0.993																				
100	91	81	70	58	47	37																		
0.990	0.990	0.991	0.992	0.992	0.993	0.993																		
109	101	92	82	71	59	48	38	29																
1.002	0.993	0.990	0.990	0.991	0.992	0.993	0.993	0.994																
117	110	102	93	83	72	60	49	39	30	22														
1.085	1.025	1.003	0.994	0.991	0.991	0.992	0.993	0.994	0.994	0.996														
124	118	111	103	94	84	73	61	50	40	31	23	16												
1.001	0.000	1.086	1.026	1.004	0.996	0.994	0.994	0.995	0.996	0.997	0.998	1.000												
130	125	119	112	104	95	85	74	62	51	41	32	24	17	11										
0.904	0.941	1.002	0.000	1.089	1.030	1.009	1.002	1.000	1.000	1.001	1.003	1.004	1.006	1.011										
135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7								
0.874	0.884	0.905	0.942	1.004	0.000	1.096	1.038	1.020	1.015	1.014	1.015	1.016	1.017	1.020	1.024	1.034								
139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4						
0.866	0.869	0.875	0.886	0.907	0.946	1.008	0.000	1.109	1.059	1.048	1.045	1.045	1.046	1.048	1.050	1.053	1.060	1.079						
142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2				
0.864	0.865	0.867	0.870	0.876	0.889	0.913	0.955	1.016	0.000	1.143	1.121	1.117	1.116	1.117	1.118	1.120	1.123	1.127	1.137	1.166				
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.864	0.864	0.865	0.866	0.868	0.872	0.880	0.896	0.926	0.974	1.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.53. Variant 13, pin-by-pin power distribution, burnup W = 20.0 MWd/kg, State S6.

																								67
																								0.996
																						79	68	56
																						0.995	0.996	0.996
																				90	80	69	57	46
																				0.993	0.994	0.995	0.996	0.996
																		100	91	81	70	58	47	37
																		0.993	0.992	0.993	0.994	0.995	0.995	0.995
																	109	101	92	82	71	59	48	38	29
																	1.006	0.996	0.993	0.993	0.993	0.994	0.995	0.995	0.995
																117	110	102	93	83	72	60	49	39	30	22
																1.092	1.031	1.007	0.997	0.994	0.993	0.994	0.995	0.995	0.996	0.997
														124	118	111	103	94	84	73	61	50	40	31	23	16
														0.973	0.000	1.092	1.032	1.008	0.999	0.996	0.996	0.996	0.997	0.998	0.999	1.001
												130	125	119	112	104	95	85	74	62	51	41	32	24	17	11
												0.918	0.942	0.973	0.000	1.095	1.035	1.012	1.003	1.001	1.001	1.002	1.002	1.004	1.005	1.010
										135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7
										0.895	0.904	0.919	0.942	0.974	0.000	1.099	1.041	1.021	1.015	1.013	1.013	1.014	1.015	1.017	1.020	1.029
							139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4	
							0.889	0.891	0.896	0.905	0.920	0.945	0.976	0.000	1.108	1.058	1.044	1.040	1.039	1.040	1.040	1.042	1.045	1.050	1.066	
		142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2		
		0.887	0.888	0.889	0.892	0.897	0.907	0.925	0.950	0.980	0.000	1.132	1.106	1.099	1.096	1.096	1.096	1.097	1.099	1.103	1.111	1.132		
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.887	0.887	0.888	0.888	0.890	0.893	0.900	0.913	0.934	0.961	0.987	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.54. Variant 13, pin-by-pin power distribution, burnup W = 30.0 MWd/kg, State S6.

67
0.999

79 68 56
0.998 0.999 0.999

90 80 69 57 46
0.996 0.997 0.998 0.998 0.998

100 91 81 70 58 47 37
0.995 0.995 0.996 0.996 0.997 0.997 0.997

109 101 92 82 71 59 48 38 29
1.009 0.999 0.995 0.995 0.995 0.996 0.997 0.997 0.996

117 110 102 93 83 72 60 49 39 30 22
1.089 1.033 1.009 0.999 0.996 0.995 0.995 0.996 0.996 0.996 0.997

124 118 111 103 94 84 73 61 50 40 31 23 16
0.963 0.000 1.089 1.033 1.010 1.000 0.997 0.996 0.997 0.997 0.997 0.998 0.999

130 125 119 112 104 95 85 74 62 51 41 32 24 17 11
0.933 0.946 0.963 0.000 1.091 1.035 1.013 1.004 1.001 1.000 1.001 1.001 1.002 1.003 1.006

135 131 126 120 113 105 96 86 75 63 52 42 33 25 18 12 7
0.919 0.925 0.934 0.947 0.964 0.000 1.093 1.040 1.020 1.012 1.010 1.010 1.010 1.011 1.012 1.014 1.021

139 136 132 127 121 114 106 97 87 76 64 53 43 34 26 19 13 8 4
0.916 0.917 0.920 0.925 0.935 0.948 0.964 0.000 1.098 1.052 1.037 1.032 1.030 1.030 1.031 1.031 1.033 1.037 1.049

142 140 137 133 128 122 115 107 98 88 77 65 54 44 35 27 20 14 9 5 2
0.915 0.915 0.916 0.917 0.920 0.927 0.937 0.950 0.966 0.000 1.114 1.088 1.079 1.075 1.074 1.073 1.074 1.075 1.077 1.083 1.098

144 143 141 138 134 129 123 116 108 99 89 78 66 55 45 36 28 21 15 10 6 3 1
0.915 0.915 0.915 0.915 0.916 0.918 0.922 0.930 0.942 0.955 0.969 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

Fig. 4.55. Variant 13, pin-by-pin power distribution, burnup W = 40.0 MWd/kg, State S6.

															67									
															1.000									
														79	68	56								
														0.999	1.000	1.000								
												90	80	69	57	46								
												0.997	0.998	0.999	0.999	0.999								
											100	91	81	70	58	47	37							
											0.996	0.996	0.997	0.997	0.998	0.998	0.997							
										109	101	92	82	71	59	48	38	29						
										1.009	0.999	0.996	0.996	0.996	0.997	0.997	0.997	0.996						
									117	110	102	93	83	72	60	49	39	30	22					
									1.080	1.031	1.009	0.999	0.996	0.995	0.995	0.996	0.996	0.995	0.995					
								124	118	111	103	94	84	73	61	50	40	31	23	16				
								0.968	0.000	1.080	1.031	1.009	1.000	0.996	0.995	0.995	0.995	0.995	0.995	0.995				
							130	125	119	112	104	95	85	74	62	51	41	32	24	17	11			
							0.951	0.957	0.968	0.000	1.080	1.031	1.010	1.002	0.999	0.998	0.997	0.997	0.997	0.997	0.999			
						135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7		
						0.946	0.948	0.951	0.957	0.968	0.000	1.081	1.034	1.015	1.008	1.005	1.004	1.004	1.004	1.004	1.005	1.010		
				139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4		
				0.946	0.946	0.946	0.948	0.951	0.957	0.967	0.000	1.083	1.042	1.028	1.022	1.020	1.019	1.019	1.019	1.019	1.022	1.030		
		142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2		
		0.947	0.947	0.946	0.946	0.946	0.948	0.952	0.957	0.967	0.000	1.093	1.068	1.059	1.054	1.052	1.051	1.051	1.051	1.052	1.055	1.067		
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.948	0.948	0.947	0.946	0.946	0.946	0.947	0.949	0.953	0.959	0.970	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.56. Variant 13, pin-by-pin power distribution, burnup W = 50.0 MWd/kg, State S6.

															67									
															1.000									
														79	68	56								
														0.999	1.000	1.000								
												90	80	69	57	46								
												0.997	0.998	0.999	0.999	0.998								
											100	91	81	70	58	47	37							
											0.996	0.995	0.996	0.997	0.997	0.997	0.996							
										109	101	92	82	71	59	48	38	29						
										1.007	0.998	0.995	0.995	0.995	0.995	0.995	0.995	0.994						
									117	110	102	93	83	72	60	49	39	30	22					
									1.069	1.026	1.006	0.998	0.995	0.994	0.994	0.994	0.993	0.992	0.991					
								124	118	111	103	94	84	73	61	50	40	31	23	16				
								0.981	0.000	1.068	1.025	1.006	0.997	0.994	0.993	0.992	0.992	0.991	0.990	0.990				
							130	125	119	112	104	95	85	74	62	51	41	32	24	17	11			
							0.971	0.972	0.981	0.000	1.067	1.025	1.006	0.998	0.994	0.993	0.992	0.992	0.991	0.990	0.991			
						135	131	126	120	113	105	96	86	75	63	52	42	33	25	18	12	7		
						0.973	0.972	0.970	0.971	0.980	0.000	1.066	1.025	1.008	1.001	0.998	0.997	0.996	0.995	0.994	0.995	0.997		
					139	136	132	127	121	114	106	97	87	76	64	53	43	34	26	19	13	8	4	
					0.978	0.976	0.973	0.971	0.970	0.970	0.980	0.000	1.066	1.030	1.017	1.011	1.009	1.007	1.006	1.005	1.005	1.006	1.012	
			142	140	137	133	128	122	115	107	98	88	77	65	54	44	35	27	20	14	9	5	2	
			0.981	0.980	0.977	0.975	0.972	0.970	0.968	0.969	0.979	0.000	1.073	1.051	1.041	1.037	1.034	1.033	1.032	1.031	1.031	1.033	1.042	
144	143	141	138	134	129	123	116	108	99	89	78	66	55	45	36	28	21	15	10	6	3	1		
0.983	0.982	0.981	0.979	0.976	0.974	0.971	0.969	0.968	0.970	0.982	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		

Fig. 4.57. Variant 13, pin-by-pin power distribution, burnup W = 60.0 MWd/kg, State S6.

4.4.2.2 Collision probability cell and assembly (WIMS-ABBN) calculations (T. I. Bagretsova, Z. N. Chizhikova, V. M. Dekoussar, G. M. Jerdev, A. G. Kalashnikov, E. N. Kapranova, V. E. Korobitsin, G. N. Manturov, A. L. Moseev, M. N. Nikolaev, Y. V. Rozhikhin, M. Y. Semenov, A. A. Tsyboulia, and A. M. Tsiboulia)

All fuel pin cell neutronic characteristics (Sect. 4.3.1, Variants 1–10) were obtained using the WIMS code. For fuel assemblies (Variants 11 and 12), only k_{eff} and k_0 were calculated by WIMS-ABBN. Note that the value of B^2 was specified as 0.003, and the concentrations of ^{135}Xe and ^{149}Sm in fuel at BOL were 9.4581E–09 and 7.3667E–08 atoms/(b·cm), respectively. The current version of WIMS-ABBN does not provide an edit of the pin-by-pin power distribution.

For the State S1, values of k_{eff} , k_0 , M^2; actinides densities; and ^{135}Xe and ^{149}Sm densities were reported at burnup intervals of 2 MWd/kg HM. Values of k_0 were calculated with B^2-fluxes. Values of M^2 were determined with the formula:

$$M^2 = \left(\frac{k_0}{k_{eff}} - 1 \right) \Big/ B^2 \quad .$$

The concentrations [atoms/(b·cm)] of actinides and total FPs listed below were calculated using WIMS-AVERAGE-CREDE codes. The concentrations of total FPs (FPs of uranium isotopes and FPs of plutonium isotopes) were assumed to be the number of fissioned nuclei. These concentrations include the one-half concentrations of ^{135}Xe and ^{149}Sm. In addition, the concentrations of ^{135}Xe and ^{149}Sm were reported separately.

Cell flux (Φ_{cell}) is the one-group cell-averaged flux if the cell neutron capture is equal to 1 neutron/(s·cm), that is, $\Phi_{cell} = 1/\Sigma_a S_{cell}$ where S_{cell} is the area of the cell. In the following text, several ratios are noted. These are defined as:

fuel/cell is Φ_{fuel}/Φ_{cell} ,

clad/cell is Φ_{clad}/Φ_{cell} ,

moderator/cell is Φ_{mod}/Φ_{cell} ,

where Φ_{fuel} , Φ_{clad}, and Φ_{mod} are one-group region-averaged fluxes.

Macroscopic cross sections, Σ, were computed using the formula

$$\sum = \frac{\sum_R \sum_{g=1}^{G} \Phi_g^R \sum_{n_R} \left(N_{n_R}^R \sigma_{g n_R}^R \right)}{\sum_R \sum_{g=1}^{G} \Phi_g^R} \quad ,$$

where R represents fuel, clad, and moderator; G = 69; n_R represents the nuclides of fuel, clad, and moderator; and $N_{n_R}^R$ is the number density of nuclide n in region R. One-group microscopic cross sections were determined for nuclides ^{135}Xe, ^{149}Sm, ^{235}U, ^{236}U, ^{238}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{242}Pu by the formula

$$\bar{\sigma} = \frac{\sum_{g=1}^{G} \Phi_{g\ fuel} \cdot \sigma_g}{\sum_{g=1}^{G} \Phi_{g\ fuel}} .$$

Reaction rates are RR = $\Phi_{fuel} \cdot \bar{\sigma}$ (b). The microscopic cross sections of total FPs were not reported, because these values are not readily computed from the results of a WIMS calculation.

Results of calculations are given in Tables 4.166–4.227.

Table 4.166. Values of k_{eff}, k_0, and M^2 for Variant 1, State 1, at burnup intervals

Burnup interval (MWd/kg HM)	k_{eff}	k_0	M^2 (cm^2)
0.00	1.057201	1.261381	64.38
2.00	1.040725	1.241017	64.15
4.00	1.023227	1.219578	63.96
6.00	1.005321	1.197757	63.81
8.00	0.988107	1.176859	63.67
10.00	0.971815	1.157151	63.57
12.00	0.956443	1.138599	63.48
14.00	0.941923	1.121126	63.42
16.00	0.928153	1.104590	63.36
18.00	0.915025	1.088854	63.32
20.00	0.902456	1.073811	63.29
22.00	0.890375	1.059370	63.27
24.00	0.878734	1.045469	63.25
26.00	0.867476	1.032036	63.23
28.00	0.856560	1.019020	63.22
30.00	0.845957	1.006385	63.21
32.00	0.835645	0.994099	63.21
34.00	0.825606	0.982146	63.20
36.00	0.815829	0.970508	63.20
38.00	0.806305	0.959173	63.20
40.00	0.797030	0.948139	63.20
42.00	0.787994	0.937389	63.20
44.00	0.779191	0.926920	63.20
46.00	0.770631	0.916741	63.20
48.00	0.762321	0.906861	63.20
50.00	0.754265	0.897285	63.20
52.00	0.746468	0.888017	63.21
54.00	0.738932	0.879060	63.21
56.00	0.731659	0.870415	63.21
58.00	0.724650	0.862086	63.22
60.00	0.717907	0.854073	63.22

Table 4.167. Nuclide concentration [atoms/(b·cm)] at specific burnup levels for Variant 1, State 1

Nuclide	Burnup (MWd/kg)				
	0.0	2.0	4.0	6.0	8.0
^{235}U	0.8737E–03	0.8268E–03	0.7826E–03	0.7409E–03	0.7013E–03
^{236}U	0.8737E–18	0.8708E–05	0.1687E–04	0.2454E–04	0.3178E–04
^{237}U	0.0000E+00	0.3822E–07	0.5542E–07	0.7089E–07	0.8508E–07
^{238}U	0.1874E–01	0.1872E–01	0.1869E–01	0.1867E–01	0.1864E–01
^{237}Np	0.8737E–18	0.1220E–06	0.3423E–06	0.6319E–06	0.9817E–06
^{238}Np	0.0000E+00	0.4100E–09	0.9449E–09	0.1666E–08	0.2558E–08
^{239}Np	0.0000E+00	0.1582E–05	0.1608E–05	0.1636E–05	0.1665E–05
^{236}Pu	0.0000E+00	0.3736E–13	0.2145E–12	0.5923E–12	0.1221E–11
^{237}Pu	0.0000E+00	0.1305E–12	0.8072E–12	0.2429E–11	0.5383E–11
^{238}Pu	0.8737E–18	0.3370E–08	0.1340E–07	0.3277E–07	0.6395E–07
^{239}Pu	0.8737E–18	0.1881E–04	0.3611E–04	0.5098E–04	0.6386E–04
^{240}Pu	0.8737E–18	0.5614E–06	0.2059E–05	0.4098E–05	0.6456E–05
^{241}Pu	0.8737E–18	0.5027E–07	0.3779E–06	0.1102E–05	0.2218E–05
^{242}Pu	0.8737E–18	0.4823E–09	0.7729E–08	0.3516E–07	0.9743E–07
^{241}Am	0.8737E–33	0.7240E–10	0.1156E–08	0.5208E–08	0.1424E–07
^{242m}Am	0.0000E+00	0.1417E–12	0.4246E–11	0.2640E–10	0.8855E–10
^{243}Am	0.8737E–18	0.3305E–11	0.1158E–09	0.8337E–09	0.3213E–08
^{242}Cm	0.0000E+00	0.1276E–11	0.4217E–10	0.2868E–09	0.1045E–08
^{243}Cm	0.0000E+00	0.1040E–14	0.7437E–13	0.7925E–12	0.3977E–11
^{244}Cm	0.8737E–18	0.3149E–13	0.2403E–11	0.2726E–10	0.1455E–09
^{245}Cm	0.8737E–18	0.7909E–16	0.1285E–13	0.2265E–12	0.1652E–11
FP ^{5}U	0.0000E+00	0.4062E–04	0.7897E–04	0.1154E–03	0.1501E–03
FP Pu	0.0000E+00	0.1063E–05	0.4307E–05	0.9406E–05	0.1614E–04
^{135}Xe	0.9458E–08	0.1008E–07	0.1019E–07	0.1026E–07	0.1030E–07
^{149}Sm	0.7367E–07	0.8149E–07	0.8791E–07	0.9358E–07	0.9853E–07
	10.0	12.0	14.0	16.0	18.0
^{235}U	0.6636E–03	0.6277E–03	0.5935E–03	0.5609E–03	0.5297E–03
^{236}U	0.3863E–04	0.4510E–04	0.5121E–04	0.5699E–04	0.6245E–04
^{237}U	0.9734E–07	0.1092E–06	0.1207E–06	0.1319E–06	0.1428E–06
^{238}U	0.1862E–01	0.1859E–01	0.1856E–01	0.1853E–01	0.1851E–01
^{237}Np	0.1379E–05	0.1818E–05	0.2295E–05	0.2805E–05	0.3345E–05
^{238}Np	0.3595E–08	0.4766E–08	0.6065E–08	0.7485E–08	0.9023E–08
^{239}Np	0.1693E–05	0.1721E–05	0.1748E–05	0.1775E–05	0.1802E–05
^{236}Pu	0.2141E–11	0.3383E–11	0.4974E–11	0.6936E–11	0.9287E–11
^{237}Pu	0.1002E–10	0.1665E–10	0.2553E–10	0.3690E–10	0.5099E–10
^{238}Pu	0.1091E–06	0.1700E–06	0.2484E–06	0.3460E–06	0.4641E–06
^{239}Pu	0.7509E–04	0.8491E–04	0.9351E–04	0.1011E–03	0.1077E–03
^{240}Pu	0.9007E–05	0.1167E–04	0.1440E–04	0.1717E–04	0.1993E–04
^{241}Pu	0.3671E–05	0.5394E–05	0.7320E–05	0.9390E–05	0.1155E–04
^{242}Pu	0.2073E–06	0.3749E–06	0.6072E–06	0.9090E–06	0.1283E–05
^{241}Am	0.2983E–07	0.5295E–07	0.8408E–07	0.1232E–06	0.1700E–06
^{242m}Am	0.2139E–09	0.4220E–09	0.7265E–09	0.1134E–08	0.1647E–08
^{243}Am	0.8852E–08	0.1979E–07	0.3838E–07	0.6716E–07	0.1088E–06
^{242}Cm	0.2725E–08	0.5772E–08	0.1062E–07	0.1766E–07	0.2719E–07
^{243}Cm	0.1331E–10	0.3461E–10	0.7577E–10	0.1464E–09	0.2574E–09
^{244}Cm	0.5179E–09	0.1430E–08	0.3324E–08	0.6812E–08	0.1270E–07
^{245}Cm	0.7487E–11	0.2520E–10	0.6917E–10	0.1637E–09	0.3464E–09
FP ^{5}U	0.1833E–03	0.2150E–03	0.2455E–03	0.2747E–03	0.3027E–03
FP Pu	0.2434E–04	0.3388E–04	0.4468E–04	0.5665E–04	0.6972E–04
^{135}Xe	0.1031E–07	0.1031E–07	0.1029E–07	0.1025E–07	0.1021E–07
^{149}Sm	0.1028E–06	0.1065E–06	0.1097E–06	0.1123E–06	0.1145E–06

Table 4.167. (continued)

Nuclide	Burnup (MWd/kg)				
	20.0	22.0	24.0	26.0	28.0
^{235}U	0.4999E–03	0.4715E–03	0.4444E–03	0.4185E–03	0.3938E–03
^{236}U	0.6759E–04	0.7243E–04	0.7697E–04	0.8124E–04	0.8523E–04
^{237}U	0.1534E–06	0.1636E–06	0.1736E–06	0.1832E–06	0.1926E–06
^{238}U	0.1848E–01	0.1845E–01	0.1842E–01	0.1839E–01	0.1836E–01
^{237}Np	0.3912E–05	0.4503E–05	0.5114E–05	0.5743E–05	0.6385E–05
^{238}Np	0.1067E–07	0.1243E–07	0.1429E–07	0.1624E–07	0.1828E–07
^{239}Np	0.1829E–05	0.1856E–05	0.1882E–05	0.1908E–05	0.1935E–05
^{236}Pu	0.1204E–10	0.1521E–10	0.1880E–10	0.2281E–10	0.2725E–10
^{237}Pu	0.6800E–10	0.8810E–10	0.1114E–09	0.1382E–09	0.1683E–09
^{238}Pu	0.6044E–06	0.7680E–06	0.9560E–06	0.1169E–05	0.1409E–05
^{239}Pu	0.1135E–03	0.1186E–03	0.1231E–03	0.1271E–03	0.1305E–03
^{240}Pu	0.2269E–04	0.2541E–04	0.2808E–04	0.3071E–04	0.3327E–04
^{241}Pu	0.1377E–04	0.1601E–04	0.1824E–04	0.2044E–04	0.2258E–04
^{242}Pu	0.1730E–05	0.2250E–05	0.2841E–05	0.3501E–05	0.4226E–05
^{241}Am	0.2238E–06	0.2840E–06	0.3494E–06	0.4193E–06	0.4927E–06
^{242m}Am	0.2261E–08	0.2967E–08	0.3757E–08	0.4616E–08	0.5532E–08
^{243}Am	0.1658E–06	0.2408E–06	0.3362E–06	0.4540E–06	0.5963E–06
^{242}Cm	0.3946E–07	0.5461E–07	0.7272E–07	0.9376E–07	0.1177E–06
^{243}Cm	0.4203E–09	0.6469E–09	0.9485E–09	0.1336E–08	0.1817E–08
^{244}Cm	0.2197E–07	0.3582E–07	0.5561E–07	0.8287E–07	0.1193E–06
^{245}Cm	0.6710E–09	0.1210E–08	0.2060E–08	0.3337E–08	0.5187E–08
FP ^{5}U	0.3297E–03	0.3556E–03	0.3805E–03	0.4045E–03	0.4275E–03
FP Pu	0.8384E–04	0.9895E–04	0.1150E–03	0.1320E–03	0.1498E–03
^{135}Xe	0.1015E–07	0.1009E–07	0.1002E–07	0.9942E–08	0.9862E–08
^{149}Sm	0.1163E–06	0.1177E–06	0.1187E–06	0.1194E–06	0.1199E–06
	30.0	32.0	34.0	36.0	38.0
^{235}U	0.3702E–03	0.3477E–03	0.3263E–03	0.3059E–03	0.2866E–03
^{236}U	0.8896E–04	0.9244E–04	0.9567E–04	0.9866E–04	0.1014E–03
^{237}U	0.2017E–06	0.2105E–06	0.2190E–06	0.2273E–06	0.2352E–06
^{238}U	0.1833E–01	0.1830E–01	0.1827E–01	0.1823E–01	0.1820E–01
^{237}Np	0.7040E–05	0.7705E–05	0.8374E–05	0.9048E–05	0.9723E–05
^{238}Np	0.2040E–07	0.2260E–07	0.2487E–07	0.2721E–07	0.2960E–07
^{239}Np	0.1961E–05	0.1987E–05	0.2013E–05	0.2039E–05	0.2065E–05
^{236}Pu	0.3211E–10	0.3740E–10	0.4309E–10	0.4917E–10	0.5564E–10
^{237}Pu	0.2021E–09	0.2394E–09	0.2803E–09	0.3248E–09	0.3727E–09
^{238}Pu	0.1675E–05	0.1969E–05	0.2290E–05	0.2638E–05	0.3012E–05
^{239}Pu	0.1335E–03	0.1361E–03	0.1384E–03	0.1403E–03	0.1420E–03
^{240}Pu	0.3577E–04	0.3820E–04	0.4054E–04	0.4280E–04	0.4498E–04
^{241}Pu	0.2467E–04	0.2668E–04	0.2862E–04	0.3046E–04	0.3222E–04
^{242}Pu	0.5014E–05	0.5861E–05	0.6761E–05	0.7709E–05	0.8702E–05
^{241}Am	0.5684E–06	0.6459E–06	0.7237E–06	0.8014E–06	0.8781E–06
^{242m}Am	0.6491E–08	0.7481E–08	0.8485E–08	0.9492E–08	0.1049E–07
^{243}Am	0.7646E–06	0.9609E–06	0.1185E–05	0.1439E–05	0.1722E–05
^{242}Cm	0.1443E–06	0.1735E–06	0.2050E–06	0.2386E–06	0.2739E–06
^{243}Cm	0.2401E–08	0.3095E–08	0.3899E–08	0.4817E–08	0.5848E–08
^{244}Cm	0.1667E–06	0.2271E–06	0.3023E–06	0.3945E–06	0.5058E–06
^{245}Cm	0.7780E–08	0.1132E–07	0.1602E–07	0.2212E–07	0.2990E–07
FP ^{5}U	0.4497E–03	0.4711E–03	0.4916E–03	0.5113E–03	0.5303E–03
FP Pu	0.1685E–03	0.1881E–03	0.2084E–03	0.2294E–03	0.2512E–03
^{135}Xe	0.9777E–08	0.9690E–08	0.9600E–08	0.9509E–08	0.9416E–08
^{149}Sm	0.1201E–06	0.1201E–06	0.1199E–06	0.1195E–06	0.1191E–06

Table 4.167. (continued)

Nuclide	Burnup (MWd/kg)				
	40.0	42.0	44.0	46.0	48.0
^{235}U	0.2682E–03	0.2507E–03	0.2341E–03	0.2184E–03	0.2036E–03
^{236}U	0.1039E–03	0.1063E–03	0.1084E–03	0.1103E–03	0.1120E–03
^{237}U	0.2428E–06	0.2502E–06	0.2573E–06	0.2639E–06	0.2704E–06
^{238}U	0.1817E–01	0.1814E–01	0.1810E–01	0.1807E–01	0.1803E–01
^{237}Np	0.1040E–04	0.1107E–04	0.1173E–04	0.1239E–04	0.1304E–04
^{238}Np	0.3203E–07	0.3451E–07	0.3703E–07	0.3956E–07	0.4213E–07
^{239}Np	0.2090E–05	0.2116E–05	0.2142E–05	0.2166E–05	0.2192E–05
^{236}Pu	0.6247E–10	0.6966E–10	0.7717E–10	0.8498E–10	0.9308E–10
^{237}Pu	0.4241E–09	0.4788E–09	0.5366E–09	0.5974E–09	0.6612E–09
^{238}Pu	0.3413E–05	0.3840E–05	0.4291E–05	0.4767E–05	0.5264E–05
^{239}Pu	0.1434E–03	0.1446E–03	0.1456E–03	0.1464E–03	0.1471E–03
^{240}Pu	0.4707E–04	0.4907E–04	0.5098E–04	0.5281E–04	0.5454E–04
^{241}Pu	0.3388E–04	0.3545E–04	0.3693E–04	0.3831E–04	0.3961E–04
^{242}Pu	0.9736E–05	0.1080E–04	0.1190E–04	0.1303E–04	0.1417E–04
^{241}Am	0.9532E–06	0.1026E–05	0.1096E–05	0.1163E–05	0.1227E–05
^{242m}Am	0.1147E–07	0.1243E–07	0.1334E–07	0.1422E–07	0.1506E–07
^{243}Am	0.2036E–05	0.2379E–05	0.2752E–05	0.3154E–05	0.3584E–05
^{242}Cm	0.3107E–06	0.3487E–06	0.3876E–06	0.4270E–06	0.4668E–06
^{243}Cm	0.6990E–08	0.8238E–08	0.9587E–08	0.1103E–07	0.1256E–07
^{244}Cm	0.6382E–06	0.7939E–06	0.9749E–06	0.1183E–05	0.1421E–05
^{245}Cm	0.3965E–07	0.5167E–07	0.6629E–07	0.8383E–07	0.1046E–06
FP ^{5}U	0.5485E–03	0.5661E–03	0.5829E–03	0.5991E–03	0.6147E–03
FP Pu	0.2736E–03	0.2968E–03	0.3206E–03	0.3450E–03	0.3701E–03
^{135}Xe	0.9323E–08	0.9229E–08	0.9136E–08	0.9043E–08	0.8951E–08
^{149}Sm	0.1184E–06	0.1177E–06	0.1169E–06	0.1161E–06	0.1151E–06
	50.0	52.0	54.0	56.0	58.0
^{235}U	0.1895E–03	0.1763E–03	0.1638E–03	0.1520E–03	0.1410E–03
^{236}U	0.1135E–03	0.1148E–03	0.1160E–03	0.1170E–03	0.1178E–03
^{237}U	0.2766E–06	0.2823E–06	0.2876E–06	0.2927E–06	0.2973E–06
^{238}U	0.1800E–01	0.1796E–01	0.1793E–01	0.1789E–01	0.1786E–01
^{237}Np	0.1368E–04	0.1431E–04	0.1492E–04	0.1552E–04	0.1610E–04
^{238}Np	0.4470E–07	0.4727E–07	0.4983E–07	0.5237E–07	0.5488E–07
^{239}Np	0.2217E–05	0.2241E–05	0.2265E–05	0.2288E–05	0.2310E–05
^{236}Pu	0.1014E–09	0.1100E–09	0.1188E–09	0.1278E–09	0.1369E–09
^{237}Pu	0.7275E–09	0.7963E–09	0.8671E–09	0.9400E–09	0.1015E–08
^{238}Pu	0.5783E–05	0.6322E–05	0.6878E–05	0.7450E–05	0.8036E–05
^{239}Pu	0.1477E–03	0.1482E–03	0.1485E–03	0.1488E–03	0.1490E–03
^{240}Pu	0.5619E–04	0.5775E–04	0.5922E–04	0.6061E–04	0.6192E–04
^{241}Pu	0.4081E–04	0.4194E–04	0.4298E–04	0.4394E–04	0.4483E–04
^{242}Pu	0.1534E–04	0.1651E–04	0.1769E–04	0.1888E–04	0.2007E–04
^{241}Am	0.1287E–05	0.1343E–05	0.1395E–05	0.1443E–05	0.1488E–05
^{242m}Am	0.1584E–07	0.1657E–07	0.1725E–07	0.1787E–07	0.1844E–07
^{243}Am	0.4041E–05	0.4523E–05	0.5030E–05	0.5559E–05	0.6110E–05
^{242}Cm	0.5066E–06	0.5461E–06	0.5852E–06	0.6235E–06	0.6609E–06
^{243}Cm	0.1416E–07	0.1582E–07	0.1754E–07	0.1930E–07	0.2108E–07
^{244}Cm	0.1689E–05	0.1989E–05	0.2324E–05	0.2693E–05	0.3099E–05
^{245}Cm	0.1290E–06	0.1573E–06	0.1898E–06	0.2269E–06	0.2687E–06
FP ^{5}U	0.6296E–03	0.6440E–03	0.6577E–03	0.6710E–03	0.6837E–03
FP Pu	0.3957E–03	0.4220E–03	0.4488E–03	0.4761E–03	0.5040E–03
^{135}Xe	0.8860E–08	0.8772E–08	0.8686E–08	0.8602E–08	0.8521E–08
^{149}Sm	0.1142E–06	0.1132E–06	0.1122E–06	0.1112E–06	0.1102E–06

Table 4.167. (continued)

Nuclide	Burnup (MWd/kg)
	60.0
^{235}U	0.1306E–03
^{236}U	0.1185E–03
^{237}U	0.3017E–06
^{238}U	0.1782E–01
^{237}Np	0.1666E–04
^{238}Np	0.5735E–07
^{239}Np	0.2332E–05
^{236}Pu	0.1461E–09
^{237}Pu	0.1090E–08
^{238}Pu	0.8634E–05
^{239}Pu	0.1491E–03
^{240}Pu	0.6315E–04
^{241}Pu	0.4565E–04
^{242}Pu	0.2125E–04
^{241}Am	0.1528E–05
^{242m}Am	0.1896E–07
^{243}Am	0.6679E–05
^{242}Cm	0.6972E–06
^{243}Cm	0.2289E–07
^{244}Cm	0.3541E–05
^{245}Cm	0.3157E–06
FP ^{5}U	0.6959E–03
FP Pu	0.5323E–03
^{135}Xe	0.8443E–08
^{149}Sm	0.1092E–06

Table 4.168. Variant 1, State 1

Burnup (MWd/kg HM)	Cell flux $(cm^2 \cdot s)^{-1}$	Fuel/cell	Clad/cell	Moderator/ cell	One-group cell-averaged macroscopic cross sections (cm^{-1})	
					Absorption	$\nu \cdot$ fis
0.00	33.9299	1.0017	0.9995	0.9990	2.0935E–02	2.6333E–02
10.00	33.3289	1.0016	0.9996	0.9991	2.1312E–02	2.4594E–02
20.00	33.0941	1.0015	0.9996	0.9992	2.1463E–02	2.2983E–02
30.00	33.0070	1.0015	0.9997	0.9992	2.1520E–02	2.1594E–02
40.00	32.9814	1.0014	0.9997	0.9992	2.1537E–02	2.0357E–02
50.00	32.9825	1.0014	0.9997	0.9992	2.1536E–02	1.9262E–02
60.00	32.9900	1.0014	0.9997	0.9992	2.1531E–02	1.8328E–02

Table 4.169. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 1, State 1, 0.00 MWd/kg HM

Nuclide	Absorption		ν · fis	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	1.45699E+05	4.295219+06	0.00000E+00	0.00000E+00
^{149}Sm	4.59210E+03	1.56081E+05	0.00000E+00	0.00000E+00
^{235}U	4.26215E+01	1.44866E+03	8.44601E+01	2.87072E+03
^{236}U	7.87941E+00	2.69737E+02	5.51642E–01	1.87497E+01
^{238}U	1.00245E+00	3.40721E+01	2.81140E–01	9.55566E+00
^{238}Pu	2.687246+01	9.11743E+02	7.06046E+00	2.39978E+02
^{239}Pu	1.46650E+02	4.92893E+03	2.66825E+02	8.99028E+03
^{240}Pu	2.25836E+02	7.67689E+03	1.86437E+00	6.34145E+01
^{241}Pu	1.27143E+02	4.32149E+03	2.79947E+02	9.51513E+03
^{242}Pu	2.90199E+01	9.86486E+02	1.31055E+00	4.54403E+01

Table 4.170. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 1, State 1, 10.00 MWd/kg HM

Nuclide	Absorption		ν · fis	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	1.28809E+05	4.30000E+06	0.00000E+00	0.00000E+00
^{149}Sm	4.04804E+03	1.35135E+05	0.00000E+00	0.00000E+00
^{235}U	3.86890E+01	1.29154E+03	7.61909E+01	2.54346E+03
^{236}U	6.66047E+00	2.22345E+02	5.61878E–01	1.87570E+01
^{238}U	9.97153E–01	3.32877E+01	2.86382E–01	9.56021E+00
^{238}Pu	2.44212E+01	8.15248E+02	6.92969E+00	2.31332E+02
^{239}Pu	1.23457E+02	4.12134E+03	2.25552E+02	7.52956E+03
^{240}Pu	1.70330E+02	5.68607E+03	1.86393E+00	6.22231E+01
^{241}Pu	1.10802E+02	3.69889E+03	2.44644E+02	8.16688E+03
^{242}Pu	2.92392E+01	9.76085E+02	1.33459E+00	4.45522E+01

Table 4.171. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 1, State 1, 20.00 MWd/kg HM

Nuclide	Absorption		ν · fis	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	1.23378E+05	4.08928E+06	0.00000E+00	0.00000E+00
^{149}Sm	3.86163E+03	1.27991E+05	0.00000E+00	0.00000E+00
^{235}U	3.73115E+01	1.23666E+03	7.32648E+01	2.42831E+03
^{236}U	6.10140E+00	2.02227E+02	5.66531E–01	1.87773E+01
^{238}U	9.95995E–01	3.30116E+01	2.88767E–01	9.57099E+00
^{238}Pu	2.36506E+01	7.83883E+02	6.89924E+00	2.28671E+02
^{239}Pu	1.14408E+02	3.79198E+03	2.09549E+02	6.94535E+03
^{240}Pu	1.29568E+02	4.29443E+03	1.85465E+00	6.14711E+01
^{241}Pu	1.04670E+02	3.46923E+03	2.31412E+02	7.66999E+03
^{242}Pu	2.91845E+01	9.67301E+02	1.34544E+00	4.45937E+01

Table 4.172. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 1, State 1, 30.00 MWd/kg HM

Nuclide	Absorption		ν · fis	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	1.22238E+05	4.04055E+06	0.00000E+00	0.00000E+00
^{149}Sm	3.81093E+03	1.25970E+05	0.00000E+00	0.00000E+00
^{235}U	3.69163E+01	1.22026E+03	7.24009E+01	2.39320E+03
^{236}U	5.87031E+00	1.94042E+02	5.68974E–01	1.88074E+01
^{238}U	9.96445E–01	3.29373E+01	2.90035E–01	9.58707E+00
^{238}Pu	2.34837E+01	7.76249E+02	6.90338E+00	2.28190E+02
^{239}Pu	1.10504E+02	3.65269E+03	2.02759E+02	6.70215E+03
^{240}Pu	1.08096E+02	3.57310E+03	1.84899E+00	6.11182E+01
^{241}Pu	1.02299E+02	3.38149E+03	2.26327E+02	7.48120E+03
^{242}Pu	2.88828E+01	9.54717E+02	1.35095E+00	4.46553E+01

Table 4.173. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 1, State 1, 40.00 MWd/kg HM

Nuclide	Absorption		ν · fis	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	1.22961E+05	4.06116E+06	0.00000E+00	0.00000E+00
^{149}Sm	3.81998E+03	1.26166E+05	0.00000E+00	0.00000E+00
^{235}U	3.70043E+01	1.22218E+03	7.25149E+01	2.39502E+03
^{236}U	5.74282E+00	1.89674E+02	5.70472E–01	1.88415E+01
^{238}U	9.97627E–01	3.29496E+01	2.90824E–01	9.60534E+00
^{238}Pu	2.35746E+01	7.78621E+02	6.92167E+00	2.28609E+02
^{239}Pu	1.08893E+02	3.59652E+03	2.00070E+02	6.60792E+03
^{240}Pu	9.57244E+01	3.16159E+03	1.84574E+00	6.09609E+01
^{241}Pu	1.01603E+02	3.35573E+03	2.24870E+02	7.42702E+03
^{242}Pu	2.84085E+01	9.38274E+02	1.35416E+00	4.47252E+01

Table 4.174. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 1, State 1, 50.00 MWd/kg HM

Nuclide	Absorption		ν · fis	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	1.24451E+05	4.11042E+06	0.00000E+00	0.00000E+00
^{149}Sm	3.85474E+03	1.27316E+05	0.00000E+00	0.00000E+00
^{235}U	3.72435E+01	1.23009E+03	7.29726E+01	2.41017E+03
^{236}U	5.66510E+00	1.87109E+02	5.71533E–01	1.88768E+01
^{238}U	9.99277E–01	3.30045E+01	2.91394E–01	9.62427E+00
^{238}Pu	2.37701E+01	7.85089E+02	6.94474E+00	2.29373E+02
^{239}Pu	1.08400E+02	3.58028E+03	1.99368E+02	6.58479E+03
^{240}Pu	8.80976E+01	2.90972E+03	1.84396E+00	6.09031E+01
^{241}Pu	1.01694E+02	3.35879E+03	2.25119E+02	7.43530E+03
^{242}Pu	2.78499E+01	9.19838E+02	1.35630E+00	4.47962E+01

Table 4.175. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 1, State 1, 60.00 MWd/kg HM

Nuclide	Absorption		ν · fis	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	1.25933E+05	4.16027E+06	0.00000E+00	0.00000E+00
^{149}Sm	3.89153E+03	1.28559E+05	0.00000E+00	0.00000E+00
^{235}U	3.75074E+01	1.23908E+03	7.34839E+01	2.42758E+03
^{236}U	5.60898E+00	1.85296E+02	5.72527E–01	1.89137E+01
^{238}U	1.00103E+00	3.30695E+01	2.91934E–01	9.64420E+00
^{238}Pu	2.39619E+01	7.91594E+02	6.96588E+00	2.30122E+02
^{239}Pu	1.08316E+02	3.57829E+03	1.99363E+02	6.58606E+03
^{240}Pu	8.31420E+01	2.74664E+03	1.84353E+00	6.09020E+01
^{241}Pu	1.01997E+02	3.36952E+03	2.25814E+02	7.45988E+03
^{242}Pu	2.72670E+01	9.00782E+02	1.35824E+00	4.48701E+01

Table 4.176. Values of k_{eff}, k_0, and M^2 for Variant 1, States 3–6, at burnup intervals

Burnup interval (MWd/kg HM)	State	k_{eff}	k_0	M^2 (cm^2)
0.00				
	S3	1.102399	1.316708	64.80
	S4	1.096189	1.309056	64.73
	S5	1.110852	1.327139	64.90
	S6	1.216047	1.367108	41.41
10.00				
	S3	1.009508	1.203141	63.94
	S4	1.009126	1.202638	63.92
	S5	1.023220	1.220053	64.12
	S6	1.130077	1.269410	41.10
20.00				
	S3	0.936577	1.115427	63.65
	S4	0.937106	1.116047	63.65
	S5	0.951205	1.133485	63.88
	S6	1.054730	1.184606	41.05
30.00				
	S3	0.877926	1.045388	63.58
	S4	0.878094	1.045579	63.58
	S5	0.891741	1.062458	63.81
	S6	0.988909	1.110753	41.07
40.00				
	S3	0.827450	0.985274	63.58
	S4	0.826718	0.984380	63.57
	S5	0.839626	1.000341	63.80
	S6	0.929021	1.043600	41.11
50.00				
	S3	0.783449	0.932941	63.60
	S4	0.781646	0.930745	63.58
	S5	0.793722	0.945681	63.82
	S6	0.874999	0.983028	41.15
60.00				
	S3	0.746037	0.888467	63.64
	S4	0.743223	0.885041	63.60
	S5	0.754496	0.898991	63.84
	S6	0.828197	0.930539	41.19

Table 4.177. Values of k_{eff}, k_0, and M^2 for Variant 2, State 1, at burnup intervals

Burnup interval (MWd/kg HM)	k_{eff}	k_0	M^2 (cm^2)
0.00	1.014868	1.200379	60.93
2.00	0.978119	1.156438	60.77
4.00	0.958640	1.133404	60.77
6.00	0.941670	1.113351	60.77
8.00	0.926362	1.095272	60.78
10.00	0.912340	1.078722	60.79
12.00	0.899346	1.063393	60.80
14.00	0.887191	1.049060	60.82
16.00	0.875734	1.035558	60.83
18.00	0.864891	1.022787	60.85
20.00	0.854564	1.010631	60.88
22.00	0.844664	0.998980	60.90
24.00	0.835136	0.987773	60.92
26.00	0.825946	0.976966	60.95
28.00	0.817053	0.966513	60.98
30.00	0.808441	0.956392	61.00
32.00	0.800105	0.946599	61.03
34.00	0.792030	0.937117	61.06
36.00	0.784217	0.927940	61.09
38.00	0.776660	0.919067	61.12
40.00	0.769354	0.910490	61.15
42.00	0.762294	0.902205	61.18
44.00	0.755477	0.894206	61.21
46.00	0.748897	0.886489	61.24
48.00	0.742554	0.879049	61.27
50.00	0.736444	0.871885	61.30
52.00	0.730561	0.864992	61.34
54.00	0.724905	0.858366	61.37
56.00	0.719472	0.852003	61.40
58.00	0.714257	0.845900	61.44
60.00	0.709259	0.840051	61.47

Table 4.178. Nuclide concentration [atoms/(b·cm)] at specific burnup levels for Variant 2, State 1

	Burnup (MWd/kg)				
Nuclide	0.0	2.0	4.0	6.0	8.0
^{235}U	0.3839E–04	0.3703E–04	0.3567E–04	0.3433E–04	0.3301E–04
^{236}U	0.3839E–19	0.3076E–06	0.6085E–06	0.9009E–06	0.1185E–05
^{237}U	0.0000E+00	0.2968E–07	0.3123E–07	0.3249E–07	0.3371E–07
^{238}U	0.1892E–01	0.1889E–01	0.1886E–01	0.1883E–01	0.1881E–01
^{237}Np	0.3839E–19	0.1132E–06	0.2565E–06	0.4007E–06	0.5455E–06
^{238}Np	0.0000E+00	0.3970E–09	0.7336E–09	0.1083E–08	0.1445E–08
^{239}Np	0.0000E+00	0.1723E–05	0.1757E–05	0.1786E–05	0.1814E–05
^{236}Pu	0.0000E+00	0.4474E–13	0.2171E–12	0.5198E–12	0.9513E–12
^{237}Pu	0.0000E+00	0.2322E–12	0.1135E–11	0.2923E–11	0.5798E–11
^{238}Pu	0.3839E–19	0.4976E–08	0.1570E–07	0.3310E–07	0.5845E–07
^{239}Pu	0.6588E–03	06260E–03	0.5962E–03	0.5677E–03	0.5405E–03
^{240}Pu	0.4232E–04	0.5517E–04	0.6678E–04	0.7727E–04	0.8677E–04
^{241}Pu	0.7025E–05	0.1283E–04	0.1899E–04	0.2526E–04	0.3153E–04
^{242}Pu	0.3839E–19	0.2081E–06	0.5443E–06	0.1015E–05	0.1624E–05
^{241}Am	0.7025E–20	0.6013E–07	0.1518E–06	0.2729E–06	0.4214E–06
^{242m}Am	0.0000E+00	0.1858E–09	0.7949E–09	0.1869E–08	0.3421E–08
^{243}Am	0.3839E–19	0.4082E–08	0.1988E–07	0.5276E–07	0.1083E–06
^{242}Cm	0.7025E–35	0.1631E–08	0.7454E–08	0.1864E–07	0.3620E–07
^{243}Cm	0.7025E–35	0.2899E–11	0.2564E–10	0.9363E–10	0.2373E–09
^{244}Cm	0.3839E–19	0.8844E–10	0.8318E–09	0.3221E–08	0.8641E–08
^{245}Cm	0.3839E–19	0.4854E–12	0.8893E–11	0.5043E–10	0.1768E–09
FP ^{5}U	0.0000E+00	0.3985E–05	0.8035E–05	0.1212E–04	0.1625E–04
FP Pu	0.0000E+00	0.3613E–04	0.7222E–04	0.1082E–03	0.1442E–03
^{135}Xe	0.9458E–08	1.6771E–08	1.6455E–08	1.6141E–08	1.5833E–08
^{149}Sm	0.7367E–07	1.6311E–07	1.7454E–07	1.7743E–07	1.7926E–07
	10.0	12.0	14.0	16.0	18.0
^{235}U	0.3171E–04	0.3043E–04	0.2917E–04	0.2794E–04	0.2673E–04
^{236}U	0.1460E–05	0.1727E–05	0.1983E–05	0.2230E–05	0.2467E–05
^{237}U	0.3488E–07	0.3602E–07	0.3711E–07	0.3818E–07	0.3922E–07
^{238}U	0.1878E–01	0.1875E–01	0.1872E–01	0.1869E–01	0.1866E–01
^{237}Np	0.6901E–06	0.8346E–06	0.9781E–06	0.1121E–05	0.1262E–05
^{238}Np	0.1816E–08	0.2198E–08	0.2587E–08	0.2984E–08	0.3387E–08
^{239}Np	0.1841E–05	0.1866E–05	0.1891E–05	0.1914E–05	0.1937E–05
^{236}Pu	0.1506E–11	0.2183E–11	0.2974E–11	0.3878E–11	0.4886E–11
^{237}Pu	0.9944E–11	0.1558E–10	0.2288E–10	0.3207E–10	0.4330E–10
^{238}Pu	0.9292E–07	0.1380E–06	0.1948E–06	0.2648E–06	0.3490E–06
^{239}Pu	0.5145E–03	0.4898E–03	0.4664E–03	0.4442E–03	0.4233E–03
^{240}Pu	0.9531E–04	0.1030E–03	0.1098E–03	0.1158E–03	0.1211E–03
^{241}Pu	0.3767E–04	0.4363E–04	0.4931E–04	0.5471E–04	0.5975E–04
^{242}Pu	0.2371E–05	0.3256E–05	0.4271E–05	0.5415E–05	0.6677E–05
^{241}Am	0.5935E–06	0.7860E–06	0.9944E–06	0.1216E–05	0.1445E–05
^{242m}Am	0.5423E–08	0.7840E–08	0.1060E–07	0.1366E–07	0.1691E–07
^{243}Am	0.1915E–06	0.3077E–06	0.4609E–06	0.6555E–06	0.8942E–06
^{242}Cm	0.6072E–07	0.9274E–07	0.1323E–06	0.1796E–06	0.2342E–06
^{243}Cm	0.4888E–09	0.8829E–09	0.1451E–08	0.2225E–08	0.3230E–08
^{244}Cm	0.1881E–07	0.3585E–07	0.6210E–07	0.1003E–06	0.1533E–06
^{245}Cm	0.4723E–09	0.1063E–08	0.2117E–08	0.3858E–08	0.6547E–08
FP ^{5}U	0.2041E–04	0.2460E–04	0.2881E–04	0.3305E–04	0.3730E–04
FP Pu	0.1801E–03	0.2161E–03	0.2519E–03	0.2879E–03	0.3237E–03
^{135}Xe	1.5530E–08	1.5234E–08	1.4944E–08	1.4661E–08	1.4384E–08
^{149}Sm	1.8038E–07	1.8088E–07	1.8084E–07	1.8035E–07	1.7945E–07

Table 4.178. (continued)

Nuclide	Burnup (MWd/kg)				
	20.0	22.0	24.0	26.0	28.0
^{235}U	0.2555E–04	0.2439E–04	0.2326E–04	0.2217E–04	0.2110E–04
^{236}U	0.2695E–05	0.2912E–05	0.3119E–05	0.3315E–05	0.3502E–05
^{237}U	0.4024E–07	0.4123E–07	0.4219E–07	0.4313E–07	0.4405E–07
^{238}U	0.1863E–01	0.1859E–01	0.1856E–01	0.1853E–01	0.1850E–01
^{237}Np	0.1402E–05	0.1541E–05	0.1677E–05	0.1812E–05	0.1944E–05
^{238}Np	0.3796E–08	0.4210E–08	0.4629E–08	0.5051E–08	0.5478E–08
^{239}Np	0.1960E–05	0.1982E–05	0.2004E–05	0.2026E–05	0.2047E–05
^{236}Pu	0.5999E–11	0.7206E–11	0.8508E–11	0.9894E–11	0.1136E–10
^{237}Pu	0.5677E–10	0.7257E–10	0.9088E–10	0.1117E–09	0.1352E–09
^{238}Pu	0.4486E–06	0.5642E–06	0.6968E–06	0.8465E–06	0.1014E–05
^{239}Pu	0.4035E–03	0.3850E–03	0.3675E–03	0.3513E–03	0.3360E–03
^{240}Pu	0.1257E–03	0.1296E–03	0.1329E–03	0.1356E–03	0.1378E–03
^{241}Pu	0.6444E–04	0.6873E–04	0.7264E–04	0.7614E–04	0.7925E–04
^{242}Pu	0.8052E–05	0.9526E–05	0.1110E–04	0.1274E–04	0.1447E–04
^{241}Am	0.1679E–05	0.1914E–05	0.2147E–05	0.2374E–05	0.2593E–05
^{242m}Am	0.2032E–07	0.2379E–07	0.2728E–07	0.3070E–07	0.3403E–07
^{243}Am	0.1181E–05	0.1515E–05	0.1902E–05	0.2338E–05	0.2827E–05
^{242}Cm	0.2958E–06	0.3638E–06	0.4377E–06	0.5165E–06	0.5996E–06
^{243}Cm	0.4493E–08	0.6024E–08	0.7844E–08	0.9949E–08	0.1235E–07
^{244}Cm	0.2244E–06	0.3164E–06	0.4330E–06	0.5772E–06	0.7527E–06
^{245}Cm	0.1052E–07	0.1612E–07	0.2381E–07	0.3400E–07	0.4724E–07
FP ^{5}U	0.4158E–04	0.4587E–04	0.5018E–04	0.5449E–04	0.5883E–04
FP Pu	0.3596E–03	0.3954E–03	0.4312E–03	0.4670E–03	0.5028E–03
^{135}Xe	1.4113E–08	1.3849E–08	1.3592E–08	1.3341E–08	1.3097E–08
^{149}Sm	1.7822E–07	1.7672E–07	1.7498E–07	1.7305E–07	1.7097E–07
	30.0	32.0	34.0	36.0	38.0
^{235}U	0.2006E–04	0.1905E–04	0.1808E–04	0.1713E–04	0.1622E–04
^{236}U	0.3678E–05	0.3845E–05	0.4000E–05	0.4147E–05	0.4283E–05
^{237}U	0.4494E–07	0.4581E–07	0.4665E–07	0.4747E–07	0.4826E–07
^{238}U	0.1846E–01	0.1843E–01	0.1840E–01	0.1836E–01	0.1833E–01
^{237}Np	0.2074E–05	0.2201E–05	0.2325E–05	0.2447E–05	0.2566E–05
^{238}Np	0.5906E–08	0.6336E–08	0.6766E–08	0.7198E–08	0.7627E–08
^{239}Np	0.2069E–05	0.2090E–05	0.2110E–05	0.2131E–05	0.2152E–05
^{236}Pu	0.1291E–10	0.1453E–10	0.1621E–10	0.1795E–10	0.1975E–10
^{237}Pu	0.1612E–09	0.1898E–09	0.2209E–09	0.2544E–09	0.2901E–09
^{238}Pu	0.1199E–05	0.1401E–05	0.1620E–05	0.1856E–05	0.2107E–05
^{239}Pu	0.3219E–03	0.3087E–03	0.2966E–03	0.2853E–03	0.2749E–03
^{240}Pu	0.1394E–03	0.1406E–03	0.1414E–03	0.1417E–03	0.1417E–03
^{241}Pu	0.8197E–04	0.8433E–04	0.8631E–04	0.8795E–04	0.8926E–04
^{242}Pu	0.1625E–04	0.1808E–04	0.1995E–04	0.2185E–04	0.2376E–04
^{241}Am	0.2802E–05	0.2998E–05	0.3180E–05	0.3347E–05	0.3497E–05
^{242m}Am	0.3720E–07	0.4019E–07	0.4296E–07	0.4549E–07	0.4776E–07
^{243}Am	0.3365E–05	0.3954E–05	0.4590E–05	0.5273E–05	0.5997E–05
^{242}Cm	0.6858E–06	0.7747E–06	0.8647E–06	0.9555E–06	0.1046E–05
^{243}Cm	0.1503E–07	0.1798E–07	0.2118E–07	0.2462E–07	0.2825E–07
^{244}Cm	0.9621E–06	0.1209E–05	0.1497E–05	0.1827E–05	0.2203E–05
^{245}Cm	0.6402E–07	0.8494E–07	0.1105E–06	0.1414E–06	0.1780E–06
FP ^{5}U	0.6317E–04	0.6752E–04	0.7188E–04	0.7625E–04	0.8063E–04
FP Pu	0.5386E–03	0.5745E–03	0.6102E–03	0.6461E–03	0.6818E–03
^{135}Xe	1.2859E–08	1.2628E–08	1.2405E–08	1.2188E–08	1.1979E–08
^{149}Sm	1.6877E–07	1.6649E–07	1.6415E–07	1.6177E–07	1.5937E–07

Table 4.178. (continued)

Nuclide	Burnup (MWd/kg)				
	40.0	42.0	44.0	46.0	48.0
^{235}U	0.1534E–04	0.1449E–04	0.1368E–04	0.1290E–04	0.1215E–04
^{236}U	0.4409E–05	0.4525E–05	0.4633E–05	0.4730E–05	0.4819E–05
^{237}U	0.4902E–07	0.4975E–07	0.5044E–07	0.5111E–07	0.5177E–07
^{238}U	0.1830E–01	0.1826E–01	0.1823E–01	0.1819E–01	0.1816E–01
^{237}Np	0.2682E–05	0.2794E–05	0.2903E–05	0.3009E–05	0.3111E–05
^{238}Np	0.8055E–08	0.8478E–08	0.8899E–08	0.9314E–08	0.9734E–08
^{239}Np	0.2172E–05	0.2191E–05	0.2210E–05	0.2229E–05	0.2249E–05
^{236}Pu	0.2160E–10	0.2349E–10	0.2542E–10	0.2738E–10	0.2937E–10
^{237}Pu	0.3280E–09	0.3678E–09	0.4093E–09	0.4523E–09	0.4966E–09
^{238}Pu	0.2372E–05	0.2650E–05	0.2940E–05	0.3240E–05	0.3549E–05
^{239}Pu	0.2653E–03	0.2565E–03	0.2484E–03	0.2410E–03	0.2342E–03
^{240}Pu	0.1414E–03	0.1408E–03	0.1399E–03	0.1388E–03	0.1376E–03
^{241}Pu	0.9027E–04	0.9099E–04	0.9145E–04	0.9167E–04	0.9167E–04
^{242}Pu	0.2568E–04	0.2759E–04	0.2949E–04	0.3136E–04	0.3321E–04
^{241}Am	0.3630E–05	0.3746E–05	0.3845E–05	0.3927E–05	0.3992E–05
^{242m}Am	0.4976E–07	0.5149E–07	0.5295E–07	0.5415E–07	0.5508E–07
^{243}Am	0.6763E–05	0.7564E–05	0.8399E–05	0.9262E–05	0.1015E–04
^{242}Cm	0.1135E–05	0.1221E–05	0.1305E–05	0.1386E–05	0.1462E–05
^{243}Cm	0.3206E–07	0.3600E–07	0.4005E–07	0.4415E–07	0.4829E–07
^{244}Cm	0.2627E–05	0.3099E–05	0.3624E–05	0.4200E–05	0.4829E–05
^{245}Cm	0.2211E–06	0.2710E–06	0.3284E–06	0.3935E–06	0.4670E–06
FP ^{5}U	0.8501E–04	0.8940E–04	0.9379E–04	0.9819E–04	0.1026E–03
FP Pu	0.7177E–03	0.7535E–03	0.7893E–03	0.8251E–03	0.8610E–03
^{135}Xe	1.1778E–08	1.1583E–08	1.1396E–08	1.1215E–08	1.1042E–08
^{149}Sm	1.5698E–07	1.5459E–07	1.5222E–07	1.4989E–07	1.4759E–07
	50.0	52.0	54.0	56.0	58.0
^{235}U	0.1143E–04	0.1074E–04	0.1009E–04	0.9463E–05	0.8870E–05
^{236}U	0.4899E–05	0.4970E–05	0.5032E–05	0.5087E–05	0.5133E–05
^{237}U	0.5235E–07	0.5292E–07	0.5345E–07	0.5396E–07	0.5446E–07
^{238}U	0.1812E–01	0.1808E–01	0.1805E–01	0.1801E–01	0.1797E–01
^{237}Np	0.3210E–05	0.3305E–05	0.3396E–05	0.3484E–05	0.3568E–05
^{238}Np	0.1013E–07	0.1053E–07	0.1091E–07	0.1130E–07	0.1168E–07
^{239}Np	0.2265E–05	0.2282E–05	0.2299E–05	0.2316E–05	0.2333E–05
^{236}Pu	0.3137E–10	0.3340E–10	0.3542E–10	0.3745E–10	0.3948E–10
^{237}Pu	0.5417E–09	0.5876E–09	0.6339E–09	0.6805E–09	0.7270E–09
^{238}Pu	0.3864E–05	0.4185E–05	0.4509E–05	0.4835E–05	0.5160E–05
^{239}Pu	0.2280E–03	0.2223E–03	0.2170E–03	0.2123E–03	0.2079E–03
^{240}Pu	0.1361E–03	0.1346E–03	0.1329E–03	0.1311E–03	0.1293E–03
^{241}Pu	0.9147E–04	0.9110E–04	0.9059E–04	0.8994E–04	0.8918E–04
^{242}Pu	0.3501E–04	0.3678E–04	0.3848E–04	0.4014E–04	0.4173E–04
^{241}Am	0.4041E–05	0.4076E–05	0.4096E–05	0.4103E–05	0.4098E–05
^{242m}Am	0.5577E–07	0.5622E–07	0.5646E–07	0.5650E–07	0.5635E–07
^{243}Am	0.1106E–04	0.1199E–04	0.1293E–04	0.1388E–04	0.1483E–04
^{242}Cm	0.1533E–05	0.1600E–05	0.1661E–05	0.1716E–05	0.1766E–05
^{243}Cm	0.5240E–07	0.5647E–07	0.6044E–07	0.6430E–07	0.6800E–07
^{244}Cm	0.5511E–05	0.6248E–05	0.7036E–05	0.7878E–05	0.8769E–05
^{245}Cm	0.5490E–06	0.6399E–06	0.7397E–06	0.8490E–06	0.9672E–06
FP ^{5}U	0.1070E–03	0.1114E–03	0.1158E–03	0.1202E–03	0.1246E–03
FP Pu	0.8969E–03	0.9328E–03	0.9686E–03	0.1005E–02	0.1040E–02
^{135}Xe	1.0875E–08	1.0714E–08	1.0560E–08	1.0411E–08	1.0269E–08
^{149}Sm	1.4533E–07	1.4312E–07	1.4096E–07	1.3886E–07	1.3682E–07

Table 4.178. (continued)

Nuclide	Burnup (MWd/kg)
	60.0
^{235}U	0.8307E–05
^{236}U	0.5172E–05
^{237}U	0.5487E–07
^{238}U	0.1794E–01
^{237}Np	0.3648E–05
^{238}Np	0.1203E–07
^{239}Np	0.2347E–05
^{236}Pu	0.4149E–10
^{237}Pu	0.7730E–09
^{238}Pu	0.5484E–05
^{239}Pu	0.2039E–03
^{240}Pu	0.1275E–03
^{241}Pu	0.8832E–04
^{242}Pu	0.4325E–04
^{241}Am	0.4083E–05
^{242m}Am	0.5605E–07
^{243}Am	0.1578E–04
^{242}Cm	0.1809E–05
^{243}Cm	0.7153E–07
^{244}Cm	0.9710E–05
^{245}Cm	0.1095E–05
FP ^{5}U	0.1290E–03
FP Pu	0.1076E–02
^{135}Xe	1.0132E–08
^{149}Sm	1.3483E–07

Table 4.179. Variant 2, State 1

Burnup (MWd/kg HM)	Cell flux $(cm^2 \cdot s)^{-1}$	Fuel/cell	Clad/cell	Moderator/ cell	One-group cell-averaged macroscopic cross sections (cm^{-1}) Absorption	$\nu \cdot$ fis
0.00	31.5170	1.0005	1.0003	0.9996	2.2537E–02	2.7013E–02
10.00	31.5190	1.0004	1.0002	0.9997	2.2536E–02	2.4270E–02
20.00	31.6220	1.0006	1.0001	0.9996	2.2463E–02	2.2660E–02
30.00	31.7489	1.0007	1.0001	0.9996	2.2373E–02	2.1353E–02
40.00	31.8815	1.0008	1.0000	0.9995	2.2280E–02	2.0239E–02
50.00	32.0076	1.0009	0.9999	0.9994	2.2192E–02	1.9300E–02
60.00	32.1237	1.0010	0.9999	0.9994	2.2112E–02	1.8524E–02

Table 4.180. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 2, State 1, 0.00 MWd/kg HM

Nuclide	Absorption Cross section (b)	Absorption Reaction rate	$\nu \cdot$ fis Cross section (b)	$\nu \cdot$ fis Reaction rate
^{135}Xe	6.42460E+04	2.02589E+06	0.00000E+00	0.00000E+00
^{149}Sm	2.04676E+03	6.45409E+04	0.00000E+00	0.00000E+00
^{235}U	2.52799E+01	7.97159E+02	4.78063E+01	1.50749E+03
^{236}U	8.32421E+00	2.62490E+02	5.88519E–01	1.85579E+01
^{238}U	9.82196E–01	3.09719E+01	3.00002E–01	9.46005E+00
^{238}Pu	1.53419E+01	4.83780E+02	6.35107E+00	2.00270E+02
^{239}Pu	5.95876E+01	1.87899E+03	1.10279E+02	3.47747E+03
^{240}Pu	1.01865E+02	3.21214E+03	1.90834E+00	6.01762E+01
^{241}Pu	6.14681E+01	1.93829E+03	1.37282E+02	4.32897E+03
^{242}Pu	3.08955E+01	9.74236E+02	1.39826E+00	4.40916E+01

Table 4.181. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 2, State 1, 10.00 MWd/kg HM

Nuclide	Absorption Cross section (b)	Absorption Reaction rate	$\nu \cdot$ fis Cross section (b)	$\nu \cdot$ fis Reaction rate
^{135}Xe	6.74523E+04	2.12691E+06	0.00000E+00	0.00000E+00
^{149}Sm	2.13657E+03	6.73706E+04	0.00000E+00	0.00000E+00
^{235}U	2.58190E+01	8.14129E+02	4.89413E+01	1.54322E+03
^{236}U	8.12485E+00	2.56195E+02	5.89208E–01	1.85790E+01
^{238}U	9.81248E–01	3.09409E+01	3.00367E–01	9.47125E+00
^{238}Pu	1.57980E+01	4.98146E+02	6.39937E+00	2.01786E+02
^{239}Pu	6.32911E+01	1.99570E+03	1.16811E+02	3.68331E+03
^{240}Pu	6.81416E+01	2.14866E+03	1.88980E+00	5.95898E+01
^{241}Pu	6.39801E+01	2.01743E+03	1.42674E+02	4.49883E+03
^{242}Pu	3.03975E+01	9.58502E+02	1.39966E+00	4.41344E+01

Table 4.182. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 2, State 1, 20.00 MWd/kg HM

Nuclide	Absorption		ν · fis	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	7.38821E+04	2.33759E+06	0.00000E+00	0.00000E+00
^{149}Sm	2.32611E+03	7.35969E+04	0.00000E+00	0.00000E+00
^{235}U	2.70502E+01	8.55859E+02	5.15276E+01	1.63031E+03
^{236}U	7.88789E+00	2.49570E+02	5.88376E–01	1.86160E+01
^{238}U	9.81472E–01	3.10534E+01	2.99960E–01	9.49062E+00
^{238}Pu	1.66811E+01	5.27782E+02	6.46965E+00	2.04697E+02
^{239}Pu	6.87423E+01	2.17498E+03	1.26675E+02	4.00795E+03
^{240}Pu	5.92878E+01	1.87584E+03	1.88121E+00	5.95208E+01
^{241}Pu	6.81735E+01	2.15698E+03	1.51795E+02	4.80273E+03
^{242}Pu	2.95262E+01	9.34200E+02	1.39736E+00	4.42119E+01

Table 4.183. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 2, State 1, 30.00 MWd/kg HM

Nuclide	Absorption		ν · fis	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	8.05510E+04	2.55917E+06	0.00000E+00	0.00000E+00
^{149}Sm	2.52411E+03	8.01929E+04	0.00000E+00	0.00000E+00
^{235}U	2.83642E+01	9.01154E+02	5.42828E+01	1.72461E+03
^{236}U	7.75145E+00	2.46271E+02	5.87166E–01	1.86548E+01
^{238}U	9.82834E–01	3.12256E+01	2.99362E–01	9.51101E+00
^{238}Pu	1.75927E+01	5.58936E+02	6.53829E+00	2.07727E+02
^{239}Pu	7.42806E+01	2.35996E+03	1.36741E+02	4.34438E+03
^{240}Pu	5.62304E+01	1.78649E+03	1.87467E+00	5.95599E+01
^{241}Pu	7.25342E+01	2.30447E+03	1.61293E+02	5.12440E+03
^{242}Pu	2.84996E+01	9.05460E+02	1.39410E+00	4.42919E+01

Table 4.184. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 2, State 1, 40.00 MWd/kg HM

Nuclide	Absorption		ν · fis	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	8.70109E+04	2.77627E+06	0.00000E+00	0.00000E+00
^{149}Sm	2.71639E+03	8.66724E+04	0.00000E+00	0.00000E+00
^{235}U	2.96486E+01	9.46006E+02	5.69733E+01	1.81786E+03
^{236}U	7.65869E+00	2.44368E+02	5.85918E–01	1.86951E+01
^{238}U	9.85026E–01	3.14296E+01	2.98750E–01	9.53232E+00
^{238}Pu	1.84732E+01	5.89429E+02	6.60294E+00	2.10682E+02
^{239}Pu	7.93975E+01	2.53336E+03	1.46092E+02	4.66141E+03
^{240}Pu	5.57358E+01	1.77838E+03	1.86995E+00	5.96651E+01
^{241}Pu	7.67257E+01	2.44811E+03	1.70435E+02	5.43810E+03
^{242}Pu	2.74671E+01	8.76401E+02	1.39071E+00	4.43740E+01

Table 4.185. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 2, State 1, 50.00 MWd/kg HM

Nuclide	Absorption		$\nu\Sigma_f$	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	9.29618E+04	2.97817E+06	0.00000E+00	0.00000E+00
^{149}Sm	2.89358E+03	9.27001E+04	0.00000E+00	0.00000E+00
^{235}U	3.08288E+01	9.87650E+02	5.94466E+01	1.90447E+03
^{236}U	7.58759E+00	2.43081E+02	5.84843E–01	1.87364E+01
^{238}U	9.87581E–01	3.16388E+01	2.98231E–01	9.55433E+00
^{238}Pu	1.92828E+01	6.17754E+02	6.66182E+00	2.13422E+02
^{239}Pu	8.39194E+01	2.68849E+03	1.54384E+02	4.94594E+03
^{240}Pu	5.65818E+01	1.81269E+03	1.86677E+00	5.98051E+01
^{241}Pu	8.05210E+01	2.57961E+03	1.78724E+02	5.72572E+03
^{242}Pu	2.65292E+01	8.49909E+02	1.38772E+00	4.44579E+01

Table 4.186. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 2, State 1, 60.00 MWd/kg HM

Nuclide	Absorption		$\nu\Sigma_f$	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	9.82804E+04	3.16023E+06	0.00000E+00	0.00000E+00
^{149}Sm	3.05188E+03	9.81341E+04	0.00000E+00	0.00000E+00
^{235}U	3.18777E+01	1.02504E+03	6.16467E+01	1.98227E+03
^{236}U	7.52929E+00	2.42108E+02	5.83989E–01	1.87785E+01
^{238}U	9.90279E–01	3.18429E+01	2.97828E–01	9.57681E+00
^{238}Pu	2.00066E+01	6.43320E+02	6.71426E+00	2.15900E+02
^{239}Pu	8.77861E+01	2.82280E+03	1.61501E+02	5.19313E+03
^{240}Pu	5.81522E+01	1.86991E+03	1.86481E+00	5.99639E+01
^{241}Pu	8.38480E+01	2.69616E+03	1.86002E+02	5.98097E+03
^{242}Pu	2.57479E+01	8.27937E+02	1.38525E+00	4.45435E+01

Table 4.187. Values of k_{eff}, k_0, and M^2 for Variant 2, States 3–6, at burnup intervals

Burnup interval (MWd/kg HM)	State	k_{eff}	k_0	M^2 (cm^2)
0.00				
	S3	1.038514	1.229005	61.14
	S4	1.030995	1.219671	61.00
	S5	1.048349	1.241009	61.26
	S6	1.177853	1.317066	39.40
10.00				
	S3	0.934317	1.105333	61.01
	S4	0.941181	1.113528	61.04
	S5	0.957335	1.133302	61.27
	S6	1.075220	1.202489	39.45
20.00				
	S3	0.876596	1.037320	61.12
	S4	0.882754	1.044690	61.15
	S5	0.897602	1.062844	61.36
	S6	1.005561	1.124870	39.55
30.00				
	S3	0.830721	0.983400	61.26
	S4	0.835698	0.989365	61.29
	S5	0.849446	1.006177	61.50
	S6	0.948028	1.060845	39.67
40.00				
	S3	0.791909	0.937856	61.43
	S4	0.795482	0.942144	61.46
	S5	0.808284	0.957807	61.66
	S6	0.898716	1.005987	39.79
50.00				
	S3	0.759240	0.899570	61.61
	S4	0.761392	0.902152	61.62
	S5	0.773382	0.916836	61.83
	S6	0.856919	0.959508	39.91
60.00				
	S3	0.732262	0.868016	61.80
	S4	0.733088	0.869002	61.80
	S5	0.744392	0.882862	62.00
	S6	0.822389	0.921146	40.03

Table 4.188. Values of k_{eff}, k_0, and M^2 for Variant 3 (spent fuel), State 1

k_{eff}	k_0	M^2 (cm^2)
0.913592	1.090056	61.21

Table 4.189. Atom densities for nuclides in Variant 3 (spent fuel), State 1

Nuclide	Atom density [atoms/(b·cm)]
^{235}U	3.7843E–4
^{236}U	8.6365E–5
^{238}U	1.8327E–2
^{237}Np	2.4823E–5
^{238}Pu	6.7254E–6
^{239}Np	1.8332E–6
^{239}Pu	1.3111E–4
^{240}Pu	3.6233E–5
^{241}Pu	2.1701E–5
^{242}Pu	4.7576E–6
^{241}Am	4.9491E–7
^{242m}Am	7.9194E–9
^{243}Am	6.6925E–7
^{242}Cm	1.2582E–7
^{243}Cm	2.0629E–9
^{244}Cm	1.2387E–7
^{135}Xe	9.4581E–09
^{149}Sm	7.3667E–08

Table 4.190. Variant 3 (spent fuel), State 1

Cell flux	33.5966
Fuel/cell	1.0017
Clad/cell	0.9996
Moderator/cell	0.9990
One-group cell-averaged macroscopic cross sections (cm^{-1})	
Absorption	2.1142E–02
$\nu\Sigma_f$	2.2982E–02

Table 4.191. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 3 (spent fuel), State 1

Nuclide	Absorption		$\nu\Sigma_f$	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	1.35198E+05	4.54997E+06	0.00000E+00	0.00000E+00
^{149}Sm	4.20313E+03	1.41453E+05	0.00000E+00	0.00000E+00
^{235}U	3.97109E+01	1.33644E+03	7.81200E+01	2.62906E+03
^{236}U	6.08583E+00	2.04814E+02	5.61080E–01	1.88827E+01
^{238}U	1.00008E+00	3.36570E+01	2.86061E–01	9.62715E+00
^{238}Pu	2.53657E+01	8.53663E+02	7.01749E+00	2.36168E+02
^{239}Pu	1.18952E+02	4.00323E+03	2.18520E+02	7.35411E+03
^{240}Pu	1.13371E+02	3.81542E+03	1.82711E+00	6.14899E+01
^{241}Pu	1.10783E+02	3.72830E+03	2.45050E+02	8.24695E+03
^{242}Pu	2.98445E+01	1.00439E+03	1.33215E+00	4.48324E+01

Table 4.192. Values of k_{eff}, k_0, and M^2 for Variant 3 (spent fuel), States 3–6

State	k_{eff}	k_0	M^2 (cm^2)
S3	0.950623	1.135361	64.8
S4	0.946480	1.130290	64.7
S5	0.961517	1.148940	65.0
S6	1.061931	1.195115	41.8

Table 4.193. Values of k_{eff}, k_0, and M^2 for Variant 4 (spent fuel), State 1

k_{eff}	k_0	M^2 (cm^2)
0.859819	1.023622	60.54

Table 4.194. Atom densities for nuclides in Variant 4 (spent fuel), State 1

Nuclide	Atom density [atoms/(b·cm)]
^{235}U	3.7843E–4
^{236}U	8.6365E–5
^{238}U	1.8327E–2
^{237}Np	2.4823E–5
^{238}Pu	6.7254E–6
^{239}Np	1.8332E–6
^{239}Pu	1.3111E–4
^{240}Pu	3.6233E–5
^{241}Pu	2.1701E–5
^{242}Pu	4.7576E–6
^{241}Am	4.9491E–7
^{242m}Am	7.9194E–9
^{243}Am	6.6925E–7
^{242}Cm	1.2582E–7
^{243}Cm	2.0629E–9
^{244}Cm	1.2387E–7
^{103}Rh	1.8890E–5
^{131}Xe	1.4255E–5
^{143}Nd	2.6692E–5
^{147}Pm	6.1574E–6
^{133}Cs	3.5974E–5
^{99}Tc	3.3320E–5
^{152}Sm	2.6842E–6
^{151}Sm	3.0757E–7
^{145}Nd	1.9975E–5
^{153}Eu	2.4801E–6
^{109}Ag	2.2037E–6
^{155}Eu	9.6857E–8
^{95}Mo	3.3720E–5
^{154}Eu	5.1189E–7
^{101}Ru	3.1134E–5
^{135}Xe	9.4581E–9
^{149}Sm	7.3667E–8

Table 4.195. Variant 4 (spent fuel), State 1

Cell flux	33.1513
Fuel/cell	1.0016
Clad/cell	0.9997
Moderator/cell	0.9991
One-group cell-averaged macroscopic cross sections (cm^{-1})	
Absorption	2.1426E–02
$\nu\Sigma_f$	2.1868E–02

Table 4.196. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 4 (spent fuel), State 1

Nuclide	Absorption		$\nu\Sigma_f$	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	1.25959E+05	4.18253E+06	0.00000E+00	0.00000E+00
^{149}Sm	3.92479E+03	1.30325E+05	0.00000E+00	0.00000E+00
^{235}U	3.76626E+01	1.25061E+03	7.39427E+01	2.45531E+03
^{236}U	5.89617E+00	1.95786E+02	5.66974E–01	1.88267E+01
^{238}U	9.85231E–01	3.27152E+01	2.89023E–01	9.59717E+00
^{238}Pu	2.40177E+01	7.97522E+02	6.93903E+00	2.30415E+02
^{239}Pu	1.12742E+02	3.74365E+03	2.06943E+02	6.87166E+03
^{240}Pu	1.08094E+02	3.58932E+03	1.84274E+00	6.11891E+01
^{241}Pu	1.04637E+02	3.47452E+03	2.31495E+02	7.68693E+03
^{242}Pu	2.91096E+01	9.66602E+02	1.34621E+00	4.47017E+01

Table 4.197. Values of k_{eff}, k_0, and M^2 for Variant 4 (spent fuel), States 3–6

State	k_{eff}	k_0	M^2 (cm^2)
S3	0.893113	1.064275	60.68
S4	0.889012	1.059256	60.63
S5	0.902535	1.075988	60.81
S6	1.000713	1.124507	38.76

Table 4.198. Values of k_{eff}, k_0, and M^2 for Variant 7, State 1, at burnup 0.00 MWd/kg HM

k_{eff}	k_0	M^2 (cm^2)
1.096719	1.299160	61.53

Table 4.199. Atom densities for nuclides in Variant 7, State 1

Nuclide	Atom density [atoms/(b·cm)]
^{235}U	3.8393E–05
^{238}U	1.8917E–02
^{239}Pu	6.5875E–04
^{135}Xe	9.4581E–09
^{149}Sm	7.3667E–08

Table 4.200. Variant 7, State 1

Cell flux	31.9309
Fuel/cell	1.0005
Clad/cell	1.0002
Moderator/cell	0.9997
One-group cell-averaged macroscopic cross sections (cm^{-1})	
Absorption	2.2245E–02
$\nu \cdot \sigma_f$	2.8858E–02

Table 4.201. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 7, State 1

Nuclide	Absorption		$\nu\Sigma_f$	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	7.14895E+04	2.28381E+06	0.00000E+00	0.00000E+00
^{149}Sm	2.27721E+03	7.27479E+04	0.00000E+00	0.00000E+00
^{235}U	2.71867E+01	8.68510E+02	5.17798E+01	1.65416E+03
^{236}U	8.30265E+00	2.65237E+02	5.81686E–01	1.85826E+01
^{238}U	9.84200E–01	3.14414E+01	2.96523E–01	9.47277E+00
^{238}Pu	1.63912E+01	5.23635E+02	6.39272E+00	2.04223E+02
^{239}Pu	6.48567E+01	2.07192E+03	1.20160E+02	3.83863E+03
^{240}Pu	2.43866E+02	7.79058E+03	1.97061E+00	6.29532E+01
^{241}Pu	6.60613E+01	2.11040E+03	1.47404E+02	4.70899E+03
^{242}Pu	3.08098E+01	9.84253E+02	1.38205E+00	4.41512E+01

Table 4.202. Values of k_{eff}, k_0, and M^2 for Variant 7, States 3–6

State	k_{eff}	k_0	M^2 (cm^2)
S3	1.123681	1.331827	61.74
S4	1.115072	1.321315	61.65
S5	1.130273	1.340097	61.88
S6	1.254206	1.403625	39.71

Table 4.203. Values of k_{eff}, k_0, and M^2 for Variant 8, State 1, at burnup 0.00 MWd/kg HM

k_{eff}	k_0	M^2 (cm^2)
0.916009	1.091462	63.84

Table 4.204. Atom densities for nuclides in Variant 8, State 1

Nuclide	Atom density [atoms/(b·cm)]
^{235}U	6.9714E–04
^{238}U	1.8917E–02
^{240}Pu	4.2323E–05
^{135}Xe	9.4581E–09
^{149}Sm	7.3667E–08

Table 4.205. Calculated reactor physics parameters for Variant 8, State 1

Cell flux $(cm^2 \cdot s)^{-1}$	34.1097
Fuel/cell	1.0017
Clad/cell	0.9995
Moderator/cell	0.9990
One-group cell-averaged macroscopic cross sections (cm^{-1})	
Absorption	2.0824E–02
$\nu\Sigma_f$	2.2654E–02

Table 4.206. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 8, State 1

Nuclide	Absorption		$\nu\Sigma_f$	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	1.60629E+05	5.48846E+06	0.00000E+00	0.00000E+00
^{149}Sm	5.01345E+03	1.71303E+05	0.00000E+00	0.00000E+00
^{235}U	4.53040E+01	1.54798E+03	8.98957E+01	3.07161E+03
^{236}U	8.02109E+00	2.74070E+02	5.46712E–01	1.86804E+01
^{238}U	1.01559E+00	3.47012E+01	2.64413E–01	9.52138E+00
^{238}Pu	2.89509E+01	9.89212E+02	7.23245E+00	2.47123E+02
^{239}Pu	1.52834E+02	5.22212E+03	2.78760E+02	9.52486E+03
^{240}Pu	1.07067E+02	3.65832E+03	1.78078E+00	6.08468E+01
^{241}Pu	1.34894E+02	4.60913E+03	2.97145E+02	1.01530E+04
^{242}Pu	2.95821E+01	1.01078E+03	1.29948E+00	4.44013E+01

Table 4.207. Values of k_{eff}, k_0, and M^2 for Variant 8, States 3–6

State	k_{eff}	k_0	M^2 (cm^2)
S3	0.959939	1.145297	64.36
S4	0.956303	1.140823	64.32
S5	0.972836	1.161186	64.54
S6	1.077974	1.211193	41.19

Table 4.208. Values of k_{eff}, k_0, and M^2 for Variant 9, State 1, at burnup 0.00 MWd/kg HM

k_{eff}	k_0	M^2 (cm^2)
1.324651	1.569745	61.68

Table 4.209. Atom densities for nuclides in Variant 9, State 1

Nuclide	Atom density [atoms/(b·cm)]
^{235}U	3.8393E–05
^{238}U	1.8917E–02
^{241}Pu	6.6577E–04
^{135}Xe	9.4581E–09
^{149}Sm	7.3667E–08

Table 4.210. Calculated reactor physics parameters for Variant 9, State 1

Cell flux $(cm^2 \cdot s)^{-1}$	31.6694
Fuel/cell	1.0008
Clad/cell	1.0000
Moderator/cell	0.9995
One-group cell-averaged macroscopic cross sections (cm^{-1})	
Absorption	2.2429E–02
$\nu\Sigma_f$	3.5164E–02

Table 4.211. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 9, State 1

	Absorption		$\nu\Sigma_f$	
Nuclide	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	6.59869E+04	2.09140E+06	0.00000E+00	0.00000E+00
^{149}Sm	2.13107E+03	6.75424E+04	0.00000E+00	0.00000E+00
^{235}U	2.65331E+01	8.40944E+02	5.06481E+01	1.60525E+03
^{236}U	7.38056E+00	2.33921E+02	5.85963E–01	1.85716E+01
^{238}U	9.39181E–01	2.97666E+01	2.98638E–01	9.46509E+00
^{238}Pu	1.56180E+01	4.95001E+02	6.34277E+00	2.01029E+02
^{239}Pu	7.80721E+01	2.47443E+03	1.41929E+02	4.49833E+03
^{240}Pu	2.27011E+02	7.19492E+03	1.97400E+00	6.25642E+01
^{241}Pu	6.65443E+01	2.10907E+03	1.47323E+02	4.66929E+03
^{242}Pu	2.81783E+01	8.93087E+02	1.39188E+00	4.41145E+01

Table 4.212. Values of k_{eff}, k_0, and M^2 for Variant 9, States 3–6

State	k_{eff}	k_0	M^2 (cm^2)
S3	1.355241	1.609750	62.60
S4	1.344285	1.593380	61.77
S5	1.361112	1.613962	61.92
S6	1.474650	1.650087	39.66

Table 4.213. Values of k_{eff}, k_0, and M^2 for Variant 10, State 1, at burnup intervals

Burnup interval (MWd/kg HM)	k_{eff}	k_0	M^2 (cm^2)
0.00	0.951653	1.101303	52.38
2.00	0.934617	1.081095	52.24
4.00	0.927020	1.072250	52.22
6.00	0.920565	1.064754	52.21
8.00	0.914571	1.057808	52.21
10.00	0.908824	1.051154	52.20
12.00	0.903248	1.044704	52.20
14.00	0.897811	1.038419	52.20
16.00	0.892494	1.032280	52.21
18.00	0.887285	1.026268	52.21
20.00	0.882176	1.020373	52.22
22.00	0.877158	1.014588	52.23
24.00	0.872228	1.008907	52.23
26.00	0.867379	1.003322	52.24
28.00	0.862608	0.997832	52.25
30.00	0.857912	0.992427	52.26
32.00	0.853288	0.987108	52.28
34.00	0.848733	0.981875	52.29
36.00	0.844244	0.976716	52.30
38.00	0.839817	0.971631	52.32
40.00	0.835457	0.966627	52.33
42.00	0.831165	0.961702	52.35
44.00	0.826932	0.956848	52.37
46.00	0.822750	0.952054	52.39
48.00	0.818633	0.947338	52.41
50.00	0.814584	0.942701	52.43
52.00	0.810597	0.938138	52.45
54.00	0.806653	0.933623	52.47
56.00	0.802779	0.929194	52.49
58.00	0.798977	0.924849	52.51
60.00	0.795248	0.920587	52.54

Table 4.214. Nuclide concentration [atoms/(b·cm)] at specific burnup levels for Variant 10, State 1

Nuclide	Burnup (MWd/kg)				
	0.0	2.0	4.0	6.0	8.0
^{235}U	0.5000E–04	0.4873E–04	0.4748E–04	0.4626E–04	0.4506E–04
^{236}U	0.5000E–19	0.3482E–06	0.6857E–06	0.1012E–05	0.1328E–05
^{237}U	0.0000E+00	0.3489E–07	0.3592E–07	0.3681E–07	0.3766E–07
^{238}U	0.2210E–01	0.2207E–01	0.2203E–01	0.2200E–01	0.2196E–01
^{237}Np	0.5000E–19	0.1782E–06	0.3896E–06	0.6000E–06	0.8089E–06
^{238}Np	0.0000E+00	0.4319E–09	0.7703E–09	0.1109E–08	0.1449E–08
^{239}Np	0.0000E+00	0.1715E–05	0.1724E–05	0.1731E–05	0.1738E–05
^{236}Pu	0.0000E+00	0.2449E–11	0.7485E–11	0.1334E–10	0.1939E–10
^{237}Pu	0.0000E+00	0.3528E–08	0.4819E–08	0.5295E–08	0.5482E–08
^{238}Pu	0.3000E–04	0.2964E–04	0.2948E–04	0.2950E–04	0.2964E–04
^{239}Pu	0.1160E–02	0.1134E–02	0.1111E–02	0.1088E–02	0.1066E–02
^{240}Pu	0.4900E–03	0.4894E–03	0.4886E–03	0.4877E–03	0.4865E–03
^{241}Pu	0.1900E–03	0.1968E–03	0.2032E–03	0.2090E–03	0.2145E–03
^{242}Pu	0.1050E–03	0.1050E–03	0.1051E–03	0.1053E–03	0.1056E–03
^{241}Am	0.2500E–04	0.2506E–04	0.2516E–04	0.2530E–04	0.2545E–04
^{242m}Am	0.0000E+00	0.1162E–06	0.2109E–06	0.2880E–06	0.3508E–06
^{243}Am	0.5000E–19	0.2304E–05	0.4493E–05	0.6570E–05	0.8543E–05
^{242}Cm	0.2500E–19	0.9293E–06	0.1657E–05	0.2228E–05	0.2680E–05
^{243}Cm	0.2500E–19	0.2860E–08	0.1030E–07	0.2092E–07	0.3365E–07
^{244}Cm	0.5000E–19	0.6892E–07	0.2681E–06	0.5860E–06	0.1012E–05
^{245}Cm	0.5000E–19	0.5431E–09	0.4211E–08	0.1375E–07	0.3151E–07
FP ^{5}U	0.0000E+00	0.5170E–05	0.1036E–04	0.1556E–04	0.2078E–04
FP Pu	0.0000E+00	0.4420E–04	0.8837E–04	0.1325E–03	0.1767E–03
^{135}Xe	0.9458E–08	2.5701E–08	2.5653E–08	2.5581E–08	2.5499E–08
^{149}Sm	0.7367E–07	3.6582E–07	4.8216E–07	5.2373E–07	5.4172E–07
	10.0	12.0	14.0	16.0	18.0
^{235}U	0.4389E–04	0.4274E–04	0.4161E–04	0.4051E–04	0.3943E–04
^{236}U	0.1634E–05	0.1929E–05	0.2215E–05	0.2490E–05	0.2756E–05
^{237}U	0.3847E–07	0.3925E–07	0.4001E–07	0.4075E–07	0.4147E–07
^{238}U	0.2193E–01	0.2189E–01	0.2186E–01	0.2182E–01	0.2179E–01
^{237}Np	0.1016E–05	0.1221E–05	0.1424E–05	0.1625E–05	0.1824E–05
^{238}Np	0.1787E–08	0.2126E–08	0.2465E–08	0.2803E–08	0.3141E–08
^{239}Np	0.1745E–05	0.1752E–05	0.1758E–05	0.1765E–05	0.1772E–05
^{236}Pu	0.2541E–10	0.3137E–10	0.3723E–10	0.4301E–10	0.4872E–10
^{237}Pu	0.5574E–08	0.5641E–08	0.5707E–08	0.5778E–08	0.5857E–08
^{238}Pu	0.2989E–04	0.3021E–04	0.3060E–04	0.3103E–04	0.3151E–04
^{239}Pu	0.1045E–02	0.1024E–02	0.1004E–02	0.9840E–03	0.9648E–03
^{240}Pu	0.4852E–03	0.4838E–03	0.4822E–03	0.4804E–03	0.4786E–03
^{241}Pu	0.2195E–03	0.2241E–03	0.2283E–03	0.2321E–03	0.2356E–03
^{242}Pu	0.1059E–03	0.1063E–03	0.1068E–03	0.1074E–03	0.1080E–03
^{241}Am	0.2564E–04	0.2583E–04	0.2604E–04	0.2626E–04	0.2649E–04
^{242m}Am	0.4018E–06	0.4435E–06	0.4776E–06	0.5056E–06	0.5286E–06
^{243}Am	0.1042E–04	0.1220E–04	0.1391E–04	0.1553E–04	0.1709E–04
^{242}Cm	0.3040E–05	0.3331E–05	0.3570E–05	0.3769E–05	0.3937E–05
^{243}Cm	0.4767E–07	0.6245E–07	0.7755E–07	0.9266E–07	0.1076E–06
^{244}Cm	0.1535E–05	0.2148E–05	0.2842E–05	0.3610E–05	0.4446E–05
^{245}Cm	0.5941E–07	0.9924E–07	0.1523E–06	0.2199E–06	0.3028E–06
FP ^{5}U	0.2599E–04	0.3121E–04	0.3644E–04	0.4168E–04	0.4693E–04
FP Pu	0.2209E–03	0.2651E–03	0.3093E–03	0.3535E–03	0.3977E–03
^{135}Xe	2.5412E–08	2.5323E–08	2.5230E–08	2.5136E–08	2.5040E–08
^{149}Sm	5.5146E–07	5.5764E–07	5.6179E–07	5.6448E–07	5.6600E–07

Table 4.214. (continued)

Nuclide	Burnup (MWd/kg)				
	20.0	22.0	24.0	26.0	28.0
^{235}U	0.3836E–04	0.3733E–04	0.3631E–04	0.3531E–04	0.3434E–04
^{236}U	0.3013E–05	0.3260E–05	0.3499E–05	0.3728E–05	0.3949E–05
^{237}U	0.4217E–07	0.4286E–07	0.4352E–07	0.4417E–07	0.4481E–07
^{238}U	0.2175E–01	0.2172E–01	0.2168E–01	0.2165E–01	0.2161E–01
^{237}Np	0.2020E–05	0.2214E–05	0.2406E–05	0.2594E–05	0.2780E–05
^{238}Np	0.3478E–08	0.3815E–08	0.4150E–08	0.4484E–08	0.4819E–08
^{239}Np	0.1779E–05	0.1785E–05	0.1792E–05	0.1799E–05	0.1806E–05
^{236}Pu	0.5438E–10	0.5999E–10	0.6556E–10	0.7108E–10	0.7658E–10
^{237}Pu	0.5943E–08	0.6034E–08	0.6131E–08	0.6231E–08	0.6335E–08
^{238}Pu	0.3202E–04	0.3256E–04	0.3312E–04	0.3369E–04	0.3429E–04
^{239}Pu	0.9461E–03	0.9278E–03	0.9101E–03	0.8929E–03	0.8761E–03
^{240}Pu	0.4766E–03	0.4744E–03	0.4722E–03	0.4698E–03	0.4673E–03
^{241}Pu	0.2388E–03	0.2416E–03	0.2442E–03	0.2465E–03	0.2485E–03
^{242}Pu	0.1087E–03	0.1094E–03	0.1102E–03	0.1110E–03	0.1118E–03
^{241}Am	0.2672E–04	0.2694E–04	0.2716E–04	0.2738E–04	0.2758E–04
^{242m}Am	0.5475E–06	0.5632E–06	0.5762E–06	0.5871E–06	0.5962E–06
^{243}Am	0.1858E–04	0.2000E–04	0.2138E–04	0.2269E–04	0.2396E–04
^{242}Cm	0.4083E–05	0.4210E–05	0.4325E–05	0.4429E–05	0.4526E–05
^{243}Cm	0.1222E–06	0.1363E–06	0.1500E–06	0.1631E–06	0.1757E–06
^{244}Cm	0.5343E–05	0.6295E–05	0.7298E–05	0.8345E–05	0.9436E–05
^{245}Cm	0.4017E–06	0.5173E–06	0.6499E–06	0.7995E–06	0.9667E–06
FP ^{5}U	0.5218E–04	0.5744E–04	0.6271E–04	0.6797E–04	0.7325E–04
FP Pu	0.4419E–03	0.4861E–03	0.5303E–03	0.5745E–03	0.6187E–03
^{135}Xe	2.4942E–08	2.4842E–08	2.4741E–08	2.4638E–08	2.4534E–08
^{149}Sm	5.6651E–07	5.6616E–07	5.6505E–07	5.6329E–07	5.6096E–07
	30.0	32.0	34.0	36.0	38.0
^{235}U	0.3338E–04	0.3245E–04	0.3153E–04	0.3064E–04	0.2976E–04
^{236}U	0.4161E–05	0.4365E–05	0.4561E–05	0.4748E–05	0.4928E–05
^{237}U	0.4543E–07	0.4603E–07	0.4663E–07	0.4719E–07	0.4776E–07
^{238}U	0.2157E–01	0.2154E–01	0.2150E–01	0.2146E–01	0.2143E–01
^{237}Np	0.2963E–05	0.3143E–05	0.3320E–05	0.3495E–05	0.3666E–05
^{238}Np	0.5151E–08	0.5483E–08	0.5813E–08	0.6140E–08	0.6468E–08
^{239}Np	0.1813E–05	0.1820E–05	0.1827E–05	0.1833E–05	0.1841E–05
^{236}Pu	0.8205E–10	0.8750E–10	0.9292E–10	0.9832E–10	0.1037E–09
^{237}Pu	0.6442E–08	0.6551E–08	0.6662E–08	0.6775E–08	0.6890E–08
^{238}Pu	0.3490E–04	0.3552E–04	0.3615E–04	0.3679E–04	0.3743E–04
^{239}Pu	0.8597E–03	0.8438E–03	0.8283E–03	0.8132E–03	0.7985E–03
^{240}Pu	0.4647E–03	0.4619E–03	0.4591E–03	0.4562E–03	0.4531E–03
^{241}Pu	0.2502E–03	0.2518E–03	0.2531E–03	0.2541E–03	0.2550E–03
^{242}Pu	0.1127E–03	0.1136E–03	0.1145E–03	0.1155E–03	0.1164E–03
^{241}Am	0.2778E–04	0.2796E–04	0.2814E–04	0.2829E–04	0.2843E–04
^{242m}Am	0.6038E–06	0.6101E–06	0.6154E–06	0.6198E–06	0.6234E–06
^{243}Am	0.2518E–04	0.2636E–04	0.2750E–04	0.2860E–04	0.2966E–04
^{242}Cm	0.4617E–05	0.4703E–05	0.4784E–05	0.4863E–05	0.4938E–05
^{243}Cm	0.1878E–06	0.1994E–06	0.2105E–06	0.2211E–06	0.2312E–06
^{244}Cm	0.1057E–04	0.1173E–04	0.1292E–04	0.1415E–04	0.1539E–04
^{245}Cm	0.1151E–05	0.1353E–05	0.1572E–05	0.1808E–05	0.2061E–05
FP ^{5}U	0.7853E–04	0.8382E–04	0.8912E–04	0.9442E–04	0.9973E–04
FP Pu	0.6629E–03	0.7071E–03	0.7514E–03	0.7956E–03	0.8399E–03
^{135}Xe	2.4428E–08	2.4322E–08	2.4214E–08	2.4106E–08	2.3996E–08
^{149}Sm	5.5814E–07	5.5490E–07	5.5130E–07	5.4738E–07	5.4318E–07

Table 4.214. (continued)

Nuclide	Burnup (MWd/kg)				
	40.0	42.0	44.0	46.0	48.0
^{235}U	0.2890E–04	0.2807E–04	0.2725E–04	0.2645E–04	0.2567E–04
^{236}U	0.5100E–05	0.5264E–05	0.5421E–05	0.5571E–05	0.5713E–05
^{237}U	0.4830E–07	0.4884E–07	0.4938E–07	0.4986E–07	0.5036E–07
^{238}U	0.2139E–01	0.2135E–01	0.2132E–01	0.2128E–01	0.2124E–01
^{237}Np	0.3834E–05	0.3999E–05	0.4160E–05	0.4318E–05	0.4473E–05
^{238}Np	0.6794E–08	0.7117E–08	0.7444E–08	0.7758E–08	0.8076E–08
^{239}Np	0.1848E–05	0.1855E–05	0.1863E–05	0.1869E–05	0.1876E–05
^{236}Pu	0.1090E–09	0.1144E–09	0.1196E–09	0.1249E–09	0.1301E–09
^{237}Pu	0.7006E–08	0.7122E–08	0.7240E–08	0.7358E–08	0.7476E–08
^{238}Pu	0.3809E–04	0.3875E–04	0.3941E–04	0.4008E–04	0.4076E–04
^{239}Pu	0.7843E–03	0.7704E–03	0.7569E–03	0.7438E–03	0.7310E–03
^{240}Pu	0.4500E–03	0.4468E–03	0.4435E–03	0.4401E–03	0.4366E–03
^{241}Pu	0.2557E–03	0.2562E–03	0.2566E–03	0.2568E–03	0.2568E–03
^{242}Pu	0.1174E–03	0.1184E–03	0.1194E–03	0.1205E–03	0.1215E–03
^{241}Am	0.2856E–04	0.2866E–04	0.2875E–04	0.2882E–04	0.2887E–04
^{242m}Am	0.6262E–06	0.6284E–06	0.6300E–06	0.6310E–06	0.6315E–06
^{243}Am	0.3070E–04	0.3170E–04	0.3267E–04	0.3361E–04	0.3453E–04
^{242}Cm	0.5010E–05	0.5081E–05	0.5148E–05	0.5213E–05	0.5276E–05
^{243}Cm	0.2409E–06	0.2502E–06	0.2591E–06	0.2677E–06	0.2759E–06
^{244}Cm	0.1666E–04	0.1796E–04	0.1926E–04	0.2059E–04	0.2193E–04
^{245}Cm	0.2330E–05	0.2615E–05	0.2914E–05	0.3229E–05	0.3558E–05
FP ^{5}U	0.1050E–03	0.1104E–03	0.1157E–03	0.1210E–03	0.1264E–03
FP Pu	0.8841E–03	0.9283E–03	0.9725E–03	0.1017E–02	0.1061E–02
^{135}Xe	2.3885E–08	2.3773E–08	2.3660E–08	2.3546E–08	2.3432E–05
^{149}Sm	5.3875E–07	5.3412E–07	5.2933E–07	5.2439E–07	5.1933E–07
	50.0	52.0	54.0	56.0	58.0
^{235}U	0.2491E–04	0.2416E–04	0.2344E–04	0.2273E–04	0.2203E–04
^{236}U	0.5849E–05	0.5978E–05	0.6100E–05	0.6215E–05	0.6324E–05
^{237}U	0.5084E–07	0.5130E–07	0.5176E–07	0.5222E–07	0.5263E–07
^{238}U	0.2120E–01	0.2117E–01	0.2113E–01	0.2109E–01	0.2105E–01
^{237}Np	0.4625E–05	0.4773E–05	0.4918E–05	0.5059E–05	0.5197E–05
^{238}Np	0.8392E–08	0.8705E–08	0.9016E–08	0.9331E–08	0.9629E–08
^{239}Np	0.1883E–05	0.1890E–05	0.1898E–05	0.1906E–05	0.1912E–05
^{236}Pu	0.1353E–09	0.1405E–09	0.1456E–09	0.1507E–09	0.1558E–09
^{237}Pu	0.7595E–08	0.7714E–08	0.7832E–08	0.7951E–08	0.8068E–08
^{238}Pu	0.4143E–04	0.4210E–04	0.4278E–04	0.4345E–04	0.4412E–04
^{239}Pu	0.7187E–03	0.7066E–03	0.6949E–03	0.6836E–03	0.6725E–03
^{240}Pu	0.4331E–03	0.4295E–03	0.4258E–03	0.4220E–03	0.4182E–03
^{241}Pu	0.2567E–03	0.2564E–03	0.2560E–03	0.2555E–03	0.2549E–03
^{242}Pu	0.1225E–03	0.1236E–03	0.1246E–03	0.1257E–03	0.1267E–03
^{241}Am	0.2890E–04	0.2892E–04	0.2891E–04	0.2889E–04	0.2884E–04
^{242m}Am	0.6314E–06	0.6309E–06	0.6299E–06	0.6284E–06	0.6264E–06
^{243}Am	0.3543E–04	0.3630E–04	0.3715E–04	0.3797E–04	0.3878E–04
^{242}Cm	0.5336E–05	0.5394E–05	0.5449E–05	0.5501E–05	0.5550E–05
^{243}Cm	0.2837E–06	0.2912E–06	0.2984E–06	0.3052E–06	0.3118E–06
^{244}Cm	0.2328E–04	0.2465E–04	0.2602E–04	0.2741E–04	0.2880E–04
^{245}Cm	0.3901E–05	0.4257E–05	0.4625E–05	0.5005E–05	0.5397E–05
FP ^{5}U	0.1317E–03	0.1371E–03	0.1424E–03	0.1478E–03	0.1532E–03
FP Pu	0.1105E–02	0.1150E–02	0.1194E–02	0.1238E–02	0.1283E–02
^{135}Xe	2.3316E–08	2.3201E–08	2.3084E–08	2.2966E–08	2.2849E–08
^{149}Sm	5.1419E–07	5.0898E–07	5.0371E–07	4.9839E–07	4.9305E–07

Table 4.214. (continued)

Nuclide	Burnup (MWd/kg)
	60.0
^{235}U	0.2136E–04
^{236}U	0.6427E–05
^{237}U	0.5305E–07
^{238}U	0.2101E–01
^{237}Np	0.5331E–05
^{238}Np	0.9931E–08
^{239}Np	0.1919E–05
^{236}Pu	0.1608E–09
^{237}Pu	0.8185E–08
^{238}Pu	0.4479E–04
^{239}Pu	0.6618E–03
^{240}Pu	0.4143E–03
^{241}Pu	0.2541E–03
^{242}Pu	0.1277E–03
^{241}Am	0.2878E–04
^{242m}Am	0.6240E–06
^{243}Am	0.3957E–04
^{242}Cm	0.5596E–05
^{243}Cm	0.3181E–06
^{244}Cm	0.3019E–04
^{245}Cm	0.5799E–05
FP ^{5}U	0.1585E–03
FP Pu	0.1327E–02
^{135}Xe	2.2731E–08
^{149}Sm	4.8771E–07

Table 4.215. Variant 10, State 1

Burnup (MWd/kg HM)	Cell flux $(cm^2 \cdot s)^{-1}$	Fuel/cell	Clad/cell	Moderator/ cell	One-group cell-averaged macroscopic cross sections (cm^{-1}) Absorption	$\nu\Sigma_f$
0.00	28.2553	0.9991	1.0011	1.0003	2.5139E–02	2.7670E–02
10.00	28.2357	0.9990	1.0010	1.0004	2.5156E–02	2.6428E–02
20.00	28.2514	0.9991	1.0010	1.0003	2.5143E–02	2.5638E–02
30.00	28.2810	0.9992	1.0009	1.0003	2.5116E–02	2.4909E–02
40.00	28.3214	0.9993	1.0009	1.0002	2.5080E–02	2.4225E–02
50.00	28.3721	0.9993	1.0008	1.0002	2.5036E–02	2.3582E–02
60.00	28.4305	0.9994	1.0008	1.0002	2.4984E–02	2.2981E–02

Table 4.216. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 10, State 1, 0.00 MWd/kg HM

Nuclide	Absorption Cross section (b)	Absorption Reaction rate	$\nu\Sigma_f$ Cross section (b)	$\nu\Sigma_f$ Reaction rate
^{135}Xe	2.15221E+04	6.07561E+05	0.00000E+00	0.00000E+00
^{149}Sm	7.25600E+02	2.04834E+04	0.00000E+00	0.00000E+00
^{235}U	1.50310E+01	4.24319E+02	2.69247E+01	7.60075E+02
^{236}U	7.40963E+00	2.09171E+02	6.12621E–01	1.72940E+01
^{238}U	8.84084E–01	2.49573E+01	3.11557E–01	8.79515E+00
^{238}Pu	8.80461E+00	2.48551E+02	5.97511E+00	1.68675E+02
^{239}Pu	2.78397E+01	7.85905E+02	5.14878E+01	1.45348E+03
^{240}Pu	2.38637E+01	6.73662E+02	1.94353E+00	5.48651E+01
^{241}Pu	3.25585E+01	9.19114E+02	7.36201E+01	2.07827E+03
^{242}Pu	1.35220E+01	3.81722E+02	1.46103E+00	4.12443E+01

Table 4.217. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 10, State 1, 10.00 MWd/kg HM

Nuclide	Absorption Cross section (b)	Absorption Reaction rate	$\nu\Sigma_f$ Cross section (b)	$\nu\Sigma_f$ Reaction rate
^{135}Xe	2.09074E+04	5.89730E+05	0.00000E+00	0.00000E+00
^{149}Sm	7.05144E+02	1.98899E+04	0.00000E+00	0.00000E+00
^{235}U	1.48903E+01	4.20009E+02	2.66703E+01	7.52285E+02
^{236}U	7.17145E+00	2.02285E+02	6.13980E–01	1.73185E+01
^{238}U	8.79452E–01	2.48067E+01	3.12265E–01	8.80803E+00
^{238}Pu	8.72372E+00	2.46069E+02	5.97679E+00	1.68587E+02
^{239}Pu	2.80981E+01	7.92559E+02	5.18344E+01	1.46209E+03
^{240}Pu	2.33726E+01	6.59271E+02	1.94722E+00	5.49250E+01
^{241}Pu	3.22083E+01	9.08497E+02	7.27859E+01	2.05307E+03
^{242}Pu	1.33213E+01	3.75753E+02	1.46401E+00	4.12954E+01

Table 4.218. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 10, State 1, 20.00 MWd/kg HM

Nuclide	Absorption		$\nu\Sigma_f$	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	2.15497E+04	6.08245E+05	0.00000E+00	0.00000E+00
^{149}Sm	7.24508E+02	2.04494E+04	0.00000E+00	0.00000E+00
^{235}U	1.49853E+01	4.22965E+02	2.69000E+01	7.59260E+02
^{236}U	6.94684E+00	1.96077E+02	6.14876E–01	1.73551E+01
^{238}U	8.76547E–01	2.47408E+01	3.12738E–01	8.82711E+00
^{238}Pu	8.80310E+00	2.48470E+02	5.98756E+00	1.69001E+02
^{239}Pu	2.89080E+01	8.15937E+02	5.32447E+01	1.50285E+03
^{240}Pu	2.32127E+01	6.55185E+02	1.94960E+00	5.50280E+01
^{241}Pu	3.25099E+01	9.17600E+02	7.34096E+01	2.07201E+03
^{242}Pu	1.31275E+01	3.70527E+02	1.46589E+00	4.13753E+01

Table 4.219. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 10, State 1, 30.00 MWd/kg HM

Nuclide	Absorption		$\nu\Sigma_f$	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	2.23544E+04	6.31678E+05	0.00000E+00	0.00000E+00
^{149}Sm	7.49071E+02	2.11668E+04	0.00000E+00	0.00000E+00
^{235}U	1.51280E+01	4.27477E+02	2.72207E+01	7.69187E+02
^{236}U	6.81355E+00	1.92534E+02	6.15524E–01	1.73932E+01
^{238}U	8.74851E–01	2.47211E+01	3.13087E–01	8.84705E+00
^{238}Pu	8.90634E+00	2.51670E+02	5.99858E+00	1.69505E+02
^{239}Pu	2.98411E+01	8.43234E+02	5.48851E+01	1.55091E+03
^{240}Pu	2.32519E+01	6.57040E+02	1.95131E+00	5.51392E+01
^{241}Pu	3.29636E+01	9.31468E+02	7.43726E+01	2.10158E+03
^{242}Pu	1.29470E+01	3.65850E+02	1.46717E+00	4.14584E+01

Table 4.220. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 10, State 1, 40.00 MWd/kg HM

Nuclide	Absorption		$\nu\Sigma_f$	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	2.32752E+04	6.58693E+05	0.00000E+00	0.00000E+00
^{149}Sm	7.77371E+02	2.19998E+04	0.00000E+00	0.00000E+00
^{235}U	1.53054E+01	4.33149E+02	2.76077E+01	7.81307E+02
^{236}U	6.71997E+00	1.90177E+02	6.15994E–01	1.74329E+01
^{238}U	8.74067E–01	2.47364E+01	3.13349E–01	8.86789E+00
^{238}Pu	9.02738E+00	2.55477E+02	6.00974E+00	1.70078E+02
^{239}Pu	3.08581E+01	8.73293E+02	5.66865E+01	1.60425E+03
^{240}Pu	2.34508E+01	6.63664E+02	1.95254E+00	5.52577E+01
^{241}Pu	3.35319E+01	9.48962E+02	7.55908E+01	2.13924E+03
^{242}Pu	1.27827E+01	3.61754E+02	1.46800E+00	4.15449E+01

Table 4.221. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 10, State 1, 50.00 MWd/kg HM

Nuclide	Absorption		ν · fis	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	2.42920E+04	6.88755E+05	0.00000E+00	0.00000E+00
^{149}Sm	8.08771E+02	2.29312E+04	0.00000E+00	0.00000E+00
^{235}U	1.55124E+01	4.39826E+02	2.80508E+01	7.95329E+02
^{236}U	6.65142E+00	1.88589E+02	6.16309E–01	1.74744E+01
^{238}U	8.74055E–01	2.47823E+01	3.13536E–01	8.88975E+00
^{238}Pu	9.16418E+00	2.59834E+02	6.02109E+00	1.70717E+02
^{239}Pu	3.19196E+01	9.05022E+02	5.85859E+01	1.66110E+03
^{240}Pu	2.37914E+01	6.74563E+02	1.95335E+00	5.53839E+01
^{241}Pu	3.41964E+01	9.69578E+02	7.70232E+01	2.18385E+03
^{242}Pu	1.26378E+01	3.58323E+02	1.46845E+00	4.16352E+01

Table 4.222. One-group fuel-averaged microscopic cross sections and reaction rates $(cm^3 \cdot s)^{-1}$ for Variant 10, State 1, 60.00 MWd/kg HM

Nuclide	Absorption		ν · fis	
	Cross section (b)	Reaction rate	Cross section (b)	Reaction rate
^{135}Xe	2.53896E+04	7.21412E+05	0.00000E+00	0.00000E+00
^{149}Sm	8.42763E+02	2.39460E+04	0.00000E+00	0.00000E+00
^{235}U	1.57457E+01	4.47394E+02	2.85432E+01	8.11019E+02
^{236}U	6.60162E+00	1.87577E+02	6.16504E–01	1.75172E+01
^{238}U	8.74710E–01	2.48538E+01	3.13664E–01	8.91237E+00
^{238}Pu	9.31409E+00	2.64648E+02	6.03273E+00	1.71413E+02
^{239}Pu	3.30088E+01	9.37904E+02	6.05444E+01	1.72029E+03
^{240}Pu	2.42600E+01	6.89319E+02	1.95386E+00	5.55164E+01
^{241}Pu	3.49401E+01	9.92777E+02	7.86313E+01	2.23421E+03
^{242}Pu	1.25131E+01	3.55544E+02	1.46860E+00	4.17284E+01

Table 4.223. Values of k_{eff}, k_0, and M^2 for Variant 10, States 3–6, at burnup intervals

Burnup interval (MWd/kg HM)	State	k_{eff}	k_0	M^2 (cm^2)
0.00				
	S3	0.962945	1.114784	52.56
	S4	0.956595	1.106939	52.39
	S5	0.971554	1.124812	52.58
	S6	1.085059	1.195600	33.96
10.00				
	S3	0.919020	1.063325	52.34
	S4	0.926034	1.071500	52.36
	S5	0.940086	1.088277	52.55
	S6	1.050507	1.157432	33.93
20.00				
	S3	0.892226	1.032366	52.36
	S4	0.899659	1.041040	52.38
	S5	0.913000	1.056966	52.56
	S6	1.021706	1.125731	33.94
30.00				
	S3	0.867888	1.004329	52.40
	S4	0.875468	1.013190	52.44
	S5	0.888209	1.028392	52.61
	S6	0.995443	1.096889	33.97
40.00				
	S3	0.845408	0.978500	52.48
	S4	0.852986	0.987360	52.51
	S5	0.865208	1.001943	52.68
	S6	0.970921	1.070012	34.02
50.00				
	S3	0.824549	0.954590	52.57
	S4	0.832033	0.963348	52.61
	S5	0.843806	0.977391	52.77
	S6	0.948039	1.044971	34.08
60.00				
	S3	0.805260	0.932533	52.68
	S4	0.812595	0.941120	52.72
	S5	0.823965	0.954685	52.88
	S6	0.927017	1.022004	34.16

Table 4.224. Values of k_{eff}, k_0, and M^2 for Variant 11, State 1, at burnup intervals

Burnup interval (MWd/kg HM)	k_{eff}	k_0	M^2 (cm^2)
0.00	1.067325	1.268655	62.88
2.00	1.052738	1.250868	62.73
4.00	1.036045	1.230669	62.62
6.00	1.018702	1.209840	62.54
8.00	1.001709	1.189500	62.49
10.00	0.985442	1.170084	62.46
12.00	0.969909	1.151585	62.44
14.00	0.955068	1.133941	62.43
16.00	0.940840	1.117056	62.43
18.00	0.927153	1.100833	62.44
20.00	0.913929	1.085180	62.46
22.00	0.901110	1.070018	62.48
24.00	0.888667	1.055292	62.50
26.00	0.876513	1.040943	62.53
28.00	0.864636	1.026929	62.57
30.00	0.853008	1.013219	62.61
32.00	0.841613	0.999789	62.65
34.00	0.830441	0.986627	62.69
36.00	0.819486	0.973724	62.74
38.00	0.808736	0.961068	62.79
40.00	0.798191	0.948659	62.84
42.00	0.787865	0.936510	62.89
44.00	0.777770	0.924635	62.94
46.00	0.767917	0.913044	63.00
48.00	0.758314	0.901750	63.05
50.00	0.748974	0.890765	63.10
52.00	0.739906	0.880102	63.16
54.00	0.731122	0.869771	63.21
56.00	0.722630	0.859786	63.27
58.00	0.714448	0.850162	63.32
60.00	0.706580	0.840910	63.37

Table 4.225. Values of k_{eff}, k_0, and M^2 for Variant 11, States 2–6, at burnup intervals

Burnup interval (MWd/kg HM)	State	k_{eff}	k_0	M^2 (cm^2)
0.00				
	S2	0.836140	0.993292	62.65
	S3	1.122129	1.334940	63.22
	S4	1.108469	1.318388	63.13
	S5	1.122600	1.335561	63.23
	S6	1.215566	1.361893	40.13
10.00				
	S2	0.777704	0.923031	62.29
	S3	1.032661	1.227080	62.76
	S4	1.023678	1.216221	62.70
	S5	1.037223	1.232718	62.83
	S6	1.131347	1.267195	40.03
20.00				
	S2	0.721042	0.855690	62.25
	S3	0.957517	1.137790	62.76
	S4	0.949428	1.127998	62.69
	S5	0.962932	1.144453	62.84
	S6	1.053000	1.179691	40.10
30.00				
	S2	0.671115	0.796590	62.32
	S3	0.894455	1.063282	62.92
	S4	0.885725	1.052746	62.86
	S5	0.898693	1.068562	63.01
	S6	0.980900	1.099367	40.26
40.00				
	S2	0.625606	0.742832	62.46
	S3	0.838106	0.996928	63.17
	S4	0.828109	0.984859	63.10
	S5	0.840224	0.999653	63.25
	S6	0.912525	1.023258	40.45
50.00				
	S2	0.583784	0.693435	62.61
	S3	0.787620	0.937563	63.46
	S4	0.776172	0.923728	63.37
	S5	0.787319	0.937364	63.53
	S6	0.849080	0.952641	40.66
60.00				
	S2	0.547176	0.650182	62.75
	S3	0.744077	0.886378	63.75
	S4	0.731318	0.870939	63.64
	S5	0.741532	0.883459	63.80
	S6	0.793371	0.890612	40.86

Table 4.226. Values of k_{eff}, k_0, and M^2 for Variant 12, State 1, at burnup intervals

Burnup interval (MWd/kg HM)	k_{eff}	k_0	M^2 (cm^2)
0.00	1.036702	1.222146	59.62
2.00	0.999858	1.178552	59.57
4.00	0.979760	1.154975	59.61
6.00	0.961965	1.134127	59.66
8.00	0.945590	1.115084	59.75
10.00	0.930523	1.097459	59.80
12.00	0.916395	1.080949	59.86
14.00	0.903029	1.065342	59.91
16.00	0.890293	1.050480	59.98
18.00	0.878080	1.036242	60.04
20.00	0.866329	1.022550	60.11
22.00	0.854969	1.009324	60.18
24.00	0.843959	0.996512	60.25
26.00	0.833259	0.984068	60.33
28.00	0.822867	0.971985	60.41
30.00	0.812770	0.960249	60.48
32.00	0.802960	0.948852	60.56
34.00	0.793433	0.937785	60.64
36.00	0.784186	0.927047	60.73
38.00	0.775221	0.916638	60.81
40.00	0.766534	0.906557	60.89
42.00	0.758114	0.896798	60.98
44.00	0.749996	0.887378	61.06
46.00	0.742161	0.878291	61.14
48.00	0.734612	0.869540	61.22
50.00	0.727350	0.861122	61.31
52.00	0.720373	0.853039	61.39
54.00	0.713679	0.845286	61.47
56.00	0.707271	0.837868	61.55
58.00	0.701146	0.830782	61.63
60.00	0.695299	0.824017	61.71

Table 4.227. Values of k_{eff}, k_0, and M^2 for Variant 12, States 2–6, at burnup intervals

Burnup interval (MWd/kg HM)	State	k_{eff}	k_0	M^2 (cm^2)
0.00				
	S2	0.853671	1.006694	59.75
	S3	1.066465	1.257618	59.74
	S4	1.055072	1.244025	59.70
	S5	1.071798	1.264312	59.87
	S6	1.192732	1.329291	38.16
10.00				
	S2	0.763832	0.901064	59.89
	S3	0.958878	1.131286	59.93
	S4	0.960961	1.133698	59.92
	S5	0.976433	1.152447	60.09
	S6	1.083808	1.208490	38.35
20.00				
	S2	0.706642	0.834146	60.15
	S3	0.895192	1.057036	60.26
	S4	0.895794	1.057707	60.25
	S5	0.909878	1.074782	60.41
	S6	1.004534	1.120859	38.60
30.00				
	S2	0.658263	0.777652	60.46
	S3	0.842394	0.995712	60.67
	S4	0.840908	0.993908	60.65
	S5	0.853790	1.009543	60.81
	S6	0.936008	1.045269	38.91
40.00				
	S2	0.616422	0.728834	60.79
	S3	0.796898	0.942977	61.10
	S4	0.793102	0.938416	61.07
	S5	0.804933	0.952794	61.23
	S6	0.876100	0.979129	39.20
50.00				
	S2	0.581065	0.687611	61.12
	S3	0.758340	0.898375	61.55
	S4	0.752307	0.891126	61.51
	S5	0.763230	0.904422	61.66
	S6	0.825147	0.922888	39.48
60.00				
	S2	0.552183	0.653971	61.45
	S3	0.726805	0.861967	61.99
	S4	0.718767	0.852297	61.93
	S5	0.728922	0.864678	62.08
	S6	0.783515	0.876968	39.76

4.4.2.3 Fine mesh diffusion theory assembly/core (TRIANG-PWR) calculations (T. I. Bagretsova, Z. N. Chizhikova, V. M. Dekoussar, G. M. Jerdev, A. G. Kalashnikov, E. N. Kapranova, V. E. Korobitsin, G. N. Manturov, A. L. Moseev, M. N. Nikolaev, Y. V. Rozhikhin, M. Y. Semenov, A. A. Tsyboulia, and A. M. Tsiboulia)

The variants calculated with the TRIANG–PWR code are

- Variant 11: UO_2 fuel assembly,
- Variant 12: MOX fuel assembly, and
- Variant 13: multiassembly structure.

For Variants 11, 12, and 13, the calculational model was developed assuming that the fuel could be represented by different regions (internal pins, corner, periphery, and so on) to describe the differences in the fuel pin locations (the water holes and the water of interassembly space). The depletion pin cell calculation was performed using these different fuel types. Although only seven fuel groups were used to represent each fuel assembly (UO_2 and MOX) composition, individual depletion for each pin was modeled in TRIANG-PWR so that pin-by-pin fluxes and, consequently, the pin-by-pin power distribution could be computed. All variants were calculated as 2-D representations with specified buckling equal to 0.003 and reflectory boundary conditions on each side of the hexagonal assembly.

For all calculations, pin-by-pin power distributions and actinide vectors were reported at burnup intervals of 2 MWd/kg HM from 0 to 10 MWd/kg HM and at burnup intervals of 5 MWd/kg HM up to 60 MWd/kg HM at State 1. The value of B^2 is 0.003 cm^{-2}. Initial concentrations of ^{135}Xe and ^{149}Sm in fuel are 9.4581E–09 and 0.0 atoms/(b·cm), respectively. The power distribution is normalized to the average for the entire model both in the fuel assembly calculations and in the calculations of multiassembly structure. Table 4.228 contains calculated parameters for Variant 11. Table 4.229 contains calculated parameters for Variant 12. Note that the calculation of Variant 13 was carried out for a multiassembly structure having a UO_2 to MOX ratio of 3:1 in the benchmark specification instead of a ratio of 2:1, which was assumed in the partially MOX fueled VVER–1000 design. Figures 4.58–4.78 show the power distributions for Variants 11–13 at burnup intervals of 10 MWd/kg uranium from 0 to 60 MWd/kg uranium.

These calculations were performed with two-group physics constants. The constants were generated by performing a set of WIMS-ABBN cell calculations. Selected fuel rods in the VVER assembly were modeled, and cross section data were collapsed from the ABBN fine group structure to two energy groups.

Table 4.228. Atom densities for nuclides in Variant 11, State 1, for pins at burnup intervals

Nuclide	Atom density [atoms/(b·cm)]		
	Pin 1	Pin 29	Pin 72
	Burnup (MWd/kg) = 0.0[a]		
^{235}U	8.737E–04	8.737E–04	8.737E–04
^{236}U	8.737E–19	8.737E–19	8.737E–19
^{237}U	0.000E+00	0.000E+00	0.000E+00
^{238}U	1.874E–02	1.874E–02	1.874E–02
^{237}Np	8.737E–19	8.737E–19	8.737E–19
^{238}Np	0.000E+00	0.000E+00	0.000E+00
^{239}Np	0.000E+00	0.000E+00	0.000E+00
^{236}Pu	0.000E+00	0.000E+00	0.000E+00
^{237}Pu	0.000E+00	0.000E+00	0.000E+00
^{238}Pu	8.737E–19	8.737E–19	8.737E–19
^{239}Pu	8.737E–19	8.737E–19	8.737E–19
^{240}Pu	8.737E–19	8.737E–19	8.737E–19
^{241}Pu	8.737E–19	8.737E–19	8.737E–19
^{242}Pu	8.737E–19	8.737E–19	8.737E–19
^{241}Am	8.736E–32	8.736E–32	8.736E–32
^{242}Am	0.000E+00	0.000E+00	0.000E+00
^{243}Am	8.737E–19	8.737E–19	8.737E–19
^{242}Cm	0.000E+00	0.000E+00	0.000E+00
^{243}Cm	0.000E+00	0.000E+00	0.000E+00
^{244}Cm	8.737E–19	8.737E–19	8.737E–19
^{245}Cm	8.737E–19	8.737E–19	8.737E–19
^{135}Xe	0.000E+00	0.000E+00	0.000E+00
^{149}Sm	0.000E+00	0.000E+00	0.000E+00
Total FP	0.000E+00	0.000E+00	0.000E+00
	Burnup (MWd/kg) = 2.0[b]		
^{235}U	8.237E–04	8.288E–04	8.253E–04
^{236}U	8.876E–06	8.347E–06	8.681E–06
^{237}U	3.205E–08	3.728E–08	3.284E–08
^{238}U	1.872E–02	1.872E–02	1.872E–02
^{237}Np	1.111E–07	1.153E–07	1.083E–07
^{238}Np	3.439E–10	3.935E–10	3.451E–10
^{239}Np	1.352E–06	1.580E–06	1.414E–06
^{236}Pu	3.213E–14	3.521E–14	2.975E–14
^{237}Pu	1.425E–13	1.228E–13	1.228E–13
^{238}Pu	3.173E–09	3.185E–09	3.009E–09
^{239}Pu	1.700E–05	1.791E–05	1.722E–05
^{240}Pu	5.518E–07	5.285E–07	5.301E–07
^{241}Pu	4.794E–08	4.788E–08	4.431E–08
^{242}Pu	5.665E–10	4.748E–10	4.658E–10
^{241}Am	8.384E–09	7.115E–09	6.927E–09
^{242}Am	1.876E–13	1.451E–13	1.414E–13
^{243}Am	4.137E–12	3.412E–12	3.130E–12
^{242}Cm	1.761E–12	1.314E–12	1.301E–12
^{243}Cm	1.634E–15	1.139E–15	1.093E–15
^{244}Cm	4.518E–14	3.463E–14	3.090E–14
^{245}Cm	1.335E–16	9.361E–17	8.325E–17
^{135}Xe	9.010E–09	1.030E–08	1.103E–08
^{149}Sm	6.461E–08	8.022E–08	8.591E–08
Total FP	4.429E–05	3.997E–05	4.280E–05

[a]Burnup (MWd/kg) for Pin 1 = 0.000E+00; Pin 29 = 0.000E+00; Pin 72 = 0.000E+00.

[b]Burnup (MWd/kg) for Pin 1 = 2.125E+00; Pin 29 = 1.914E+00; Pin 72 = 2.053E+00.

Table 4.228. (continued)

Nuclide	Atom density [atoms/(b·cm)]		
	Pin 1	Pin 29	Pin 72
	Burnup (MWd/kg) = 4.0[c]		
^{235}U	7.764E–04	7.862E–04	7.797E–04
^{236}U	1.721E–05	1.620E–05	1.683E–05
^{237}U	4.629E–08	5.400E–08	4.759E–08
^{238}U	1.870E–02	1.870E–02	1.870E–02
^{237}Np	3.080E–07	3.228E–07	3.031E–07
^{238}Np	7.687E–10	8.969E–10	7.782E–10
^{239}Np	1.375E–06	1.605E–06	1.438E–06
^{236}Pu	1.757E–13	1.978E–13	1.681E–13
^{237}Pu	8.040E–13	7.399E–13	7.206E–13
^{238}Pu	1.198E–08	1.246E–08	1.156E–08
^{239}Pu	3.241E–05	3.466E–05	3.296E–05
^{240}Pu	2.002E–06	1.924E–06	1.953E–06
^{241}Pu	3.377E–07	3.476E–07	3.277E–07
^{242}Pu	7.877E–09	7.083E–09	7.113E–09
^{241}Am	1.148E–07	1.058E–07	1.045E–07
^{242}Am	4.279E–12	3.903E–12	3.766E–12
^{243}Am	1.107E–10	1.069E–10	9.759E–11
^{242}Cm	4.446E–11	3.889E–11	3.831E–11
^{243}Cm	7.601E–14	6.979E–14	6.317E–14
^{244}Cm	2.235E–12	2.262E–12	1.897E–12
^{245}Cm	1.159E–14	1.244E–14	9.494E–15
^{135}Xe	9.312E–09	1.081E–08	1.155E–08
^{149}Sm	6.790E–08	8.678E–08	9.279E–08
Total FP	8.832E–05	7.991E–05	8.541E–05
	Burnup (MWd/kg) = 6.0[d]		
^{235}U	7.316E–04	7.457E–04	7.365E–04
^{236}U	2.505E–05	2.363E–05	2.452E–05
^{237}U	5.935E–08	6.902E–08	6.104E–08
^{238}U	1.868E–02	1.867E–02	1.868E–02
^{237}Np	5.656E–07	5.959E–07	5.595E–07
^{238}Np	1.342E–09	1.575E–09	1.365E–09
^{239}Np	1.401E–06	1.632E–06	1.463E–06
^{236}Pu	4.761E–13	5.430E–13	4.613E–13
^{237}Pu	2.310E–12	2.207E–12	2.112E–12
^{238}Pu	2.855E–08	3.025E–08	2.783E–08
^{239}Pu	4.542E–05	4.918E–05	4.637E–05
^{240}Pu	3.995E–06	3.843E–06	3.914E–06
^{241}Pu	9.730E–07	1.010E–06	9.591E–07
^{242}Pu	3.483E–08	3.162E–08	3.232E–08
^{241}Am	4.973E–07	4.682E–07	4.669E–07
^{242}Am	2.463E–11	2.354E–11	2.280E–11
^{243}Am	7.471E–10	7.421E–10	6.901E–10
^{242}Cm	2.827E–10	2.556E–10	2.554E–10
^{243}Cm	7.244E–13	7.042E–13	6.461E–13
^{244}Cm	2.271E–11	2.424E–11	2.067E–11
^{245}Cm	1.730E–13	2.027E–13	1.559E–13
^{135}Xe	9.263E–09	1.093E–08	1.164E–08
^{149}Sm	6.786E–08	8.850E–08	9.438E–08
Total FP	1.321E–04	1.199E–04	1.278E–04

[c]Burnup (MWd/kg) for Pin 1 = 4.246E+00; Pin 29 = 3.834E+00; Pin 72 = 4.104E+00.

[d]Burnup (MWd/kg) for Pin 1 = 6.360E+00; Pin 29 = 5.760E+00; Pin 72 = 6.151E+00.

Table 4.228. (continued)

Nuclide	Atom density [atoms/(b·cm)]		
	Pin 1	Pin 29	Pin 72
	Burnup (MWd/kg) = 8.0[e]		
^{235}U	6.891E–04	7.073E–04	6.951E–04
^{236}U	3.246E–05	3.069E–05	3.178E–05
^{237}U	7.162E–08	8.300E–08	7.382E–08
^{238}U	1.865E–02	1.865E–02	1.865E–02
^{237}Np	8.767E–07	9.263E–07	8.704E–07
^{238}Np	2.055E–09	2.415E–09	2.096E–09
^{239}Np	1.427E–06	1.659E–06	1.490E–06
^{236}Pu	9.705E–13	1.117E–12	9.483E–13
^{237}Pu	4.976E–12	4.876E–12	4.611E–12
^{238}Pu	5.488E–08	5.886E–08	5.390E–08
^{239}Pu	5.646E–05	6.185E–05	5.785E–05
^{240}Pu	6.315E–06	6.082E–06	6.203E–06
^{241}Pu	1.955E–06	2.040E–06	1.943E–06
^{242}Pu	9.604E–08	8.734E–08	9.029E–08
^{241}Am	1.338E–06	1.277E–06	1.277E–06
^{242}Am	7.966E–11	7.838E–11	7.574E–11
^{243}Am	2.814E–09	2.823E–09	2.660E–09
^{242}Cm	1.003E–09	9.209E–10	9.286E–10
^{243}Cm	3.471E–12	3.456E–12	3.205E–12
^{244}Cm	1.161E–10	1.263E–10	1.093E–10
^{245}Cm	1.175E–12	1.425E–12	1.110E–12
^{135}Xe	9.184E–09	1.101E–08	1.168E–08
^{149}Sm	6.747E–08	8.970E–08	9.537E–08
Total FP	1.757E–04	1.599E–04	1.702E–04
	Burnup (MWd/kg) = 10.0[f]		
^{235}U	6.487E–04	6.704E–04	6.560E–04
^{236}U	3.945E–05	3.736E–05	3.866E–05
^{237}U	8.213E–08	9.505E–08	8.461E–08
^{238}U	1.863E–02	1.862E–02	1.863E–02
^{237}Np	1.231E–06	1.304E–06	1.226E–06
^{238}Np	2.892E–09	3.398E–09	2.955E–09
^{239}Np	1.455E–06	1.687E–06	1.517E–06
^{236}Pu	1.689E–12	1.961E–12	1.661E–12
^{237}Pu	9.084E–12	9.075E–12	8.505E–12
^{238}Pu	9.276E–08	1.003E–07	9.163E–08
^{239}Pu	6.584E–05	7.296E–05	6.768E–05
^{240}Pu	8.833E–06	8.519E–06	8.692E–06
^{241}Pu	3.237E–06	3.397E–06	3.234E–06
^{242}Pu	2.048E–07	1.862E–07	1.940E–07
^{241}Am	2.777E–06	2.682E–06	2.679E–06
^{242}Am	1.879E–10	1.895E–10	1.819E–10
^{243}Am	7.692E–09	7.750E–09	7.367E–09
^{242}Cm	2.584E–09	2.398E–09	2.428E–09
^{243}Cm	1.135E–11	1.148E–11	1.070E–11
^{244}Cm	4.047E–10	4.447E–10	3.886E–10
^{245}Cm	5.130E–12	6.344E–12	4.987E–12
^{135}Xe	9.080E–09	1.106E–08	1.169E–08
^{149}Sm	6.683E–08	9.057E–08	9.595E–08
Total FP	2.191E–04	2.000E–04	2.124E–04

[e]Burnup (MWd/kg) for Pin 1 = 8.467E+00; Pin 29 = 7.691E+00; Pin 72 = 8.197E+00.

[f]Burnup (MWd/kg) for Pin 1 = 1.057E+01; Pin 29 = 9.628E+00; Pin 72 = 1.024E+01.

Table 4.228. (continued)

Nuclide	Atom density [atoms/(b·cm)]		
	Pin 1	Pin 29	Pin 72
	Burnup (MWd/kg) = 20.0[g]		
^{235}U	4.723E–04	5.091E–04	4.841E–04
^{236}U	6.906E–05	6.601E–05	6.793E–05
^{237}U	1.307E–07	1.500E–07	1.345E–07
^{238}U	1.851E–02	1.849E–02	1.850E–02
^{237}Np	3.486E–06	3.735E–06	3.504E–06
^{238}Np	8.766E–09	1.015E–08	8.966E–09
^{239}Np	1.597E–06	1.820E–06	1.655E–06
^{236}Pu	9.344E–12	1.116E–11	9.354E–12
^{237}Pu	5.902E–11	6.234E–11	5.685E–11
^{238}Pu	5.066E–07	5.600E–07	5.085E–07
^{239}Pu	9.536E–05	1.117E–04	9.963E–05
^{240}Pu	2.229E–05	2.181E–05	2.209E–05
^{241}Pu	1.208E–05	1.308E–05	1.229E–05
^{242}Pu	1.766E–06	1.590E–06	1.694E–06
^{241}Am	2.030E–05	2.069E–05	2.020E–05
^{242}Am	1.849E–09	2.068E–09	1.881E–09
^{243}Am	1.468E–07	1.478E–07	1.440E–07
^{242}Cm	3.707E–08	3.559E–08	3.600E–08
^{243}Cm	3.493E–10	3.683E–10	3.447E–10
^{244}Cm	1.715E–08	1.902E–08	1.709E–08
^{245}Cm	4.394E–10	5.666E–10	4.528E–10
^{135}Xe	8.599E–09	1.109E–08	1.154E–08
^{149}Sm	6.343E–08	9.172E–08	9.567E–08
Total FP	4.333E–04	4.008E–04	4.220E–04
	Burnup (MWd/kg) = 30.0[h]		
^{235}U	3.339E–04	3.784E–04	3.477E–04
^{236}U	9.073E–05	8.763E–05	8.961E–05
^{237}U	1.744E–07	1.984E–07	1.793E–07
^{238}U	1.837E–02	1.834E–02	1.837E–02
^{237}Np	6.256E–06	6.804E–06	6.338E–06
^{238}Np	1.724E–08	1.964E–08	1.760E–08
^{239}Np	1.752E–06	1.951E–06	1.801E–06
^{236}Pu	2.459E–11	3.033E–11	2.498E–11
^{237}Pu	1.705E–10	1.891E–10	1.677E–10
^{238}Pu	1.395E–06	1.580E–06	1.418E–06
^{239}Pu	1.071E–04	1.324E–04	1.137E–04
^{240}Pu	3.472E–05	3.485E–05	3.474E–05
^{241}Pu	2.108E–05	2.392E–05	2.182E–05
^{242}Pu	5.244E–06	4.734E–06	5.068E–06
^{241}Am	4.927E–05	5.414E–05	5.044E–05
^{242}Am	4.924E–09	6.148E–09	5.209E–09
^{243}Am	6.963E–07	7.048E–07	6.901E–07
^{242}Cm	1.347E–07	1.348E–07	1.335E–07
^{243}Cm	1.983E–09	2.192E–09	2.005E–09
^{244}Cm	1.338E–07	1.498E–07	1.352E–07
^{245}Cm	5.092E–09	6.852E–09	5.380E–09
^{135}Xe	7.757E–09	1.089E–08	1.104E–08
^{149}Sm	5.704E–08	9.019E–08	9.164E–08
Total FP	6.418E–04	6.037E–04	6.290E–04

[g]Burnup (MWd/kg) for Pin 1 = 2.098E+01; Pin 29 = 1.938E+01; Pin 72 = 2.043E+01.

[h]Burnup (MWd/kg) for Pin 1 = 3.117E+01; Pin 29 = 2.929E+01; Pin 72 = 3.055E+01.

Table 4.228. (continued)

Nuclide	Atom density [atoms/(b·cm)]		
	Pin 1	Pin 29	Pin 72
	Burnup (MWd/kg) = 40.0[i]		
^{235}U	2.270E–04	2.738E–04	2.407E–04
^{236}U	1.056E–04	1.031E–04	1.048E–04
^{237}U	2.139E–07	2.404E–07	2.192E–07
^{238}U	1.823E–02	1.818E–02	1.822E–02
^{237}Np	9.200E–06	1.018E–05	9.396E–06
^{238}Np	2.797E–08	3.126E–08	2.846E–08
^{239}Np	1.921E–06	2.082E–06	1.958E–06
^{236}Pu	4.717E–11	6.025E–11	4.863E–11
^{237}Pu	3.464E–10	4.061E–10	3.483E–10
^{238}Pu	2.812E–06	3.288E–06	2.900E–06
^{239}Pu	1.101E–04	1.428E–04	1.185E–04
^{240}Pu	4.484E–05	4.638E–05	4.530E–05
^{241}Pu	2.790E–05	3.334E–05	2.938E–05
^{242}Pu	1.034E–05	9.415E–06	1.007E–05
^{241}Am	7.736E–05	9.292E–05	8.169E–05
^{242}Am	7.959E–09	1.116E–08	8.744E–09
^{243}Am	1.894E–06	1.939E–06	1.898E–06
^{242}Cm	2.850E–07	2.992E–07	2.881E–07
^{243}Cm	5.677E–09	6.633E–09	5.883E–09
^{244}Cm	5.258E–07	5.976E–07	5.389E–07
^{245}Cm	2.575E–08	3.665E–08	2.800E–08
^{135}Xe	6.862E–09	1.054E–08	1.039E–08
^{149}Sm	5.013E–08	8.676E–08	8.560E–08
Total FP	8.447E–04	8.094E–04	8.335E–04
	Burnup (MWd/kg) = 50.0[j]		
^{235}U	1.478E–04	1.919E–04	1.600E–04
^{236}U	1.148E–04	1.132E–04	1.143E–04
^{237}U	2.483E–07	2.754E–07	2.538E–07
^{238}U	1.808E–02	1.801E–02	1.806E–02
^{237}Np	1.204E–05	1.357E–05	1.239E–05
^{238}Np	4.033E–08	4.425E–08	4.094E–08
^{239}Np	2.099E–06	2.212E–06	2.122E–06
^{236}Pu	7.539E–11	9.989E–11	7.886E–11
^{237}Pu	5.704E–10	7.128E–10	5.876E–10
^{238}Pu	4.681E–06	5.694E–06	4.908E–06
^{239}Pu	1.091E–04	1.475E–04	1.186E–04
^{240}Pu	5.230E–05	5.588E–05	5.337E–05
^{241}Pu	3.223E–05	4.058E–05	3.447E–05
^{242}Pu	1.645E–05	1.514E–05	1.614E–05
^{241}Am	9.633E–05	1.276E–04	1.049E–04
^{242}Am	9.941E–09	1.569E–08	1.132E–08
^{243}Am	3.829E–06	3.966E–06	3.873E–06
^{242}Cm	4.524E–07	4.997E–07	4.661E–07
^{243}Cm	1.120E–08	1.388E–08	1.188E–08
^{244}Cm	1.428E–06	1.646E–06	1.482E–06
^{245}Cm	8.289E–08	1.252E–07	9.263E–08
^{135}Xe	6.069E–09	1.015E–08	9.722E–09
^{149}Sm	4.405E–08	8.279E–08	7.939E–08
Total FP	1.042E–03	1.018E–03	1.036E–03

[i]Burnup (MWd/kg) for Pin 1 = 4.114E+01; Pin 29 = 3.938E+01; Pin 72 = 4.059E+01.

[j]Burnup (MWd/kg) for Pin 1 = 5.086E+01; Pin 29 = 4.966E+01; Pin 72 = 5.054E+01.

Table 4.228. (continued)

Nuclide	Atom density [atoms/(b·cm)]		
	Pin 1	Pin 29	Pin 72
	Burnup (MWd/kg) = 60.0[k]		
^{235}U	9.201E–05	1.300E–04	1.018E–04
^{236}U	1.190E–04	1.185E–04	1.189E–04
^{237}U	2.760E–07	3.019E–07	2.813E–07
^{238}U	1.792E–02	1.782E–02	1.789E–02
^{237}Np	1.456E–05	1.669E–05	1.509E–05
^{238}Np	5.326E–08	5.751E–08	5.393E–08
^{239}Np	2.273E–06	2.334E–06	2.281E–06
^{236}Pu	1.067E–10	1.465E–10	1.131E–10
^{237}Pu	8.158E–10	1.090E–09	8.604E–10
^{238}Pu	6.822E–06	8.674E–06	7.270E–06
^{239}Pu	1.066E–04	1.490E–04	1.167E–04
^{240}Pu	5.733E–05	6.318E–05	5.899E–05
^{241}Pu	3.456E–05	4.567E–05	3.745E–05
^{242}Pu	2.292E–05	2.133E–05	2.263E–05
^{241}Am	1.046E–04	1.529E–04	1.172E–04
^{242}Am	1.072E–08	1.896E–08	1.260E–08
^{243}Am	6.421E–06	6.721E–06	6.548E–06
^{242}Cm	6.010E–07	6.991E–07	6.298E–07
^{243}Cm	1.745E–08	2.299E–08	1.890E–08
^{244}Cm	3.071E–06	3.580E–06	3.218E–06
^{245}Cm	2.004E–07	3.197E–07	2.293E–07
^{135}Xe	5.387E–09	9.738E–09	9.092E–09
^{149}Sm	3.892E–08	7.875E–08	7.353E–08
Total FP	1.235E–03	1.231E–03	1.235E–03

[k]Burnup (MWd/kg) for Pin 1 = 6.036E+01; Pin 29 = 6.013E+01; Pin 72 = 6.040E+01.

Table 4.229. Atom densities for nuclides in Variant 12, State 1, for pins at burnup intervals

Nuclide	Atom density [atoms/(b·cm)]		
	Pin 1	Pin 29	Pin 72
	Burnup (MWd/kg) = 0.0[a]		
^{235}U	3.841E–05	3.841E–05	3.841E–05
^{236}U	3.841E–20	3.841E–20	3.841E–20
^{237}U	0.000E+00	0.000E+00	0.000E+00
^{238}U	1.892E–02	1.892E–02	1.892E–02
^{237}Np	3.841E–20	3.841E–20	3.841E–20
^{238}Np	0.000E+00	0.000E+00	0.000E+00
^{239}Np	0.000E+00	0.000E+00	0.000E+00
^{236}Pu	0.000E+00	0.000E+00	0.000E+00
^{237}Pu	0.000E+00	0.000E+00	0.000E+00
^{238}Pu	3.841E–20	3.841E–20	3.841E–20
^{239}Pu	6.587E–04	6.587E–04	6.587E–04
^{240}Pu	4.232E–05	4.232E–05	4.232E–05
^{241}Pu	7.026E–06	7.026E–06	7.026E–06
^{242}Pu	3.841E–20	3.841E–20	3.841E–20
^{241}Am	7.025E–19	7.025E–19	7.025E–19
^{242}Am	0.000E+00	0.000E+00	0.000E+00
^{243}Am	3.841E–20	3.841E–20	3.841E–20
^{242}Cm	7.026E–36	7.026E–36	7.026E–36
^{243}Cm	7.026E–36	7.026E–36	7.026E–36
^{244}Cm	3.841E–20	3.841E–20	3.841E–20
^{245}Cm	3.841E–20	3.841E–20	3.841E–20
^{135}Xe	0.000E+00	0.000E+00	0.000E+00
^{149}Sm	0.000E+00	0.000E+00	0.000E+00
Total FP	0.000E+00	0.000E+00	0.000E+00
	Burnup (MWd/kg) = 2.0[b]		
^{235}U	3.695E–05	3.710E–05	3.701E–05
^{236}U	3.021E–07	2.897E–07	2.949E–07
^{237}U	2.393E–08	2.930E–08	2.512E–08
^{238}U	1.889E–02	1.889E–02	1.889E–02
^{237}Np	1.027E–07	1.051E–07	9.987E–08
^{238}Np	3.218E–10	3.796E–10	3.300E–10
^{239}Np	1.388E–06	1.720E–06	1.500E–06
^{236}Pu	3.810E–14	4.038E–14	3.492E–14
^{237}Pu	2.627E–13	2.120E–13	2.194E–13
^{238}Pu	4.653E–09	4.609E–09	4.406E–09
^{239}Pu	6.172E–04	6.277E–04	6.214E–04
^{240}Pu	5.726E–05	5.433E–05	5.610E–05
^{241}Pu	1.267E–05	1.259E–05	1.260E–05
^{242}Pu	2.337E–07	1.950E–07	2.155E–07
^{241}Am	6.608E–06	5.643E–06	6.152E–06
^{242}Am	2.040E–10	1.700E–10	1.829E–10
^{243}Am	4.122E–09	3.726E–09	3.771E–09
^{242}Cm	1.843E–09	1.491E–09	1.627E–09
^{243}Cm	3.026E–12	2.607E–12	2.586E–12
^{244}Cm	8.440E–11	7.962E–11	7.415E–11
^{245}Cm	4.459E–13	4.334E–13	3.709E–13
^{135}Xe	1.492E–08	1.654E–08	1.818E–08
^{149}Sm	1.384E–07	1.743E–07	1.916E–07
Total FP	4.404E–05	3.776E–05	4.144E–05

[a]Burnup (MWd/kg) for Pin 1 = 0.000E+00; Pin 29 = 0.000E+00; Pin 72 = 0.000E+00.

[b]Burnup (MWd/kg) for Pin 1 = 2.202E+00; Pin 29 = 1.884E+00; Pin 72 = 2.070E+00.

Table 4.229. (continued)

Nuclide	Atom density [atoms/(b·cm)]		
	Pin 1	Pin 29	Pin 72
	Burnup (MWd/kg) = 4.0[c]		
^{235}U	3.547E–05	3.579E–05	3.560E–05
^{236}U	6.050E–07	5.817E–07	5.925E–07
^{237}U	2.519E–08	3.107E–08	2.643E–08
^{238}U	1.887E–02	1.886E–02	1.887E–02
^{237}Np	2.324E–07	2.434E–07	2.290E–07
^{238}Np	5.804E–10	7.032E–10	6.019E–10
^{239}Np	1.422E–06	1.752E–06	1.533E–06
^{236}Pu	1.799E–13	1.983E–13	1.732E–13
^{237}Pu	1.225E–12	1.042E–12	1.074E–12
^{238}Pu	1.452E–08	1.461E–08	1.398E–08
^{239}Pu	5.780E–04	5.990E–04	5.861E–04
^{240}Pu	7.098E–05	6.551E–05	6.891E–05
^{241}Pu	1.883E–05	1.863E–05	1.872E–05
^{242}Pu	6.214E–07	5.147E–07	5.755E–07
^{241}Am	1.676E–05	1.440E–05	1.575E–05
^{242}Am	8.497E–10	7.355E–10	7.929E–10
^{243}Am	2.010E–08	1.825E–08	1.896E–08
^{242}Cm	8.362E–09	6.868E–09	7.632E–09
^{243}Cm	2.561E–11	2.300E–11	2.365E–11
^{244}Cm	7.630E–10	7.454E–10	7.238E–10
^{245}Cm	7.315E–12	7.816E–12	6.997E–12
^{135}Xe	1.504E–08	1.699E–08	1.863E–08
^{149}Sm	1.435E–07	1.961E–07	2.148E–07
Total FP	8.876E–05	7.660E–05	8.389E–05
	Burnup (MWd/kg) = 6.0[d]		
^{235}U	3.403E–05	3.453E–05	3.424E–05
^{236}U	8.948E–07	8.596E–07	8.756E–07
^{237}U	2.625E–08	3.228E–08	2.751E–08
^{238}U	1.884E–02	1.884E–02	1.884E–02
^{237}Np	3.598E–07	3.799E–07	3.557E–07
^{238}Np	8.471E–10	1.033E–09	8.796E–10
^{239}Np	1.453E–06	1.780E–06	1.562E–06
^{236}Pu	4.199E–13	4.718E–13	4.088E–13
^{237}Pu	3.028E–12	2.647E–12	2.691E–12
^{238}Pu	3.018E–08	3.042E–08	2.911E–08
^{239}Pu	5.417E–04	5.718E–04	5.530E–04
^{240}Pu	8.304E–05	7.543E–05	8.015E–05
^{241}Pu	2.497E–05	2.463E–05	2.479E–05
^{242}Pu	1.158E–06	9.503E–07	1.070E–06
^{241}Am	2.978E–05	2.572E–05	2.804E–05
^{242}Am	1.924E–09	1.716E–09	1.822E–09
^{243}Am	5.265E–08	4.773E–08	4.984E–08
^{242}Cm	2.050E–08	1.699E–08	1.884E–08
^{243}Cm	9.012E–11	8.242E–11	8.452E–11
^{244}Cm	2.858E–09	2.824E–09	2.748E–09
^{245}Cm	3.895E–11	4.297E–11	3.833E–11
^{135}Xe	1.434E–08	1.658E–08	1.802E–08
^{149}Sm	1.337E–07	1.889E–07	2.051E–07
Total FP	1.322E–04	1.145E–04	1.251E–04

[c]Burnup (MWd/kg) for Pin 1 = 4.441E+00; Pin 29 = 3.822E+00; Pin 72 = 4.194E+00.

[d]Burnup (MWd/kg) for Pin 1 = 6.618E+00; Pin 29 = 5.720E+00; Pin 72 = 6.257E+00.

Table 4.229. (continued)

Nuclide	Atom density [atoms/(b·cm)]		
	Pin 1	Pin 29	Pin 72
	Burnup (MWd/kg) = 8.0[e]		
^{235}U	3.260E–05	3.327E–05	3.287E–05
^{236}U	1.177E–06	1.131E–06	1.152E–06
^{237}U	2.728E–08	3.343E–08	2.857E–08
^{238}U	1.882E–02	1.881E–02	1.882E–02
^{237}Np	4.874E–07	5.177E–07	4.828E–07
^{238}Np	1.126E–09	1.375E–09	1.169E–09
^{239}Np	1.483E–06	1.807E–06	1.591E–06
^{236}Pu	7.576E–13	8.624E–13	7.433E–13
^{237}Pu	5.879E–12	5.221E–12	5.273E–12
^{238}Pu	5.312E–08	5.333E–08	5.125E–08
^{239}Pu	5.066E–04	5.458E–04	5.214E–04
^{240}Pu	9.385E–05	8.453E–05	9.032E–05
^{241}Pu	3.106E–05	3.065E–05	3.085E–05
^{242}Pu	1.857E–06	1.514E–06	1.713E–06
^{241}Am	4.548E–05	3.961E–05	4.303E–05
^{242}Am	3.419E–09	3.138E–09	3.278E–09
^{243}Am	1.074E–07	9.734E–08	1.021E–07
^{242}Cm	3.931E–08	3.286E–08	3.635E–08
^{243}Cm	2.237E–10	2.073E–10	2.123E–10
^{244}Cm	7.543E–09	7.497E–09	7.321E–09
^{245}Cm	1.321E–10	1.484E–10	1.324E–10
^{135}Xe	1.382E–08	1.636E–08	1.767E–08
^{149}Sm	1.270E–07	1.838E–07	1.981E–07
Total FP	1.754E–04	1.527E–04	1.662E–04
	Burnup (MWd/kg) = 10.0[f]		
^{235}U	3.120E–05	3.202E–05	3.154E–05
^{236}U	1.452E–06	1.396E–06	1.422E–06
^{237}U	2.830E–08	3.456E–08	2.960E–08
^{238}U	1.879E–02	1.878E–02	1.879E–02
^{237}Np	6.147E–07	6.557E–07	6.104E–07
^{238}Np	1.417E–09	1.727E–09	1.471E–09
^{239}Np	1.513E–06	1.832E–06	1.619E–06
^{236}Pu	1.190E–12	1.367E–12	1.173E–12
^{237}Pu	9.987E–12	8.933E–12	9.006E–12
^{238}Pu	8.469E–08	8.441E–08	8.169E–08
^{239}Pu	4.735E–04	5.210E–04	4.912E–04
^{240}Pu	1.035E–04	9.278E–05	9.943E–05
^{241}Pu	3.696E–05	3.657E–05	3.676E–05
^{242}Pu	2.724E–06	2.204E–06	2.508E–06
^{241}Am	6.350E–05	5.575E–05	6.029E–05
^{242}Am	5.291E–09	4.982E–09	5.134E–09
^{243}Am	1.902E–07	1.716E–07	1.808E–07
^{242}Cm	6.557E–08	5.505E–08	6.087E–08
^{243}Cm	4.562E–10	4.261E–10	4.360E–10
^{244}Cm	1.633E–08	1.623E–08	1.593E–08
^{245}Cm	3.474E–10	3.936E–10	3.519E–10
^{135}Xe	1.331E–08	1.615E–08	1.733E–08
^{149}Sm	1.207E–07	1.789E–07	1.916E–07
Total FP	2.183E–04	1.909E–04	2.073E–04

[e]Burnup (MWd/kg) for Pin 1 = 8.783E+00; Pin 29 = 7.626E+00; Pin 72 = 8.317E+00.

[f]Burnup (MWd/kg) for Pin 1 = 1.093E+01; Pin 29 = 9.538E+00; Pin 72 = 1.037E+01.

Table 4.229. (continued)

Nuclide	Atom density [atoms/(b·cm)]		
	Pin 1	Pin 29	Pin 72
	Burnup (MWd/kg) = 20.0[g]		
^{235}U	2.440E–05	2.605E–05	2.508E–05
^{236}U	2.706E–06	2.599E–06	2.652E–06
^{237}U	3.322E–08	3.974E–08	3.452E–08
^{238}U	1.866E–02	1.864E–02	1.865E–02
^{237}Np	1.239E–06	1.344E–06	1.241E–06
^{238}Np	3.055E–09	3.618E–09	3.139E–09
^{239}Np	1.665E–06	1.947E–06	1.756E–06
^{236}Pu	4.659E–12	5.525E–12	4.665E–12
^{237}Pu	5.694E–11	5.127E–11	5.193E–11
^{238}Pu	4.226E–07	4.072E–07	4.057E–07
^{239}Pu	3.339E–04	4.123E–04	3.621E–04
^{240}Pu	1.355E–04	1.230E–04	1.311E–04
^{241}Pu	6.137E–05	6.284E–05	6.199E–05
^{242}Pu	9.557E–06	7.502E–06	8.728E–06
^{241}Am	1.706E–04	1.595E–04	1.667E–04
^{242}Am	1.783E–08	1.910E–08	1.823E–08
^{243}Am	1.208E–06	1.064E–06	1.144E–06
^{242}Cm	3.177E–07	2.717E–07	2.982E–07
^{243}Cm	4.175E–09	3.974E–09	4.042E–09
^{244}Cm	2.002E–07	1.946E–07	1.948E–07
^{245}Cm	7.700E–09	8.811E–09	7.895E–09
^{135}Xe	1.163E–08	1.542E–08	1.614E–08
^{149}Sm	1.009E–07	1.633E–07	1.704E–07
Total FP	4.294E–04	3.841E–04	4.118E–04
	Burnup (MWd/kg) = 30.0[h]		
^{235}U	1.827E–05	2.058E–05	1.919E–05
^{236}U	3.723E–06	3.591E–06	3.659E–06
^{237}U	3.797E–08	4.442E–08	3.916E–08
^{238}U	1.852E–02	1.848E–02	1.851E–02
^{237}Np	1.818E–06	2.010E–06	1.840E–06
^{238}Np	4.962E–09	5.684E–09	5.043E–09
^{239}Np	1.827E–06	2.054E–06	1.896E–06
^{236}Pu	9.878E–12	1.215E–11	1.006E–11
^{237}Pu	1.578E–10	1.493E–10	1.482E–10
^{238}Pu	1.131E–06	1.112E–06	1.105E–06
^{239}Pu	2.376E–04	3.298E–04	2.690E–04
^{240}Pu	1.451E–04	1.379E–04	1.430E–04
^{241}Pu	7.395E–05	8.087E–05	7.678E–05
^{242}Pu	1.971E–05	1.540E–05	1.805E–05
^{241}Am	2.625E–04	2.719E–04	2.677E–04
^{242}Am	2.895E–08	3.599E–08	3.139E–08
^{243}Am	3.528E–06	3.110E–06	3.363E–06
^{242}Cm	7.270E–07	6.471E–07	6.961E–07
^{243}Cm	1.382E–08	1.378E–08	1.370E–08
^{244}Cm	8.811E–07	8.620E–07	8.663E–07
^{245}Cm	4.624E–08	5.590E–08	4.893E–08
^{135}Xe	9.524E–09	1.443E–08	1.456E–08
^{149}Sm	7.858E–08	1.448E–07	1.454E–07
Total FP	6.330E–04	5.818E–04	6.139E–04

[g]Burnup (MWd/kg) for Pin 1 = 2.152E+01; Pin 29 = 1.919E+01; Pin 72 = 2.061E+01.

[h]Burnup (MWd/kg) for Pin 1 = 3.173E+01; Pin 29 = 2.907E+01; Pin 72 = 3.074E+01.

Table 4.229. (continued)

Nuclide	Atom density [atoms/(b·cm)]		
	Pin 1	Pin 29	Pin 72
	Burnup (MWd/kg) = 40.0[i]		
^{235}U	1.306E–05	1.575E–05	1.409E–05
^{236}U	4.477E–06	4.351E–06	4.420E–06
^{237}U	4.242E–08	4.858E–08	4.344E–08
^{238}U	1.837E–02	1.831E–02	1.835E–02
^{237}Np	2.328E–06	2.631E–06	2.381E–06
^{238}Np	7.050E–09	7.849E–09	7.100E–09
^{239}Np	1.993E–06	2.158E–06	2.038E–06
^{236}Pu	1.623E–11	2.078E–11	1.685E–11
^{237}Pu	3.042E–10	3.132E–10	2.978E–10
^{238}Pu	2.175E–06	2.264E–06	2.189E–06
^{239}Pu	1.779E–04	2.704E–04	2.076E–04
^{240}Pu	1.392E–04	1.409E–04	1.406E–04
^{241}Pu	7.563E–05	8.995E–05	8.112E–05
^{242}Pu	3.136E–05	2.482E–05	2.899E–05
^{241}Am	3.047E–04	3.593E–04	3.272E–04
^{242}Am	3.372E–08	4.926E–08	3.887E–08
^{243}Am	7.197E–06	6.437E–06	6.935E–06
^{242}Cm	1.166E–06	1.099E–06	1.146E–06
^{243}Cm	2.873E–08	3.051E–08	2.932E–08
^{244}Cm	2.463E–06	2.448E–06	2.453E–06
^{245}Cm	1.561E–07	2.030E–07	1.713E–07
^{135}Xe	7.815E–09	1.348E–08	1.311E–08
^{149}Sm	6.202E–08	1.288E–07	1.248E–07
Total FP	8.294E–04	7.843E–04	8.139E–04
	Burnup (MWd/kg) = 50.0[j]		
^{235}U	8.891E–06	8.347E–06	6.673E–06
^{236}U	4.971E–06	5.171E–06	5.200E–06
^{237}U	4.625E–08	5.478E–08	4.996E–08
^{238}U	1.822E–02	1.794E–02	1.801E–02
^{237}Np	2.757E–06	3.647E–06	3.224E–06
^{238}Np	9.170E–09	1.200E–08	1.115E–08
^{239}Np	2.153E–06	2.343E–06	2.297E–06
^{236}Pu	2.303E–11	4.146E–11	3.194E–11
^{237}Pu	4.650E–10	7.763E–10	6.481E–10
^{238}Pu	3.363E–06	5.496E–06	4.815E–06
^{239}Pu	1.438E–04	2.047E–04	1.480E–04
^{240}Pu	1.255E–04	1.274E–04	1.164E–04
^{241}Pu	7.043E–05	8.838E–05	7.121E–05
^{242}Pu	4.250E–05	4.313E–05	4.897E–05
^{241}Am	2.977E–04	4.098E–04	3.112E–04
^{242}Am	3.249E–08	5.635E–08	3.607E–08
^{243}Am	1.184E–05	1.576E–05	1.663E–05
^{242}Cm	1.496E–06	1.811E–06	1.717E–06
^{243}Cm	4.484E–08	7.159E–08	6.243E–08
^{244}Cm	5.269E–06	9.711E–06	9.607E–06
^{245}Cm	3.764E–07	1.097E–06	8.504E–07
^{135}Xe	6.598E–09	1.188E–08	1.093E–08
^{149}Sm	5.094E–08	1.057E–07	9.716E–08
Total FP	1.020E–03	1.204E–03	1.209E–03

[i]Burnup (MWd/kg) for Pin 1 = 4.155E+01; Pin 29 = 3.918E+01; Pin 72 = 4.074E+01.

[j]Burnup (MWd/kg) for Pin 1 = 5.105E+01; Pin 29 = 4.915E+01; Pin 72 = 5.062E+01.

Table 4.229. (continued)

Nuclide	Atom density [atoms/(b·cm)]		
	Pin 1	Pin 29	Pin 72
	Burnup (MWd/kg) = 60.0[k]		
^{235}U	5.784E–06	8.347E–06	6.673E–06
^{236}U	5.223E–06	5.171E–06	5.200E–06
^{237}U	4.921E–08	5.478E–08	4.996E–08
^{238}U	1.806E–02	1.794E–02	1.801E–02
^{237}Np	3.096E–06	3.647E–06	3.224E–06
^{238}Np	1.115E–08	1.200E–08	1.115E–08
^{239}Np	2.294E–06	2.343E–06	2.297E–06
^{236}Pu	2.958E–11	4.146E–11	3.194E–11
^{237}Pu	6.049E–10	7.763E–10	6.481E–10
^{238}Pu	4.456E–06	5.496E–06	4.815E–06
^{239}Pu	1.251E–04	2.047E–04	1.480E–04
^{240}Pu	1.101E–04	1.274E–04	1.164E–04
^{241}Pu	6.256E–05	8.838E–05	7.121E–05
^{242}Pu	5.169E–05	4.313E–05	4.897E–05
^{241}Am	2.613E–04	4.098E–04	3.112E–04
^{242}Am	2.797E–08	5.635E–08	3.607E–08
^{243}Am	1.687E–05	1.576E–05	1.663E–05
^{242}Cm	1.644E–06	1.811E–06	1.717E–06
^{243}Cm	5.731E–08	7.159E–08	6.243E–08
^{244}Cm	9.434E–06	9.711E–06	9.607E–06
^{245}Cm	7.273E–07	1.097E–06	8.504E–07
^{135}Xe	5.697E–09	1.188E–08	1.093E–08
^{149}Sm	4.305E–08	1.057E–07	9.716E–08
Total FP	1.206E–03	1.204E–03	1.209E–03

[k]Burnup (MWd/kg) for Pin 1 = 6.030E+01; Pin 29 = 6.004E+01; Pin 72 = 6.040E+01.

```
                1.063 1.032 1.026 1.023 1.023 1.023 1.023 1.023 1.026 1.032 1.063
                                                  :
            1.032  .988  .979  .976  .976  .977  .977  .976  .976  .979  .988 1.032
                                                  :
        1.026  .979  .957  .954  .954  .957  .959  .957  .954  .954  .957  .979 1.026
                                                  :
     1.023  .976  .954  .952  .955  .959 1.011 1.010  .959  .955  .952  .954  .976 1.023
                                                  :
  1.023  .976  .954  .955 1.008 1.014 1.019       1.018 1.014 1.008  .955  .954  .976 1.023
                                                  :
1.023  .977  .957  .959 1.013       1.025 1.027 1.025 1.023       1.014  .959  .957  .977 1.023
                                                  :
1.023  .977  .959 1.010 1.018 1.023 1.026 1.030 1.029 1.017 1.026 1.025 1.019 1.011  .959  .977 1.023
                                                  :
1.023  .976  .957 1.011       1.025 1.017 1.031       1.032 1.031 1.030 1.027       1.010  .957  .976 1.023
                                                  :
1.026  .976  .954  .959 1.019 1.027 1.029 1.032 1.036 1.038 1.036       1.029 1.025 1.018  .959  .954  .976 1.026
                                                  :
1.032  .979  .954  .955 1.014 1.025 1.030       1.038 1.041 1.041 1.038 1.032 1.017 1.023 1.014  .955  .954  .979 1.032
                                                  :
1.063  .988  .957  .952 1.008       1.026 1.031 1.036 1.041       1.041 1.036 1.031 1.026       1.008  .952  .957  .988 1.063
                                                  :
1.032  .979  .954  .955 1.013 1.023 1.017 1.032 1.038 1.041 1.041 1.038       1.030 1.025 1.014  .955  .954  .979 1.032
                                                  :
1.026  .976  .954  .959 1.018 1.025 1.029       1.036 1.038 1.036 1.032 1.029 1.027 1.019  .959  .954  .976 1.026
                                                  :
1.023  .976  .957 1.010       1.027 1.030 1.031 1.032       1.031 1.017 1.025       1.011  .957  .976 1.023
                                                  :
1.023  .977  .959 1.011 1.019 1.025 1.026 1.017 1.029 1.030 1.026 1.023 1.018 1.010  .959  .977 1.023
                                                  :
1.023  .977  .957  .959 1.014       1.023 1.025 1.027 1.025       1.013  .959  .957  .977 1.023
                                                  :
  1.023  .976  .954  .955 1.008 1.013 1.018       1.019 1.014 1.008  .955  .954  .976 1.023
                                                  :
     1.023  .976  .954  .952  .955  .959 1.010 1.011  .959  .955  .952  .954  .976 1.023
                                                  :
        1.026  .979  .957  .954  .954  .957  .959  .957  .954  .954  .957  .979 1.026
                                                  :
            1.032  .988  .979  .976  .976  .977  .977  .976  .976  .979  .988 1.032
                                                  :
                1.063 1.032 1.026 1.023 1.023 1.023 1.023 1.023 1.026 1.032 1.063
```

Fig. 4.58. Pin power distribution, Variant 11, State 1, at burnup = 0 MWd/kg U.

```
                1.046 1.024 1.016 1.014 1.013 1.014 1.013 1.014 1.016 1.024 1.046
                                                :
              1.024  .995  .985  .982  .982  .983  .983  .981  .981  .985  .995 1.024
                                                :
            1.016  .985  .969  .966  .967  .971  .974  .971  .967  .966  .969  .985 1.016
                                                :
          1.014  .981  .966  .964  .969  .975 1.000  .999  .975  .969  .964  .966  .982 1.014
                                                :
        1.013  .981  .967  .969  .997 1.005 1.011       1.010 1.004  .997  .969  .967  .982 1.013
                                                :
      1.014  .983  .971  .975 1.004       1.019 1.022 1.019 1.017       1.005  .975  .971  .983 1.014
                                                :
    1.013  .983  .974  .999 1.010 1.017 1.022 1.026 1.025 1.012 1.022 1.019 1.011 1.000  .974  .983 1.013
                                                :
  1.014  .982  .971 1.000       1.019 1.012 1.027       1.029 1.027 1.026 1.022        .999  .971  .981 1.014
                                                :
 1.016  .982  .967  .975 1.011 1.022 1.025 1.029 1.033 1.035 1.033       1.025 1.019 1.010  .975  .967  .981 1.016
                                                :
1.024  .985  .966  .969 1.005 1.019 1.026       1.035 1.038 1.038 1.035 1.029 1.012 1.017 1.004  .969  .966  .985 1.024
                                                :
1.046  .995  .969  .964  .997       1.022 1.027 1.033 1.038       1.038 1.033 1.027 1.022        .997  .964  .969  .995 1.046
                                                :
1.024  .985  .966  .969 1.004 1.017 1.012 1.029 1.035 1.038 1.038 1.035       1.026 1.019 1.005  .969  .966  .985 1.024
                                                :
 1.016  .981  .967  .975 1.010 1.019 1.025       1.033 1.035 1.033 1.029 1.025 1.022 1.011  .975  .967  .982 1.016
                                                :
  1.014  .981  .971  .999       1.022 1.026 1.027 1.029       1.027 1.012 1.019       1.000  .971  .982 1.014
                                                :
    1.013  .983  .974 1.000 1.011 1.019 1.022 1.012 1.025 1.026 1.022 1.017 1.010  .999  .974  .983 1.013
                                                :
      1.014  .983  .971  .975 1.005       1.017 1.019 1.022 1.019       1.004  .975  .971  .983 1.014
                                                :
        1.013  .982  .967  .969  .997 1.004 1.010       1.011 1.005  .997  .969  .967  .981 1.013
                                                :
          1.014  .982  .966  .964  .969  .975  .999 1.000  .975  .969  .964  .966  .981 1.014
                                                :
            1.016  .985  .969  .966  .967  .971  .974  .971  .967  .966  .969  .985 1.016
                                                :
              1.024  .995  .985  .981  .982  .983  .983  .982  .982  .985  .995 1.024
                                                :
                1.046 1.024 1.016 1.014 1.013 1.014 1.013 1.014 1.016 1.024 1.046
```

Fig. 4.59. Pin power distribution, Variant 11, State 1, at burnup = 10 MWd/kg U.

```
                1.026 1.012 1.005 1.002 1.002 1.002 1.002 1.002 1.005 1.012 1.026
                                                :
             1.012 1.003  .991  .988  .988  .989  .989  .988  .988  .991 1.003 1.012
                                                :
          1.005  .991  .984  .980  .982  .987  .990  .987  .981  .980  .984  .991 1.005
                                                :
       1.002  .988  .980  .979  .985  .992  .990  .990  .992  .985  .979  .980  .988 1.002
                                                :
    1.002  .988  .981  .985  .986  .996 1.003       1.002  .995  .986  .985  .982  .988 1.002
                                                :
 1.002  .989  .987  .992  .995       1.012 1.015 1.013 1.010        .996  .992  .987  .989 1.002
                                                :
1.002  .989  .990  .990 1.002 1.010 1.016 1.021 1.020 1.007 1.016 1.012 1.003  .990  .990  .989 1.002
                                                :
1.002  .988  .987  .990       1.013 1.007 1.022       1.024 1.022 1.021 1.015        .990  .987  .988 1.002
                                                :
1.005  .988  .982  .992 1.003 1.015 1.020 1.024 1.028 1.030 1.028       1.020 1.013 1.002  .992  .981  .988 1.005
                                                :
1.012  .991  .980  .985  .996 1.012 1.021       1.030 1.033 1.033 1.030 1.024 1.007 1.010  .995  .985  .980  .991 1.012
                                                :
1.026 1.003  .984  .979  .986       1.016 1.022 1.028 1.033       1.033 1.028 1.022 1.016        .986  .979  .984 1.003 1.026
                                                :
1.012  .991  .980  .985  .995 1.010 1.007 1.024 1.030 1.033 1.033 1.030       1.021 1.012  .996  .985  .980  .991 1.012
                                                :
1.005  .988  .981  .992 1.002 1.013 1.020       1.028 1.030 1.028 1.024 1.020 1.015 1.003  .992  .982  .988 1.005
                                                :
1.002  .988  .987  .990       1.015 1.021 1.022 1.024       1.022 1.007 1.013        .990  .987  .988 1.002
                                                :
1.002  .989  .990  .990 1.003 1.012 1.016 1.007 1.020 1.021 1.016 1.010 1.002  .990  .990  .989 1.002
                                                :
1.002  .989  .987  .992  .996       1.010 1.013 1.015 1.012        .995  .992  .987  .989 1.002
                                                :
1.002  .988  .982  .985  .986  .995 1.002       1.003  .996  .986  .985  .981  .988 1.002
                                                :
1.002  .988  .980  .979  .985  .992  .990  .990  .992  .985  .979  .980  .988 1.002
                                                :
1.005  .991  .984  .980  .981  .987  .990  .987  .982  .980  .984  .991 1.005
                                                :
1.012 1.003  .991  .988  .988  .989  .989  .988  .988  .991 1.003 1.012
                                                :
1.026 1.012 1.005 1.002 1.002 1.002 1.002 1.002 1.005 1.012 1.026
```

Fig. 4.60. Pin power distribution, Variant 11, State 1, at burnup = 20 MWd/kg U.

```
                1.003 1.000  .992  .990  .990  .990  .990  .990  .992 1.000 1.003
                                                  :
             1.000 1.011  .999  .995  .995  .997  .997  .995  .995  .999 1.011 1.000
                                                  :
            .992  .999 1.001  .997  .998 1.004 1.008 1.004  .998  .997 1.001  .999  .992
                                                  :
         .990  .995  .997  .996 1.002 1.011  .980  .980 1.010 1.002  .996  .997  .995  .990
                                                  :
      .990  .995  .998 1.002  .977  .987  .994        .993  .986  .977 1.002  .998  .995  .990
                                                  :
   .990  .997 1.004 1.010  .986       1.005 1.007 1.006 1.002        .987 1.011 1.004  .997  .990
                                                  :
 .990  .997 1.008  .980  .993 1.002 1.009 1.013 1.013 1.002 1.009 1.005  .994  .980 1.008  .997  .990
                                                  :
.990  .995 1.004  .980       1.006 1.002 1.015       1.017 1.015 1.013 1.007        .980 1.004  .995  .990
                                                  :
.992  .995  .998 1.011  .994 1.007 1.013 1.017 1.021 1.023 1.021       1.013 1.006  .993 1.010  .998  .995  .992
                                                  :
1.000  .999  .997 1.002  .987 1.005 1.013       1.023 1.026 1.026 1.023 1.017 1.002 1.002  .986 1.002  .997  .999 1.000
                                                  :
1.003 1.011 1.001  .996  .977       1.009 1.015 1.021 1.026       1.026 1.021 1.015 1.009        .977  .996 1.001 1.011 1.003
                                                  :
1.000  .999  .997 1.002  .986 1.002 1.002 1.017 1.023 1.026 1.026 1.023       1.013 1.005  .987 1.002  .997  .999 1.000
                                                  :
.992  .995  .998 1.010  .993 1.006 1.013       1.021 1.023 1.021 1.017 1.013 1.007  .994 1.011  .998  .995  .992
                                                  :
.990  .995 1.004  .980       1.007 1.013 1.015 1.017       1.015 1.002 1.005        .980 1.004  .995  .990
                                                  :
 .990  .997 1.008  .980  .994 1.005 1.009 1.002 1.013 1.013 1.009 1.002  .993  .980 1.008  .997  .990
                                                  :
   .990  .997 1.004 1.011  .987       1.002 1.006 1.007 1.005        .986 1.010 1.004  .997  .990
                                                  :
      .990  .995  .998 1.002  .977  .986  .993        .994  .987  .977 1.002  .998  .995  .990
                                                  :
         .990  .995  .997  .996 1.002 1.010  .980  .980 1.011 1.002  .996  .997  .995  .990
                                                  :
            .992  .999 1.001  .997  .998 1.004 1.008 1.004  .998  .997 1.001  .999  .992
                                                  :
             1.000 1.011  .999  .995  .995  .997  .997  .995  .995  .999 1.011 1.000
                                                  :
                1.003 1.000  .992  .990  .990  .990  .990  .990  .992 1.000 1.003
```

Fig. 4.61. Pin power distribution, Variant 11, State 1, at burnup = 30 MWd/kg U.

```
                    .978  .986  .979  .976  .976  .976  .976  .976  .979  .986  .978
                                                :
                  .986 1.019 1.006 1.003 1.003 1.004 1.004 1.003 1.003 1.006 1.019  .986
                                                :
                .979 1.006 1.019 1.015 1.017 1.023 1.028 1.023 1.017 1.015 1.019 1.006  .979
                                                :
              .976 1.003 1.015 1.014 1.021 1.030  .970  .970 1.030 1.021 1.014 1.015 1.003  .976
                                                :
           .976 1.003 1.017 1.021  .967  .977  .985        .984  .977  .967 1.021 1.017 1.003  .976
                                                :
        .976 1.004 1.023 1.030  .977        .996  .999  .997  .994        .977 1.030 1.023 1.004  .976
                                                :
     .976 1.004 1.028  .970  .984  .994 1.000 1.005 1.005  .995 1.000  .996  .985  .970 1.028 1.004  .976
                                                :
  .976 1.003 1.023  .970        .997  .995 1.007       1.009 1.007 1.005  .999        .970 1.023 1.003  .976
                                                :
 .979 1.003 1.017 1.030  .985  .999 1.005 1.009 1.014 1.015 1.014       1.005  .997  .984 1.030 1.017 1.003  .979
                                                :
.986 1.006 1.015 1.021  .977  .996 1.005       1.015 1.018 1.018 1.015 1.009  .995  .994  .977 1.021 1.015 1.006  .986
                                                :
.978 1.019 1.019 1.014  .967       1.000 1.007 1.014 1.018       1.018 1.014 1.007 1.000        .967 1.014 1.019 1.019  .978
                                                :
.986 1.006 1.015 1.021  .977  .994  .995 1.009 1.015 1.018 1.018 1.015       1.005  .996  .977 1.021 1.015 1.006  .986
                                                :
 .979 1.003 1.017 1.030  .984  .997 1.005       1.014 1.015 1.014 1.009 1.005  .999  .985 1.030 1.017 1.003  .979
                                                :
  .976 1.003 1.023  .970        .999 1.005 1.007 1.009       1.007  .995  .997        .970 1.023 1.003  .976
                                                :
     .976 1.004 1.028  .970  .985  .996 1.000  .995 1.005 1.005 1.000  .994  .984  .970 1.028 1.004  .976
                                                :
        .976 1.004 1.023 1.030  .977        .994  .997  .999  .996        .977 1.030 1.023 1.004  .976
                                                :
           .976 1.003 1.017 1.021  .967  .977  .984        .985  .977  .967 1.021 1.017 1.003  .976
                                                :
              .976 1.003 1.015 1.014 1.021 1.030  .970  .970 1.030 1.021 1.014 1.015 1.003  .976
                                                :
                .979 1.006 1.019 1.015 1.017 1.023 1.028 1.023 1.017 1.015 1.019 1.006  .979
                                                :
                  .986 1.019 1.006 1.003 1.003 1.004 1.004 1.003 1.003 1.006 1.019  .986
                                                :
                    .978  .986  .979  .976  .976  .976  .976  .976  .979  .986  .978
```

Fig. 4.62. Pin power distribution, Variant 11, State 1, at burnup = 40 MWd/kg U.

```
                    .955  .973  .965  .963  .963  .963  .963  .963  .965  .973  .955
                                                   :
                  .973 1.027 1.014 1.010 1.010 1.012 1.012 1.010 1.010 1.014 1.027  .973
                                                   :
                 .965 1.014 1.038 1.034 1.036 1.043 1.047 1.043 1.036 1.034 1.038 1.014  .965
                                                   :
               .963 1.010 1.034 1.033 1.041 1.050  .961  .961 1.050 1.040 1.033 1.034 1.010  .963
                                                   :
            .963 1.010 1.036 1.040  .958  .968  .975        .975  .967  .958 1.041 1.036 1.010  .963
                                                   :
         .963 1.012 1.043 1.050  .967        .987  .990  .989  .985        .968 1.050 1.043 1.012  .963
                                                   :
      .963 1.012 1.047  .961  .975  .985  .992  .997  .997  .988  .992  .987  .975  .961 1.047 1.012  .963
                                                   :
   .963 1.010 1.043  .961        .989  .988 1.000       1.001 1.000  .997  .990        .961 1.043 1.010  .963
                                                   :
 .965 1.010 1.036 1.050  .975  .990  .997 1.001 1.006 1.007 1.006        .997  .989  .975 1.050 1.036 1.010  .965
                                                   :
.973 1.014 1.034 1.041  .968  .987  .997       1.007 1.010 1.010 1.007 1.001  .988  .985  .967 1.040 1.034 1.014  .973
                                                   :
.955 1.027 1.038 1.033  .958        .992 1.000 1.006 1.010       1.010 1.006 1.000  .992        .958 1.033 1.038 1.027  .955
                                                   :
.973 1.014 1.034 1.040  .967  .985  .988 1.001 1.007 1.010 1.010 1.007        .997  .987  .968 1.041 1.034 1.014  .973
                                                   :
 .965 1.010 1.036 1.050  .975  .989  .997       1.006 1.007 1.006 1.001  .997  .990  .975 1.050 1.036 1.010  .965
                                                   :
   .963 1.010 1.043  .961        .990  .997 1.000 1.001       1.000  .988  .989        .961 1.043 1.010  .963
                                                   :
      .963 1.012 1.047  .961  .975  .987  .992  .988  .997  .997  .992  .985  .975  .961 1.047 1.012  .963
                                                   :
         .963 1.012 1.043 1.050  .968        .985  .989  .990  .987        .967 1.050 1.043 1.012  .963
                                                   :
            .963 1.010 1.036 1.041  .958  .967  .975        .975  .968  .958 1.040 1.036 1.010  .963
                                                   :
               .963 1.010 1.034 1.033 1.040 1.050  .961  .961 1.050 1.041 1.033 1.034 1.010  .963
                                                   :
                 .965 1.014 1.038 1.034 1.036 1.043 1.047 1.043 1.036 1.034 1.038 1.014  .965
                                                   :
                  .973 1.027 1.014 1.010 1.010 1.012 1.012 1.010 1.010 1.014 1.027  .973
                                                   :
                    .955  .973  .965  .963  .963  .963  .963  .963  .965  .973  .955
```

Fig. 4.63. Pin power distribution, Variant 11, State 1, at burnup = 50 MWd/kg U.

```
                    .936  .961  .953  .951  .950  .951  .950  .951  .953  .961  .936
                                                :
                  .961 1.034 1.020 1.016 1.016 1.018 1.018 1.016 1.016 1.020 1.034  .961
                                                :
                .953 1.020 1.055 1.050 1.053 1.060 1.065 1.060 1.053 1.050 1.055 1.020  .953
                                                :
              .951 1.016 1.050 1.050 1.058 1.069  .952  .951 1.069 1.058 1.050 1.050 1.016  .951
                                                :
           .950 1.016 1.053 1.058  .948  .959  .967        .966  .958  .948 1.058 1.053 1.016  .950
                                                :
        .951 1.018 1.060 1.069  .958        .979  .983  .981  .978        .959 1.069 1.060 1.018  .951
                                                :
      .950 1.018 1.065  .951  .966  .978  .985  .990  .990  .981  .985  .979  .967  .952 1.065 1.018  .950
                                                :
    .951 1.016 1.060  .952        .981  .981  .993        .995  .993  .990  .983        .951 1.060 1.016  .951
                                                :
  .953 1.016 1.053 1.069  .967  .983  .990  .995  .999 1.000  .999        .990  .981  .966 1.069 1.053 1.016  .953
                                                :
 .961 1.020 1.050 1.058  .959  .979  .990       1.000 1.004 1.004 1.000  .995  .981  .978  .958 1.058 1.050 1.020  .961
                                                :
.936 1.034 1.056 1.050  .948        .985  .993  .999 1.004       1.004  .999  .993  .985        .948 1.050 1.055 1.034  .936
                                                :
 .961 1.020 1.050 1.058  .958  .978  .981  .995 1.000 1.004 1.004 1.000        .990  .979  .959 1.058 1.050 1.020  .961
                                                :
  .953 1.016 1.053 1.069  .966  .981  .990        .999 1.000  .999  .995  .990  .983  .967 1.069 1.053 1.016  .953
                                                :
    .951 1.016 1.060  .951        .983  .990  .993  .995        .993  .981  .981        .952 1.060 1.016  .951
                                                :
      .950 1.018 1.065  .952  .967  .979  .985  .981  .990  .990  .985  .978  .966  .951 1.065 1.018  .950
                                                :
        .951 1.018 1.060 1.069  .959        .978  .981  .983  .979        .958 1.069 1.060 1.018  .951
                                                :
           .950 1.016 1.053 1.058  .948  .958  .966        .967  .959  .948 1.058 1.053 1.016  .950
                                                :
              .951 1.016 1.050 1.050 1.058 1.069  .951  .952 1.069 1.058 1.050 1.050 1.016  .951
                                                :
                .953 1.020 1.056 1.050 1.053 1.060 1.065 1.060 1.053 1.050 1.056 1.020  .953
                                                :
                  .961 1.034 1.020 1.016 1.016 1.018 1.018 1.016 1.016 1.020 1.034  .961
                                                :
                    .936  .961  .953  .951  .950  .951  .950  .951  .953  .961  .936
```

Fig. 4.64. Pin power distribution, Variant 11, State 1, at burnup = 60 MWd/kg U.

```
                1.101 1.053 1.042 1.039 1.039 1.039 1.039 1.039 1.042 1.053 1.101
                                                :
             1.053  .976  .960  .956  .956  .957  .957  .956  .956  .960  .976 1.053
                                                :
          1.042  .960  .940  .935  .937  .942  .946  .942  .937  .935  .940  .960 1.042
                                                :
       1.039  .956  .935  .935  .941  .949 1.012 1.011  .949  .941  .935  .935  .956 1.039
                                                :
    1.039  .956  .937  .941 1.009 1.019 1.026       1.025 1.018 1.009  .941  .937  .956 1.039
                                                :
 1.039  .957  .942  .949 1.018       1.037 1.039 1.035 1.032       1.019  .949  .942  .957 1.039
                                                :
1.039  .957  .946 1.011 1.025 1.032 1.037 1.044 1.041 1.016 1.037 1.037 1.026 1.012  .946  .957 1.039
                                                :
1.039  .956  .942 1.012       1.035 1.016 1.043       1.044 1.043 1.044 1.039       1.011  .942  .956 1.039
                                                :
1.042  .956  .937  .949 1.026 1.039 1.041 1.044 1.051 1.052 1.051       1.041 1.035 1.025  .949  .937  .956 1.042
                                                :
1.053  .960  .935  .941 1.019 1.037 1.044       1.052 1.058 1.058 1.052 1.044 1.016 1.032 1.018  .941  .935  .960 1.053
                                                :
1.101  .976  .940  .935 1.009       1.037 1.043 1.051 1.058       1.058 1.051 1.043 1.037       1.009  .935  .940  .976 1.101
                                                :
1.053  .960  .935  .941 1.018 1.032 1.016 1.044 1.052 1.058 1.058 1.052       1.044 1.037 1.019  .941  .935  .960 1.053
                                                :
1.042  .956  .937  .949 1.025 1.035 1.041       1.051 1.052 1.051 1.044 1.041 1.039 1.026  .949  .937  .956 1.042
                                                :
1.039  .956  .942 1.011       1.039 1.044 1.043 1.044       1.043 1.016 1.035       1.012  .942  .956 1.039
                                                :
1.039  .957  .946 1.012 1.026 1.037 1.037 1.016 1.041 1.044 1.037 1.032 1.025 1.011  .946  .957 1.039
                                                :
1.039  .957  .942  .949 1.019       1.032 1.035 1.039 1.037       1.018  .949  .942  .957 1.039
                                                :
    1.039  .956  .937  .941 1.009 1.018 1.025       1.026 1.019 1.009  .941  .937  .956 1.039
                                                :
       1.039  .956  .935  .935  .941  .949 1.011 1.012  .949  .941  .935  .935  .956 1.039
                                                :
          1.042  .960  .940  .935  .937  .942  .946  .942  .937  .935  .940  .960 1.042
                                                :
             1.053  .976  .960  .956  .956  .957  .957  .956  .956  .960  .976 1.053
                                                :
                1.101 1.053 1.042 1.039 1.039 1.039 1.039 1.039 1.042 1.053 1.101
```

Fig. 4.65. Pin power distribution, Variant 12, State 1, at burnup = 0 MWd/kg U.

```
                1.068 1.035 1.025 1.022 1.021 1.022 1.021 1.022 1.025 1.035 1.068
                                                  :
             1.035  .990  .974  .969  .969  .971  .971  .969  .969  .974  .990 1.035
                                                  :
          1.025  .974  .957  .952  .954  .960  .964  .960  .954  .952  .957  .974 1.025
                                                  :
       1.022  .969  .952  .952  .959  .968 1.001 1.001  .968  .959  .952  .952  .969 1.022
                                                  :
    1.021  .969  .954  .959  .998 1.009 1.017       1.016 1.008  .998  .959  .954  .969 1.021
                                                  :
 1.022  .971  .960  .968 1.008       1.028 1.031 1.027 1.024       1.009  .968  .960  .971 1.022
                                                  :
1.021  .971  .964 1.001 1.016 1.024 1.030 1.036 1.034 1.014 1.030 1.028 1.017 1.001  .964  .971 1.021
                                                  :
1.022  .969  .960 1.001       1.027 1.014 1.037       1.038 1.037 1.036 1.031       1.001  .960  .969 1.022
                                                  :
1.025  .969  .954  .968 1.017 1.031 1.034 1.038 1.044 1.045 1.044       1.034 1.027 1.016  .968  .954  .969 1.025
                                                  :
1.035  .974  .952  .959 1.009 1.028 1.036       1.045 1.050 1.050 1.045 1.038 1.014 1.024 1.008  .959  .952  .974 1.035
                                                  :
1.068  .990  .957  .952  .998       1.030 1.037 1.044 1.050       1.050 1.044 1.037 1.030        .998  .952  .957  .990 1.068
                                                  :
1.035  .974  .952  .959 1.008 1.024 1.014 1.038 1.045 1.050 1.050 1.045       1.036 1.028 1.009  .959  .952  .974 1.035
                                                  :
1.025  .969  .954  .968 1.016 1.027 1.034       1.044 1.045 1.044 1.038 1.034 1.031 1.017  .968  .954  .969 1.025
                                                  :
1.022  .969  .960 1.001       1.031 1.036 1.037 1.038       1.037 1.014 1.027       1.001  .960  .969 1.022
                                                  :
1.021  .971  .964 1.001 1.017 1.028 1.030 1.014 1.034 1.036 1.030 1.024 1.016 1.001  .964  .971 1.021
                                                  :
1.022  .971  .960  .968 1.009       1.024 1.027 1.031 1.028       1.008  .968  .960  .971 1.022
                                                  :
    1.021  .969  .954  .959  .998 1.008 1.016       1.017 1.009  .998  .959  .954  .969 1.021
                                                  :
       1.022  .969  .952  .952  .959  .968 1.001 1.001  .968  .959  .952  .952  .969 1.022
                                                  :
          1.025  .974  .957  .952  .954  .960  .964  .960  .954  .952  .957  .974 1.025
                                                  :
             1.035  .990  .974  .969  .969  .971  .971  .969  .969  .974  .990 1.035
                                                  :
                1.068 1.035 1.025 1.022 1.021 1.022 1.021 1.022 1.025 1.035 1.068
```

Fig. 4.66. Pin power distribution, Variant 12, State 1, at burnup = 10 MWd/kg U.

```
                    1.030 1.015 1.004 1.001 1.001 1.001 1.001 1.001 1.004 1.015 1.030
                                                      :
                 1.015 1.008  .991  .986  .986  .987  .987  .986  .985  .991 1.008 1.015
                                                      :
              1.004  .991  .978  .973  .975  .982  .986  .981  .975  .973  .978  .991 1.004
                                                      :
           1.001  .985  .973  .973  .981  .991  .988  .988  .991  .981  .973  .973  .986 1.001
                                                      :
        1.001  .986  .975  .981  .985  .997 1.005       1.004  .996  .985  .981  .975  .986 1.001
                                                      :
     1.001  .987  .981  .991  .996       1.017 1.020 1.018 1.014        .997  .991  .982  .987 1.001
                                                      :
  1.001  .987  .986  .988 1.004 1.014 1.021 1.027 1.025 1.009 1.021 1.017 1.005  .988  .986  .987 1.001
                                                      :
 1.001  .986  .982  .988       1.018 1.009 1.028       1.030 1.028 1.027 1.020        .988  .981  .986 1.001
                                                      :
1.004  .986  .975  .991 1.005 1.020 1.025 1.030 1.035 1.036 1.035       1.025 1.018 1.004  .991  .975  .985 1.004
                                                      :
1.015  .991  .973  .981  .997 1.017 1.027       1.036 1.041 1.041 1.036 1.030 1.009 1.014  .996  .981  .973  .991 1.015
                                                      :
1.030 1.008  .978  .973  .985       1.021 1.028 1.035 1.041       1.041 1.035 1.028 1.021        .985  .973  .978 1.008 1.030
                                                      :
1.015  .991  .973  .981  .996 1.014 1.009 1.030 1.036 1.041 1.041 1.036       1.027 1.017  .997  .981  .973  .991 1.015
                                                      :
1.004  .985  .975  .991 1.004 1.018 1.025       1.035 1.036 1.035 1.030 1.025 1.020 1.005  .991  .975  .986 1.004
                                                      :
 1.001  .986  .981  .988       1.020 1.027 1.028 1.030       1.028 1.009 1.018        .988  .982  .986 1.001
                                                      :
  1.001  .987  .986  .988 1.005 1.017 1.021 1.009 1.025 1.027 1.021 1.014 1.004  .988  .986  .987 1.001
                                                      :
     1.001  .987  .982  .991  .997       1.014 1.018 1.020 1.017        .996  .991  .981  .987 1.001
                                                      :
        1.001  .986  .975  .981  .985  .996 1.004       1.005  .997  .985  .981  .975  .986 1.001
                                                      :
           1.001  .986  .973  .973  .981  .991  .988  .988  .991  .981  .973  .973  .985 1.001
                                                      :
              1.004  .991  .978  .973  .975  .981  .986  .982  .975  .973  .978  .991 1.004
                                                      :
                 1.015 1.008  .991  .985  .986  .987  .987  .986  .986  .991 1.008 1.015
                                                      :
                    1.030 1.015 1.004 1.001 1.001 1.001 1.001 1.001 1.004 1.015 1.030
```

Fig. 4.67. Pin power distribution, Variant 12, State 1, at burnup = 20 MWd/kg U.

```
                    .992  .993  .982  .979  .979  .979  .979  .979  .982  .993  .992
                                                :
                  .993 1.026 1.009 1.003 1.003 1.005 1.005 1.003 1.003 1.009 1.026  .993
                                                :
                 .982 1.009 1.001  .996  .998 1.005 1.011 1.005  .998  .996 1.001 1.009  .982
                                                :
               .979 1.003  .996  .996 1.005 1.016  .975  .975 1.015 1.005  .996  .996 1.003  .979
                                                :
            .979 1.003  .998 1.005  .972  .983  .992        .991  .983  .972 1.005  .998 1.003  .979
                                                :
         .979 1.005 1.005 1.015  .983       1.005 1.008 1.006 1.002        .983 1.016 1.005 1.005  .979
                                                :
      .979 1.005 1.011  .975  .991 1.002 1.009 1.015 1.014 1.002 1.009 1.005  .992  .975 1.011 1.005  .979
                                                :
   .979 1.003 1.005  .975       1.006 1.002 1.017       1.019 1.017 1.015 1.008        .975 1.005 1.003  .979
                                                :
  .983 1.003  .998 1.016  .992 1.008 1.014 1.019 1.024 1.025 1.024       1.014 1.006  .991 1.015  .998 1.003  .982
                                                :
 .993 1.009  .996 1.005  .983 1.005 1.015       1.025 1.029 1.029 1.025 1.019 1.002 1.002  .983 1.005  .996 1.009  .993
                                                :
.992 1.026 1.001  .996  .972       1.009 1.017 1.024 1.029       1.029 1.024 1.017 1.009        .972  .996 1.001 1.026  .992
                                                :
 .993 1.009  .996 1.005  .983 1.002 1.002 1.019 1.025 1.029 1.029 1.025       1.015 1.005  .983 1.005  .996 1.009  .993
                                                :
  .982 1.003  .998 1.015  .991 1.006 1.014       1.024 1.025 1.024 1.019 1.014 1.008  .992 1.016  .998 1.003  .982
                                                :
   .979 1.003 1.005  .975       1.008 1.015 1.017 1.019       1.017 1.002 1.006        .975 1.005 1.003  .979
                                                :
      .979 1.005 1.011  .975  .992 1.005 1.009 1.002 1.014 1.015 1.009 1.002  .991  .975 1.011 1.005  .979
                                                :
         .979 1.005 1.005 1.016  .983       1.002 1.006 1.008 1.005        .983 1.015 1.005 1.005  .979
                                                :
            .979 1.003  .998 1.005  .972  .983  .991        .992  .983  .972 1.005  .998 1.003  .979
                                                :
               .979 1.003  .996  .996 1.005 1.015  .975  .975 1.016 1.005  .996  .996 1.003  .979
                                                :
                 .983 1.009 1.001  .996  .998 1.005 1.011 1.005  .998  .996 1.001 1.009  .982
                                                :
                  .993 1.026 1.009 1.003 1.003 1.005 1.005 1.003 1.003 1.009 1.026  .993
                                                :
                    .992  .993  .982  .979  .979  .979  .979  .979  .982  .993  .992
```

Fig. 4.68. Pin power distribution, Variant 12, State 1, at burnup = 30 MWd/kg U.

```
                    .958  .973  .962  .959  .959  .959  .959  .959  .962  .973  .958
                                                   :
                  .973 1.044 1.025 1.020 1.020 1.022 1.022 1.020 1.020 1.025 1.044  .973
                                                   :
                .962 1.025 1.024 1.018 1.021 1.028 1.034 1.028 1.020 1.018 1.024 1.025  .963
                                                   :
              .959 1.020 1.018 1.019 1.028 1.039  .963  .962 1.039 1.028 1.019 1.018 1.020  .959
                                                   :
            .959 1.020 1.020 1.028  .960  .971  .980        .979  .970  .960 1.028 1.021 1.020  .959
                                                   :
          .959 1.022 1.028 1.039  .971        .993  .996  .995  .991        .971 1.039 1.028 1.022  .959
                                                   :
        .959 1.022 1.034  .962  .979  .991  .998 1.004 1.004  .993  .998  .993  .980  .963 1.034 1.022  .959
                                                   :
      .959 1.020 1.028  .963        .995  .993 1.007       1.009 1.007 1.004  .996        .962 1.028 1.020  .959
                                                   :
    .962 1.020 1.021 1.039  .980  .996 1.004 1.009 1.013 1.015 1.013       1.004  .995  .979 1.039 1.020 1.020  .962
                                                   :
  .973 1.025 1.018 1.028  .971  .993 1.004       1.015 1.018 1.018 1.015 1.009  .993  .991  .970 1.028 1.018 1.025  .973
                                                   :
.958 1.044 1.024 1.019  .960        .998 1.007 1.013 1.018       1.018 1.013 1.007  .998        .960 1.019 1.024 1.044  .958
                                                   :
  .973 1.025 1.018 1.028  .970  .991  .993 1.009 1.015 1.018 1.018 1.015       1.004  .993  .971 1.028 1.018 1.025  .973
                                                   :
    .962 1.020 1.020 1.039  .979  .995 1.004       1.013 1.015 1.013 1.009 1.004  .996  .980 1.039 1.021 1.020  .963
                                                   :
      .959 1.020 1.028  .962        .996 1.004 1.007 1.009       1.007  .993  .995        .963 1.028 1.020  .959
                                                   :
        .959 1.022 1.034  .963  .980  .993  .998  .993 1.004 1.004  .998  .991  .979  .962 1.034 1.022  .959
                                                   :
          .959 1.022 1.028 1.039  .971        .991  .995  .996  .993        .970 1.039 1.028 1.022  .959
                                                   :
            .959 1.020 1.020 1.028  .960  .970  .979        .980  .971  .960 1.028 1.020 1.020  .959
                                                   :
              .959 1.020 1.018 1.019 1.028 1.039  .962  .963 1.039 1.028 1.019 1.018 1.020  .959
                                                   :
                .962 1.025 1.024 1.018 1.020 1.028 1.034 1.028 1.021 1.018 1.024 1.025  .962
                                                   :
                  .973 1.044 1.025 1.020 1.020 1.022 1.022 1.020 1.020 1.025 1.044  .973
                                                   :
                    .958  .973  .962  .959  .959  .959  .959  .959  .962  .973  .958
```

Fig. 4.69. Pin power distribution, Variant 12, State 1, at burnup = 40 MWd/kg U.

```
                    .931  .955  .945  .942  .941  .942  .941  .942  .945  .955  .931
                                                   :
                  .955 1.058 1.039 1.034 1.034 1.036 1.036 1.034 1.034 1.039 1.058  .955
                                                   :
                .945 1.039 1.044 1.038 1.041 1.049 1.054 1.049 1.040 1.038 1.044 1.039  .945
                                                   :
              .942 1.034 1.038 1.038 1.048 1.060  .951  .951 1.060 1.048 1.038 1.038 1.034  .942
                                                   :
           .941 1.034 1.040 1.048  .948  .960  .969        .968  .959  .948 1.048 1.040 1.034  .941
                                                   :
        .942 1.036 1.049 1.060  .959        .982  .986  .984  .980        .960 1.060 1.049 1.036  .942
                                                   :
     .941 1.036 1.054  .951  .968  .980  .988  .994  .994  .985  .988  .982  .969  .951 1.054 1.036  .941
                                                   :
  .942 1.034 1.049  .951        .984  .985  .997        .999  .997  .994  .986        .951 1.049 1.034  .942
                                                   :
 .945 1.034 1.040 1.060  .969  .986  .994  .999 1.004 1.005 1.004        .994  .984  .968 1.060 1.040 1.034  .945
                                                   :
.955 1.039 1.038 1.048  .960  .982  .994       1.005 1.009 1.009 1.005  .999  .985  .980  .959 1.048 1.038 1.039  .955
                                                   :
.931 1.058 1.044 1.038  .948        .988  .997 1.004 1.009       1.009 1.004  .997  .988        .948 1.038 1.044 1.058  .931
                                                   :
.955 1.039 1.038 1.048  .959  .980  .985  .999 1.005 1.009 1.009 1.005        .994  .982  .960 1.048 1.038 1.039  .955
                                                   :
 .945 1.034 1.040 1.060  .968  .984  .994       1.004 1.005 1.004  .999  .994  .986  .969 1.060 1.041 1.034  .945
                                                   :
  .942 1.034 1.049  .951        .986  .994  .997  .999        .997  .985  .984        .951 1.049 1.034  .942
                                                   :
     .941 1.036 1.054  .951  .969  .982  .988  .985  .994  .994  .988  .980  .968  .951 1.054 1.036  .941
                                                   :
        .942 1.036 1.049 1.060  .960        .980  .984  .986  .982        .959 1.060 1.049 1.036  .942
                                                   :
           .941 1.034 1.041 1.048  .948  .959  .968        .969  .960  .948 1.048 1.040 1.034  .941
                                                   :
              .942 1.034 1.038 1.038 1.048 1.060  .951  .951 1.060 1.048 1.038 1.038 1.034  .942
                                                   :
                .945 1.039 1.044 1.038 1.040 1.049 1.054 1.049 1.040 1.038 1.044 1.039  .945
                                                   :
                  .955 1.058 1.039 1.034 1.034 1.036 1.036 1.034 1.034 1.039 1.058  .955
                                                   :
                    .931  .955  .945  .942  .941  .942  .941  .942  .945  .955  .931
```

Fig. 4.70. Pin power distribution, Variant 12, State 1, at burnup = 50 MWd/kg U.

```
                    .911  .941  .931  .928  .927  .928  .927  .928  .931  .941  .911
                                                   :
                  .941 1.069 1.050 1.044 1.045 1.047 1.047 1.045 1.044 1.050 1.069  .941
                                                   :
                 .931 1.050 1.060 1.054 1.057 1.065 1.071 1.065 1.057 1.054 1.060 1.050  .931
                                                   :
               .928 1.044 1.054 1.055 1.065 1.077  .941  .941 1.077 1.065 1.055 1.054 1.044  .928
                                                   :
            .927 1.045 1.057 1.065  .938  .950  .960        .959  .950  .938 1.065 1.057 1.045  .927
                                                   :
          .928 1.047 1.065 1.077  .950        .974  .977  .976  .972        .950 1.077 1.065 1.047  .928
                                                   :
        .927 1.047 1.071  .941  .959  .972  .980  .986  .986  .977  .980  .974  .960  .941 1.071 1.047  .927
                                                   :
      .928 1.045 1.065  .941        .976  .977  .990        .992  .990  .986  .977        .941 1.065 1.045  .928
                                                   :
    .931 1.044 1.057 1.077  .960  .977  .986  .992  .997  .998  .997        .986  .976  .959 1.077 1.057 1.044  .931
                                                   :
  .941 1.050 1.054 1.065  .950  .974  .986        .998 1.002 1.002  .998  .992  .977  .972  .950 1.065 1.054 1.050  .941
                                                   :
.911 1.069 1.060 1.055  .938        .980  .990  .997 1.002       1.002  .997  .990  .980        .938 1.055 1.060 1.069  .911
                                                   :
  .941 1.050 1.054 1.065  .950  .972  .977  .992  .998 1.002 1.002  .998        .986  .974  .950 1.065 1.054 1.050  .941
                                                   :
    .931 1.044 1.057 1.077  .959  .976  .986        .997  .998  .997  .992  .986  .977  .960 1.077 1.057 1.044  .931
                                                   :
      .928 1.045 1.065  .941        .977  .986  .990  .992        .990  .977  .976        .941 1.065 1.045  .928
                                                   :
        .927 1.047 1.071  .941  .960  .974  .980  .977  .986  .986  .980  .972  .959  .941 1.071 1.047  .927
                                                   :
          .928 1.047 1.065 1.077  .950        .972  .976  .977  .974        .950 1.077 1.065 1.047  .928
                                                   :
            .927 1.045 1.057 1.065  .938  .950  .959        .960  .950  .938 1.065 1.057 1.045  .927
                                                   :
               .928 1.044 1.054 1.055 1.065 1.077  .941  .941 1.077 1.065 1.055 1.054 1.044  .928
                                                   :
                 .931 1.050 1.060 1.054 1.057 1.065 1.071 1.065 1.057 1.054 1.060 1.050  .931
                                                   :
                  .941 1.069 1.050 1.044 1.045 1.047 1.047 1.045 1.044 1.050 1.069  .941
                                                   :
                    .911  .941  .931  .928  .927  .928  .927  .928  .931  .941  .911
```

Fig. 4.71. Pin power distribution, Variant 12, State 1, at burnup = 60 MWd/kg U.

1.204																					
1.170	1.119																				
1.160	1.107	1.074																			
1.154	1.100	1.066	1.044																		
1.150	1.095	1.061	1.039	1.029																	
1.145	1.091	1.057	1.035	1.025	1.019																
1.140	1.086	1.053	1.031	1.022	1.016	1.013															
1.132	1.081	1.048	1.028	1.019	1.014	1.011	1.009														
1.119	1.072	1.042	1.023	1.016	1.011	1.009	1.007	1.006													
1.092	1.056	1.033	1.018	1.012	1.009	1.007	1.006	1.005	1.005												
1.301	1.065	1.027	1.019	1.010	1.007	1.005	1.004	1.004	1.004	1.004	1.005										
1.012	1.197	1.022	1.007	1.005	1.001	1.001	1.002	1.002	1.003	1.004	1.005	1.005									
.889	.962	1.163	.993	.996	.998	.996	.998	1.000	1.002	1.003	1.005	1.006	1.007								
.827	.861	.942	1.148	.982	.991	.995	.994	.998	1.001	1.003	1.005	1.006	1.008	1.009							
.795	.812	.849	.933	1.141	.976	.989	.994	.995	.999	1.002	1.005	1.008	1.010	1.011	1.013						
.776	.786	.805	.844	.930	1.139	.975	.990	.996	.997	1.002	1.006	1.010	1.012	1.015	1.017	1.020					
.765	.771	.782	.803	.842	.930	1.141	.976	.993	1.001	1.003	1.009	1.014	1.017	1.020	1.023	1.026	1.030				
.759	.762	.769	.781	.803	.844	.933	1.146	.980	1.001	1.010	1.014	1.020	1.025	1.029	1.033	1.036	1.040	1.046			
.755	.758	.762	.769	.782	.805	.849	.941	1.160	.989	1.016	1.026	1.038	1.045	1.050	1.054	1.058	1.062	1.068	1.076		
.753	.755	.758	.762	.771	.786	.812	.861	.962	1.193	1.010	1.042	1.065	1.076	1.084	1.089	1.093	1.097	1.102	1.110	1.122	
.753	.753	.755	.759	.765	.776	.795	.827	.889	1.012	1.301	1.055	1.107	1.126	1.137	1.143	1.148	1.152	1.157	1.164	1.176	1.210

Fig. 4.72. Pin power distribution, Variant 13, State 1, at burnup = 0 MWd/kg U.

1.169																					
1.145	1.113																				
1.134	1.099	1.074																			
1.129	1.092	1.065	1.041																		
1.125	1.088	1.060	1.036	1.025																	
1.122	1.085	1.056	1.032	1.022	1.016																
1.119	1.081	1.053	1.029	1.019	1.013	1.010															
1.114	1.078	1.051	1.027	1.017	1.011	1.008	1.006														
1.106	1.072	1.046	1.024	1.015	1.010	1.007	1.005	1.004													
1.091	1.064	1.041	1.021	1.012	1.008	1.005	1.004	1.003	1.003												
1.184	1.070	1.046	1.034	1.018	1.010	1.006	1.004	1.003	1.003	1.003	1.003										
1.005	1.122	1.038	1.025	1.020	1.008	1.005	1.003	1.002	1.002	1.002	1.003	1.003									
.901	.963	1.096	1.014	1.015	1.013	1.004	1.002	1.002	1.002	1.002	1.003	1.004	1.004								
.845	.876	.945	1.084	1.003	1.010	1.010	1.002	1.001	1.002	1.002	1.003	1.004	1.006	1.007							
.815	.831	.865	.937	1.079	.998	1.008	1.009	1.003	1.003	1.003	1.005	1.006	1.007	1.009	1.010						
.798	.807	.825	.860	.934	1.077	.997	1.009	1.011	1.005	1.006	1.007	1.009	1.010	1.012	1.014	1.016					
.789	.794	.804	.823	.859	.934	1.078	.998	1.012	1.015	1.010	1.012	1.014	1.016	1.018	1.020	1.022	1.026				
.783	.786	.792	.803	.823	.860	.937	1.083	1.001	1.019	1.024	1.020	1.023	1.026	1.028	1.030	1.033	1.037	1.043			
.780	.782	.785	.792	.804	.825	.865	.944	1.094	1.010	1.033	1.040	1.045	1.048	1.052	1.055	1.058	1.061	1.066	1.076		
.778	.779	.782	.786	.794	.807	.831	.876	.962	1.119	1.028	1.058	1.069	1.076	1.080	1.083	1.086	1.089	1.094	1.102	1.116	
.777	.778	.780	.783	.789	.798	.815	.845	.901	1.005	1.184	1.063	1.101	1.111	1.117	1.120	1.124	1.127	1.131	1.138	1.151	1.175

Fig. 4.73. Pin power distribution, Variant 13, State 1, at burnup = 10 MWd/kg U.

1.124																				
1.111	1.100																			
1.100	1.086	1.070																		
1.096	1.079	1.060	1.037																	
1.093	1.075	1.056	1.031	1.019																
1.091	1.073	1.053	1.028	1.015	1.009															
1.089	1.071	1.051	1.025	1.013	1.007	1.004														
1.087	1.069	1.049	1.023	1.012	1.006	1.002	1.000													
1.083	1.066	1.047	1.022	1.011	1.005	1.001	1.000	.999												
1.077	1.063	1.045	1.021	1.010	1.004	1.001	.999	.998	.998											
1.102	1.060	1.054	1.043	1.020	1.009	1.003	1.000	.998	.998	.997	.997									
1.018	1.075	1.039	1.034	1.029	1.011	1.004	1.000	.998	.998	.997	.997	.998								
.929	.980	1.054	1.020	1.023	1.021	1.007	1.002	.999	.998	.998	.998	.998	.999							
.876	.906	.963	1.044	1.010	1.018	1.018	1.005	1.001	.999	.999	.999	.999	1.000	1.001						
.847	.863	.895	.956	1.039	1.005	1.016	1.017	1.006	1.002	1.001	1.000	1.001	1.002	1.003	1.004					
.830	.839	.856	.890	.953	1.038	1.004	1.017	1.019	1.008	1.005	1.004	1.004	1.005	1.006	1.008	1.010				
.821	.826	.835	.854	.889	.953	1.039	1.004	1.020	1.023	1.013	1.011	1.010	1.011	1.012	1.014	1.016	1.020			
.815	.818	.824	.834	.854	.890	.955	1.043	1.008	1.026	1.032	1.022	1.022	1.023	1.024	1.025	1.029	1.032	1.038		
.812	.814	.818	.824	.835	.856	.895	.962	1.051	1.016	1.040	1.047	1.047	1.048	1.050	1.052	1.054	1.057	1.062	1.072	
.811	.812	.814	.818	.826	.839	.862	.905	.979	1.072	1.033	1.064	1.066	1.068	1.070	1.072	1.074	1.077	1.081	1.089	1.104
.810	.811	.812	.815	.821	.830	.847	.876	.929	1.018	1.102	1.057	1.082	1.086	1.088	1.090	1.092	1.094	1.097	1.104	1.117	1.130

Fig. 4.74. Pin power distribution, Variant 13, State 1, at burnup = 20 MWd/kg U.

1.078

1.076 1.089

1.065 1.074 1.067

1.061 1.066 1.057 1.033

1.058 1.063 1.053 1.027 1.016

1.057 1.061 1.050 1.025 1.013 1.006

1.056 1.060 1.049 1.023 1.011 1.004 1.001

1.056 1.059 1.048 1.022 1.010 1.003 1.000 .998

1.056 1.058 1.047 1.021 1.009 1.002 .999 .997 .996

1.056 1.058 1.048 1.022 1.009 1.002 .999 .997 .996 .995

1.036 1.039 1.057 1.050 1.024 1.011 1.003 .999 .997 .996 .995 .995

1.033 1.034 1.028 1.037 1.035 1.015 1.005 1.000 .997 .996 .995 .995 .995

.958 .999 1.016 1.017 1.027 1.029 1.011 1.003 .999 .997 .996 .996 .996 .996

.906 .935 .983 1.008 1.007 1.023 1.026 1.009 1.002 .999 .997 .997 .997 .997 .998

.877 .893 .924 .975 1.004 1.003 1.021 1.025 1.009 1.003 1.000 .999 .999 .999 1.000 1.001

.860 .869 .886 .919 .972 1.003 1.002 1.022 1.026 1.011 1.006 1.003 1.003 1.003 1.003 1.005 1.007

.851 .856 .865 .884 .918 .972 1.003 1.002 1.025 1.030 1.016 1.011 1.010 1.010 1.010 1.011 1.013 1.016

.845 .848 .854 .864 .884 .919 .975 1.006 1.005 1.031 1.038 1.026 1.023 1.022 1.022 1.023 1.025 1.028 1.034

.843 .844 .848 .854 .865 .886 .924 .982 1.014 1.012 1.043 1.053 1.049 1.048 1.048 1.049 1.051 1.054 1.059 1.069

.841 .842 .844 .848 .856 .869 .892 .934 .998 1.031 1.027 1.064 1.061 1.060 1.060 1.060 1.061 1.064 1.068 1.077 1.092

.841 .841 .843 .845 .851 .860 .877 .906 .958 1.033 1.036 1.041 1.058 1.057 1.056 1.057 1.058 1.059 1.062 1.068 1.082 1.083

Fig. 4.75. Pin power distribution, Variant 13, State 1, at burnup = 30 MWd/kg U.

1.031

1.041 1.076

1.031 1.062 1.066

1.027 1.055 1.057 1.032

1.026 1.051 1.052 1.026 1.014

1.025 1.050 1.050 1.024 1.011 1.005

1.025 1.049 1.049 1.022 1.010 1.003 .999

1.026 1.050 1.048 1.022 1.009 1.002 .998 .996

1.028 1.051 1.049 1.022 1.009 1.002 .998 .996 .995

1.032 1.054 1.052 1.024 1.010 1.002 .998 .996 .994 .994

.987 1.012 1.059 1.058 1.028 1.013 1.004 .999 .996 .995 .994 .994

1.048 1.003 1.010 1.039 1.043 1.019 1.007 1.000 .997 .995 .994 .994 .994

.984 1.016 .988 1.006 1.029 1.036 1.015 1.005 .999 .997 .995 .995 .994 .995

.934 .962 1.001 .980 .998 1.025 1.033 1.013 1.004 .999 .997 .996 .996 .996 .996

.905 .921 .952 .994 .976 .994 1.023 1.032 1.013 1.005 1.001 .999 .998 .998 .998 .999

.888 .897 .914 .947 .991 .975 .992 1.024 1.033 1.015 1.007 1.004 1.002 1.002 1.002 1.003 1.005

.879 .884 .894 .912 .946 .991 .976 .993 1.026 1.037 1.020 1.013 1.010 1.009 1.009 1.010 1.012 1.015

.874 .877 .882 .893 .912 .947 .993 .979 .995 1.032 1.045 1.029 1.024 1.023 1.022 1.023 1.024 1.027 1.033

.871 .873 .876 .882 .894 .914 .951 1.000 .986 1.002 1.043 1.060 1.053 1.050 1.049 1.049 1.050 1.053 1.058 1.068

.870 .871 .873 .877 .884 .897 .921 .962 1.015 1.000 1.014 1.063 1.055 1.051 1.050 1.050 1.050 1.052 1.056 1.064 1.080

.869 .870 .871 .874 .879 .888 .905 .934 .984 1.048 .987 1.019 1.032 1.027 1.026 1.025 1.025 1.026 1.029 1.034 1.046 1.037

Fig. 4.76. Pin power distribution, Variant 13, State 1, at burnup = 40 MWd/kg U.

.991

1.010 1.066

1.001 1.051 1.067

.997 1.044 1.057 1.032

.995 1.041 1.052 1.026 1.013

.995 1.040 1.050 1.023 1.010 1.003

.996 1.040 1.050 1.022 1.009 1.002 .998

.998 1.041 1.050 1.022 1.008 1.001 .997 .995

1.001 1.044 1.052 1.023 1.009 1.001 .997 .995 .993

1.008 1.049 1.055 1.026 1.011 1.002 .997 .995 .993 .993

.955 .983 1.057 1.064 1.032 1.014 1.004 .998 .995 .994 .993 .993

1.063 .982 .988 1.038 1.049 1.022 1.009 1.001 .997 .995 .993 .993 .993

1.009 1.033 .967 .991 1.028 1.042 1.018 1.006 1.000 .996 .995 .994 .993 .993

.960 .987 1.018 .960 .983 1.024 1.039 1.017 1.006 1.000 .997 .995 .995 .995 .995

.931 .947 .977 1.011 .956 .979 1.023 1.038 1.017 1.007 1.001 .999 .997 .997 .997 .998

.914 .923 .940 .972 1.008 .955 .978 1.023 1.039 1.019 1.009 1.004 1.002 1.001 1.001 1.002 1.003

.905 .910 .920 .938 .971 1.008 .956 .978 1.025 1.043 1.023 1.015 1.011 1.009 1.009 1.009 1.010 1.014

.900 .903 .908 .919 .938 .972 1.010 .959 .981 1.031 1.051 1.033 1.026 1.023 1.022 1.022 1.024 1.026 1.033

.897 .899 .902 .908 .920 .940 .977 1.017 .965 .986 1.041 1.066 1.056 1.052 1.050 1.050 1.050 1.053 1.058 1.069

.896 .897 .899 .903 .910 .923 .947 .987 1.032 .979 .997 1.061 1.049 1.043 1.041 1.040 1.040 1.042 1.046 1.054 1.070

.896 .896 .897 .900 .905 .914 .931 .960 1.009 1.063 .955 .995 1.007 1.000 .997 .995 .995 .996 .998 1.003 1.015 .996

Fig. 4.77. Pin power distribution, Variant 13, State 1, at burnup = 50 MWd/kg U.

.959

.985 1.058

.975 1.043 1.068

.972 1.035 1.058 1.032

.970 1.032 1.053 1.026 1.013

.970 1.031 1.051 1.023 1.009 1.002

.971 1.032 1.051 1.022 1.008 1.001 .997

.974 1.034 1.052 1.023 1.008 1.000 .996 .994

.979 1.037 1.054 1.024 1.009 1.000 .996 .993 .992

.987 1.044 1.059 1.028 1.011 1.002 .996 .994 .992 .991

.935 .956 1.055 1.070 1.035 1.016 1.004 .998 .995 .993 .992 .991

1.077 .968 .967 1.036 1.054 1.025 1.010 1.001 .996 .994 .992 .992 .991

1.031 1.048 .954 .973 1.026 1.047 1.021 1.008 1.000 .996 .994 .993 .992 .992

.982 1.009 1.033 .947 .965 1.022 1.044 1.019 1.007 1.000 .996 .994 .994 .993 .994

.953 .969 .999 1.026 .943 .962 1.020 1.043 1.019 1.008 1.001 .998 .996 .996 .996 .997

.937 .945 .963 .994 1.023 .942 .961 1.021 1.045 1.021 1.010 1.004 1.002 1.000 1.000 1.001 1.002

.927 .932 .942 .960 .993 1.023 .943 .961 1.023 1.048 1.026 1.016 1.011 1.009 1.008 1.008 1.010 1.013

.922 .925 .931 .941 .960 .994 1.025 .945 .964 1.028 1.056 1.036 1.028 1.024 1.022 1.022 1.023 1.026 1.032

.920 .921 .924 .931 .942 .962 .999 1.032 .952 .969 1.039 1.072 1.060 1.054 1.052 1.051 1.051 1.054 1.059 1.070

.918 .919 .921 .925 .932 .945 .969 1.009 1.046 .965 .979 1.058 1.043 1.036 1.033 1.032 1.032 1.033 1.037 1.045 1.062

.918 .918 .920 .922 .927 .937 .953 .982 1.031 1.077 .935 .972 .985 .977 .973 .971 .970 .971 .973 .978 .990 .964

Fig. 4.78. Pin power distribution, Variant 13, State 1, at burnup = 60 MWd/kg U.

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5. EXPERIMENTAL BENCHMARKS

(M. S. Yudkevich, N. I. Alexeyex, and V. I. Vryzgalov [MCU calculations]; T. I. Bagretsova, Z. N. Chizhikova, V. M. Dekoussar, G. M. Jerdev, A. G. Kalashnikov, E. N. Kapranova, V. E. Korobitsin, G. N. Manturov, A. L. Moseev, M. N. Nikolaev, Y. V. Rozhikhin, M. Y. Semenov, A. A. Tsyboulia, and A. M. Tsiboulia [KENO-V.a/ABBN cross section calculations])

5.1 INTRODUCTION

The goal of this work is to validate the MCU Monte Carlo code system and its current nuclear database and other Monte Carlo codes (KENO-V.a and MCNP) as applied to VVERs or PWRs with MOX fuel and as applied to criticality safety of nonreactor fuel cycle facilities. The MCU system is the principal Monte Carlo theory computer program for reactor physics and criticality safety analyses in Russia. However, the KENO and MCNP computer programs are used for verification of MCU.

Nine critical assemblies and a total of 69 cases were considered. These cases are representative of data needed to certify activities described in Chap. 2 of this report.

For each case, the value of k_{eff} and the neutron reaction rates for all nuclides are presented. Reaction rates are useful in comparing the neutron data used by different codes.

The experimental data for the calculations are documented elsewhere. Thus, only very brief descriptions of the assemblies are given in this report. The parameters of the particular cases are given in the tables along with k_{eff} values. The uncertainty in a calculated parameter from MCU is identified in parenthesis. That is, a reported value of 0.XXXX(YY) should be interpreted as 0.XXXX ± 0.00YY.

Neutron reaction rates for MCU calculations that are given in the tables are defined as follows:

- absorption $R(abs) = \int \Sigma_a(r,E)\,\Phi(r,E)drdE$
- fission $R(fis) = \int \Sigma_f(r,E)\,\Phi(r,E)drdE$
- neutron generation $R(\nu \cdot fis) = \int \nu\,\Sigma_f(r,E)\Phi(r,E)drdE$

The neutron flux $\Phi(r,E)$ is normalized to one source neutron.

The balance tables that are generated from the KENO-ABBN calculations have different definitions than those for MCU. The following designations are used in the formulas below:

$$C_i^n,\ F_i^n,\ n2n_i^n,\ \nu\Sigma_{f_i}^n$$

represent capture, fission, (n,2n), and the product, where n is the zone number and i is the isotope number;

$$\sigma_{c_{i,j}}^n,\ \sigma_{f_{i,j}}^n,\ \sigma_{n2n_{i,j}}^n,\ \sigma_{\nu\Sigma_{f_i}^n}^n$$

represent one-group capture, fission, (n,2n), and product cross section where n is the zone number and i is the isotope number; IZT is the number of physical zones (materials), INZ is the number of isotopes, and j is the energy group.

Capture for i-th isotope in n-th zone is determined as:

$$C_i^n = \rho_i^n \sum_{j=E_1}^{E_2} \sigma_{c\,i,j}^n \Phi_j^n \quad , \tag{5.1}$$

where $\Phi_j^n = V^n \hat{\varphi}_j^n$, ρ_i^n is atomic density of *i*-th isotope in *n*-th zone, $\hat{\varphi}_j^n$ is averaged flux in *n*-th zone, *j*-th group, and V^n is volume of *n*-th zone, n = 1,..., IZT, i = 1,..., INZ. E_1 and E_2 are the number of the first and the last energy group.

One-group capture cross section is determined as:

$$\hat{\sigma}_{c_i}^n = \frac{\sum_{j=E_1}^{E_2} \sigma_{c_{i,j}}^n \Phi_j^n}{\sum_{j=E_1}^{E_2} \Phi_j^n} . \tag{5.2}$$

For fission, (n,2n), and product:

$$F_i^n = \rho_i^n \sum_{j=E_1}^{E_2} \sigma_{f_{i,j}}^n \Phi_j^n , \qquad \hat{\sigma}_{f_i}^n = \frac{\sum_{j=E_1}^{E_2} \sigma_{f_{i,j}}^n \Phi_j^n}{\sum_{j=E_1}^{E_2} \Phi_j^n} ; \tag{5.3}$$

$$n2n_i^n = \rho_i^n \sum_{j=E_1}^{E_2} \sigma_{n2n_{i,j}}^n \Phi_j^n , \qquad \hat{\sigma}_{n2n_i}^n = \frac{\sum_{j=E_1}^{E_2} \sigma_{n2n_{i,j}}^n \Phi_j^n}{\sum_{j=E_1}^{E_2} \Phi_j^n} ; \tag{5.4}$$

$$\nu\Sigma_{f_i}^n = \rho_i^n \sum_{j=E_1}^{E_2} \sigma_{\nu\Sigma_{f_{i,j}}^n}^n \Phi_j^n , \qquad \hat{\sigma}_{\nu\Sigma_{f_i}^n}^n = \frac{\sum_{j=E_1}^{E_2} \sigma_{\nu\Sigma_{f_{i,j}}^n}^n \Phi_j^n}{\sum_{j=E_1}^{E_2} \Phi_j^n} . \tag{5.5}$$

The leakage L is determined as:

$$L = \sum_{n=1}^{IZT} \sum_{i=1}^{INZ} \left(\frac{\nu\Sigma_{f_i}^n + n2n_i^n}{k_{eff}} - C_i^n - F_i^n \right) , \tag{5.6}$$

where, for the leakage calculation, capture is defined as nonfission capture.

Having fission and capture power releases Q_f and Q_c (MeV), one can normalize the fluxes in zones to the reactor power P (MWt), multiplying them by a normalization coefficient determined as:

$$Pnorm = \frac{1}{B} \frac{P}{\sum_{n=1}^{IZT} \sum_{i=1}^{INZ} \left(Q_{c,i} C_i^n + Q_{f_i} F_i^n \right)} , \tag{5.7}$$

where $B = 1.6 \times 10^{-19}$ is the coefficient for translation from MeV/s to MWt.

For all KENO calculations, microscopic cross sections are generated by the CONSYST code, Averaged fluxes and volumes are output from the transport code (for these calculations, KENO; but TWODANT and MCNP output can also be accessed).

Columns in the KENO balance tables include:

- Nuclide—name of the nuclide in truncated CHARACTER*32 BNAB format,
- Capture—capture reaction rates for each nuclide integrated over Energy region,
- Fission—fission reaction rates for each nuclide integrated over Energy region,
- (n,2n)—(n,2n) reaction rates for each nuclide integrated over Energy region,
- Product—product reaction rates for each nuclide integrated over Energy region where product is fission multiplied by ν—the number of neutrons per fission,
- σ_c—one-group capture cross section for each nuclide,
- σ_f—one-group fission cross section for each nuclide,
- σ_{2n}—one-group (n,2n) cross section for each nuclide,
- $\sigma_{\nu\sigma_f}$—one-group product cross section for each nuclide, and
- ν—number of fission neutrons per fission.

The last line, Total, contains sums over all nuclides in the current zone for Capture, Fission, (n,2n), and Product. The right portion of each table is "Over all reactor (n) zones." This portion contains the same columns Capture, Fission, (n,2n), Product with reaction rates for each nuclide integrated over all N zones.

In a footnote at the bottom of the balance table, one can find the value of k_{eff}. In the case of the KENO code, this value is the system total from the KENO output with leakage calculated by MAYAK. Each table has other footnoted information such as:

- Energy region (in units of BNAB group numbers);
- Volume of current physical zone (if more than one geometry zone is filled with the same material, then this value represents the cumulative volume); and
- Flux—averaged zone flux normalized per power of the reactor.

All reaction rates in the tables for the KENO benchmarks are normalized per 1000 neutrons of source (they were just multiplied by 1000). The flux was normalized per 1 MWt.

5.2 BARE SPHERE OF ^{239}Pu METAL

Reference 1 provides a description of a critical metal sphere of plutonium and designates this experiment as PU-MET-FAST-001. The multiplication factor and reaction rates are given for this isolated bare sphere of plutonium (4 wt % ^{240}Pu) with a density of 15.61 g/cm^3. The sphere radius is equal to 6.385 cm. Calculated physics parameters are shown in Tables 5.1 and 5.2.

Table 5.1. Multiplication factor for plutonium metal sphere

Assembly	Critical mass (kg)	k_{eff}		
		Experiment	MCU	KENO-V.a (299gp.ABBN-90)
PU-MET-FAST-001	17.02 ± 0.100	1.000 ± 0.006	0.9976(8)	0.9945 ± 0.0009

Table 5.2. MCU reaction rates for plutonium metal sphere

Nuclide	R(abs)	R(ν · fis)	R(fis)
Ga	0.2158E–3		
^{239}Pu	0.3228E+0	0.9641E+0	0.3077E+0
^{240}Pu	0.1077E–1	0.3128E–1	0.9614E–2
^{241}Pu	0.9622E–3	0.2876E–2	0.9115E–3
Leakage	0.3347E+0		

5.3 WATER-REFLECTED 9-, 11-, AND 12-in.-diam CYLINDERS OF PLUTONIUM NITRATE SOLUTION

Reference 1 provides a description of cylindrical critical experiments conducted with plutonium nitrate solution and designates the series as PU-SOL-THERM-010. A cylindrical, thin-walled, stainless-steel vessel filled with $Pu(NO_3)_2$ solution is fully surrounded with water. The water reflector is effectively infinite. The ^{240}Pu content is about 3 wt %. The critical configurations differ by the diameter of the vessel, the plutonium concentration, and the solution critical height. The k_{eff} experimental uncertainty is at most ±0.0048. Calculated k-effectives from both the MCU system and the KENO-ABBN system are shown in Table 5.3 and presented in Fig. 5.1. Calculated physics parameters (reaction rates) from the MCU system are shown in Tables 5.4–5.18. Balance tables from the KENO-ABBN calculations are shown in Tables 5.19–5.32.

Table 5.3. Multiplication factors for cylindrical, plutonium nitrate critical experiments

Ref. 2 case number	Diameter (in.)	Plutonium concentration (g/L)	H/^{239}Pu	k_{eff}, MCU	KENO-V.a (ABBN-90)
9-1	9	99.09	266.9	1.0137(13)	1.01269 ± 0.00092
9-2	9	73.92	356.9	1.0096(13)	1.00684 ± 0.00088
9-3	9	54.53	484.2	1.0055(13)	1.00258 ± 0.00087
11-1	11	54.43	485.0	1.0106(11)	1.00740 ± 0.00090
11-2	11	47.21	558.1	1.0080(9)	1.00652 ± 0.00086
11-3	11	47.21	558.1	1.0079(13)	1.00476 ± 0.00087
11-4	11	41.73	605.9	1.0001(9)	0.99752 ± 0.00084
11-5	11	36.90	665.4	1.0027(9)	0.99997 ± 0.00084
11-6	11	63.99	414.3	1.0121(9)	1.00977 ± 0.00088
11-7	11	48.98	535.2	0.9985(13)	0.99890 ± 0.00088
12-1	12	48.75	543.4	1.0078(11)	1.00564 ± 0.00088
12-2	12	42.29	618.3	1.0070(8)	1.00524 ± 0.00084
12-3	12	36.52	728.1	1.0132(9)	1.01100 ± 0.00082
12-4	12	31.14	849.7	1.0086(13)	1.00731 ± 0.00081
Averaged				1.0075	

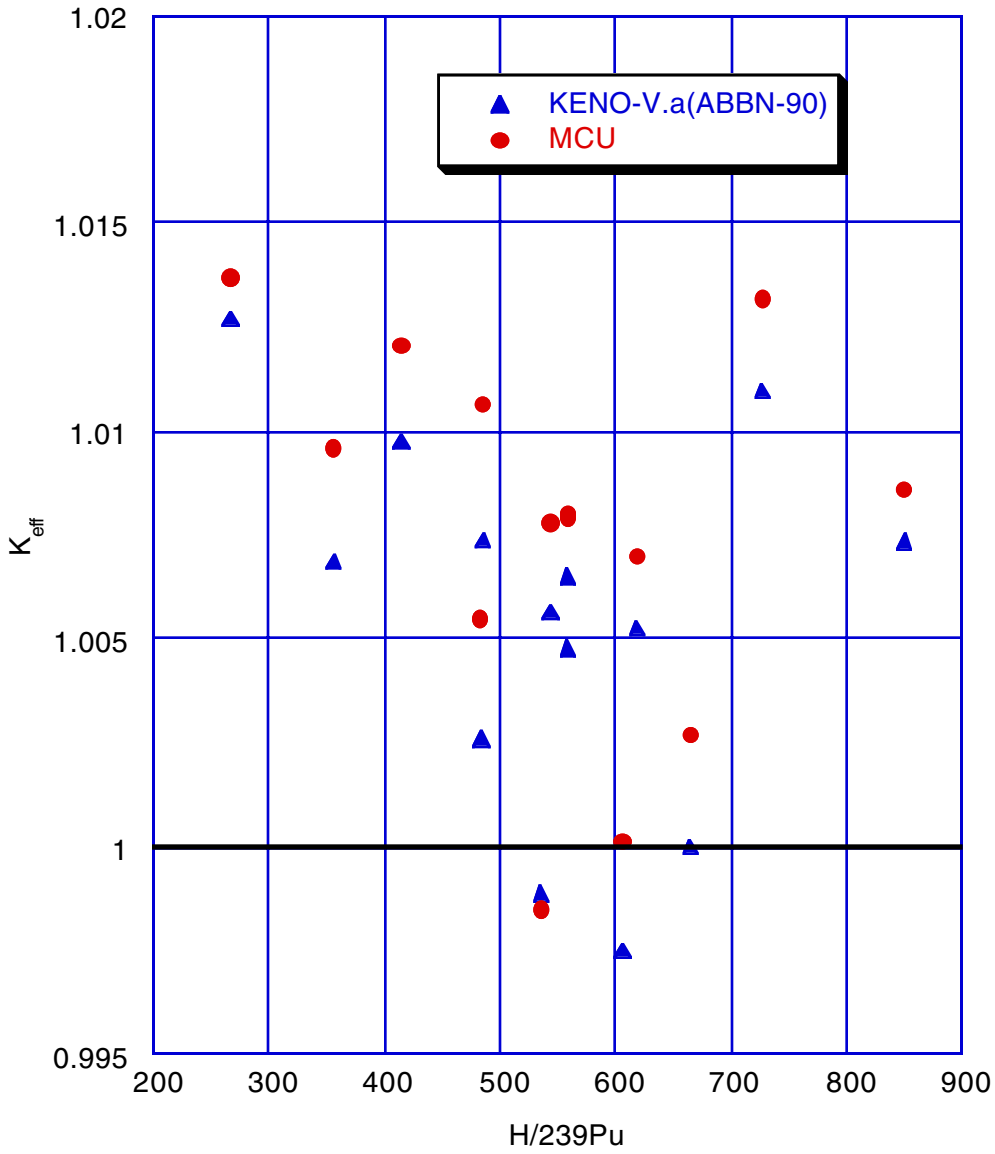

Fig. 5.1. K-effective for plutonium nitrate solutions.

Table 5.4. Reaction rates for PU-SOL-THERM-010, Case 9-1

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4088E+0		
N	0.4624E–2		
O	0.4596E–2		
Cr	0.6242E–2		
Fe	0.1803E–1		
Ni	0.5162E–2		
^{239}Pu	0.5276E+0	0.1013E+1	0.3536E+0
^{240}Pu	0.2075E–1	0.2173E–3	0.6778E–4

Table 5.5. Reaction rates for PU-SOL-THERM-010, Case 9-2

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4150E+0		
N	0.5502E–2		
O	0.4619E–2		
Cr	0.6537E–2		
Fe	0.1889E–1		
Ni	0.5397E–2		
^{239}Pu	0.5225E+0	0.1010E+1	0.3525E+0
^{240}Pu	0.1803E–1	0.1674E–3	0.5224E–4

Table 5.6. Reaction rates for PU-SOL-THERM-010, Case 9-3

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4230E+0		
N	0.6938E–2		
O	0.4612E–2		
Cr	0.6632E–2		
Fe	0.1916E–1		
Ni	0.5462E–2		
^{239}Pu	0.5169E+0	0.1006E+1	0.3510E+0
^{240}Pu	0.1524E–1	0.1276E–3	0.3987E–4

Table 5.7. Reaction rates for PU-SOL-THERM-010, Case 11-1

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3988E+0		
N	0.6980E–2		
O	0.4577E–2		
Cr	0.1073E–1		
Fe	0.3097E–1		
Ni	0.8854E–2		
^{239}Pu	0.5194E+0	0.1010E+1	0.3524E+0
^{240}Pu	0.1567E–1	0.1301E–3	0.4064E–4

Table 5.8. Reaction rates for PU-SOL-THERM-010, Case 11-2

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4004E+0		
N	0.7795E–2		
O	0.4552E–2		
Cr	0.1101E–1		
Fe	0.3176E–1		
Ni	0.9070E–2		
^{239}Pu	0.5168E+0	0.1008E+1	0.3518E+0
^{240}Pu	0.1450E–1	0.1154E–3	0.3608E–4

Table 5.9. Reaction rates for PU-SOL-THERM-010, Case 11-3

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4171E+0		
N	0.7809E–2		
O	0.4577E–2		
Cr	0.7728E–2		
Fe	0.2232E–1		
Ni	0.6356E–2		
^{239}Pu	0.5168E+0	0.1009E+1	0.3520E+0
^{240}Pu	0.1437E–1	0.1138E–3	0.3558E–4

Table 5.10. Reaction rates for PU-SOL-THERM-010, Case 11-4

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4143E+0		
N	0.1604E–1		
O	0.4765E–2		
Cr	0.7488E–2		
Fe	0.2163E–1		
Ni	0.6159E–2		
^{239}Pu	0.5119E+0	0.1001E+1	0.3492E+0
^{240}Pu	0.1377E–1	0.1056E–3	0.3302E–4

Table 5.11. Reaction rates for PU-SOL-THERM-010, Case 11-5

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4074E+0		
N	0.2524E–1		
O	0.4872E–2		
Cr	0.7019E–2		
Fe	0.2027E–1		
Ni	0.5771E–2		
^{239}Pu	0.5113E+0	0.1001E+1	0.3493E+0
^{240}Pu	0.1332E–1	0.9818E–4	0.3073E–4

Table 5.12. Reaction rates for PU-SOL-THERM-010, Case 11-6

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4106E+0		
N	0.6075E–2		
O	0.4584E–2		
Cr	0.7613E–2		
Fe	0.2199E–1		
Ni	0.6271E–2		
^{239}Pu	0.5223E+0	0.1013E+1	0.3535E+0
^{240}Pu	0.1691E–1	0.1493E–3	0.4664E–4

Table 5.13. Reaction rates for PU-SOL-THERM-010, Case 11-7

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4181E+0		
N	0.8865E–2		
O	0.4595E–2		
Cr	0.7877E–2		
Fe	0.2277E–1		
Ni	0.6483E–2		
^{239}Pu	0.5121E+0	0.9989E+0	0.3485E+0
^{240}Pu	0.1471E–1	0.1189E–3	0.3719E–4

Table 5.14. Reaction rates for PU-SOL-THERM-010, Case 11-8

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4181E+0		
N	0.8865E–2		
O	0.4595E–2		
Cr	0.7877E–2		
Fe	0.2277E–1		
Ni	0.6483E–2		
^{239}Pu	0.5121E+0	0.9989E+0	0.3485E+0
^{240}Pu	0.1471E–1	0.1189E–3	0.3719E–4

Table 5.15. Reaction rates for PU-SOL-THERM-010, Case 12-1

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4135E+0		
N	0.7532E–2		
O	0.4607E–2		
Cr	0.8160E–2		
Fe	0.2357E–1		
Ni	0.6711E–2		
^{239}Pu	0.5175E+0	0.1010E+1	0.3523E+0
^{240}Pu	0.1467E–1	0.1184E–3	0.3701E–4

Table 5.16. Reaction rates for PU-SOL-THERM-010, Case 12-2

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4135E+0		
N	0.7532E–2		
O	0.4607E–2		
Cr	0.8160E–2		
Fe	0.2357E–1		
Ni	0.6711E–2		
^{239}Pu	0.5175E+0	0.1010E+1	0.3523E+0
^{240}Pu	0.1467E–1	0.1184E–3	0.3701E–4

Table 5.17. Reaction rates for PU-SOL-THERM-010, Case 12-3

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4154E+0		
N	0.9224E–2		
O	0.4570E–2		
Cr	0.7868E–2		
Fe	0.2272E–1		
Ni	0.6464E–2		
^{239}Pu	0.5160E+0	0.1013E+1	0.3533E+0
^{240}Pu	0.1295E–1	0.9334E–4	0.2920E–4

Table 5.18. Reaction rates for PU-SOL-THERM-010, Case 12-4

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4192E+0		
N	0.1145E–1		
O	0.4593E–2		
Cr	0.7726E–2		
Fe	0.2233E–1		
Ni	0.6345E–2		
^{239}Pu	0.5128E+0	0.1009E+1	0.3520E+0
^{240}Pu	0.1207E–1	0.8231E–4	0.2577E–4

Table 5.19. Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 9-1

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	171.5442	353.2767	0.0068	1012.6600	50.1784	103.3370	0.0020	2.8665	171.5442	353.2767	0.0068	1012.6600
^{240}Pu	21.0571	0.0662	0.0001	0.2100	210.8401	0.6627	0.0011	3.1735	21.0571	0.0662	0.0001	0.2100
N	4.6926	0.0000	0.0000	0.0000	0.2511	0.0000	0.0000	0.0000	4.6926	0.0000	0.0000	0.0000
H + H (H_2O)	31.7217	0.0000	0.0000	0.0000	0.0348	0.0000	0.0000	0.0000	411.3321	0.0000	0.0000	0.0000
O	2.8478	0.0000	0.0000	0.0000	0.0056	0.0000	0.0000	0.0000	4.7605	0.0000	0.0000	0.0000
Fe	0.0164	0.0000	0.0000	0.0000	0.2848	0.0000	0.0001	0.0000	18.5665	0.0000	0.0011	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.3311	0.0000	0.0001	0.0000	6.0289	0.0000	0.0004	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.4997	0.0000	0.0000	0.0000	5.1186	0.0000	0.0001	0.0000
Total	231.8798	353.3429	0.0069	1012.8701					643.1005	353.3429	0.0084	1012.8701

[a]Energy region: from 1 to 299 groups.
Volume = 1.25959E+04.
Flux = 9.32731E+13.
[b]k_{eff} = 1.0126899.
Leakage = 3.743.

Table 5.20. Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 9-2

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	166.5925	350.9925	0.0052	1006.2150	60.9512	128.4177	0.0019	2.8668	166.5925	350.9925	0.0052	1006.2150
^{240}Pu	17.9716	0.0511	0.0001	0.1621	225.0774	0.6403	0.0010	3.1708	17.9716	0.0511	0.0001	0.1621
N	5.5976	0.0000	0.0000	0.0000	0.3037	0.0000	0.0000	0.0000	5.5976	0.0000	0.0000	0.0000
H + H (H_2O)	43.2484	0.0000	0.0000	0.0000	0.0443	0.0000	0.0000	0.0000	418.5493	0.0000	0.0000	0.0000
O	2.9025	0.0000	0.0000	0.0000	0.0054	0.0000	0.0000	0.0000	4.7751	0.0000	0.0000	0.0000
Fe	0.0135	0.0000	0.0000	0.0000	0.3600	0.0000	0.0000	0.0000	19.4176	0.0000	0.0009	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.4198	0.0000	0.0001	0.0000	6.3074	0.0000	0.0003	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.6232	0.0000	0.0000	0.0000	5.3455	0.0000	0.0001	0.0000
Total	236.3263	351.0436	0.0053	1006.3771					644.5566	351.0436	0.0066	1006.3771

[a]Energy region: from 1 to 299 groups.
Volume = 1.45233E+04.
Flux = 8.72180E+13.
[b]k_{eff} = 1.0068400.
Leakage = 3.947.

Table 5.21. Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 9-3

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	162.0835	349.6418	0.0040	1002.4983	73.8750	159.3609	0.0018	2.8672	162.0835	349.6418	0.0040	1002.4983
^{240}Pu	15.4283	0.0391	0.0001	0.1239	240.6996	0.6103	0.0010	3.1678	15.4283	0.0391	0.0001	0.1239
N	7.0950	0.0000	0.0000	0.0000	0.3709	0.0000	0.0000	0.0000	7.0950	0.0000	0.0000	0.0000
H + H (H_2O)	60.0871	0.0000	0.0000	0.0000	0.0566	0.0000	0.0000	0.0000	424.7391	0.0000	0.0000	0.0000
O	2.9855	0.0000	0.0000	0.0000	0.0051	0.0000	0.0000	0.0000	4.7997	0.0000	0.0000	0.0000
Fe	0.0208	0.0000	0.0000	0.0000	0.4562	0.0000	0.0001	0.0000	20.0822	0.0000	0.0010	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.5332	0.0000	0.0001	0.0000	6.5215	0.0000	0.0003	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.7813	0.0000	0.0000	0.0000	5.5176	0.0000	0.0001	0.0000
Total	247.7003	349.6809	0.0041	1002.6222					646.2671	349.6809	0.0055	1002.6222

[a]Energy region: from 1 to 299 groups.
Volume = 1.82843E+04.
Flux = 7.56523E+13.
[b]k_{eff} = 1.0025800.
Leakage = 4.100.

Table 5.22. Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 11-1

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	163.2749	351.2445	0.0040	1007.0620	73.1438	157.3503	0.0018	2.8671	163.2749	351.2445	0.0040	1007.0620
^{240}Pu	15.7659	0.0399	0.0001	0.1263	241.7662	0.6112	0.0010	3.1673	15.7659	0.0399	0.0001	0.1263
N	7.1430	0.0000	0.0000	0.0000	0.3657	0.0000	0.0000	0.0000	7.1430	0.0000	0.0000	0.0000
H + H (H_2O)	60.2587	0.0000	0.0000	0.0000	0.0557	0.0000	0.0000	0.0000	401.6055	0.0000	0.0000	0.0000
O	3.0414	0.0000	0.0000	0.0000	0.0051	0.0000	0.0000	0.0000	4.7539	0.0000	0.0000	0.0000
Fe	0.0209	0.0000	0.0000	0.0000	0.4491	0.0000	0.0000	0.0000	32.3429	0.0000	0.0017	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.5248	0.0000	0.0001	0.0000	10.5079	0.0000	0.0006	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.7694	0.0000	0.0000	0.0000	8.8934	0.0000	0.0001	0.0000
Total	249.5048	351.2844	0.0041	1007.1882					644.2874	351.2844	0.0065	1007.1882

[a]Energy region: from 1 to 299 groups.
Volume = 1.56941E+04.
Flux = 8.94666E+13.
[b]k_{eff} = 1.0074000.
Leakage = 4.224.

Table 5.23. Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 11-2

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	161.4716	350.8265	0.0036	1005.9396	79.4186	172.5513	0.0018	2.8673	161.4716	350.8265	0.0036	1005.9396
^{240}Pu	14.6501	0.0354	0.0001	0.1120	246.6523	0.5955	0.0009	3.1655	14.6501	0.0354	0.0001	0.1120
N	7.9821	0.0000	0.0000	0.0000	0.3992	0.0000	0.0000	0.0000	7.9821	0.0000	0.0000	0.0000
H + H (H_2O)	70.0782	0.0000	0.0000	0.0000	0.0618	0.0000	0.0000	0.0000	403.2935	0.0000	0.0000	0.0000
O	3.0725	0.0000	0.0000	0.0000	0.0049	0.0000	0.0000	0.0000	4.7351	0.0000	0.0000	0.0000
Fe	0.0259	0.0000	0.0000	0.0000	0.4970	0.0000	0.0000	0.0000	32.6714	0.0000	0.0016	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.5814	0.0000	0.0001	0.0000	10.6143	0.0000	0.0006	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.8482	0.0000	0.0000	0.0000	8.9768	0.0000	0.0001	0.0000
Total	257.2804	350.8619	0.0036	1006.0515					644.3950	350.8619	0.0059	1006.0515

[a]Energy region: from 1 to 299 groups.
Volume = 1.72667E+04.
Flux = 8.54892E+13.
[b]k_{eff} = 1.0065200.
Leakage = 4.284.

Table 5.24. Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 11-3

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	160.8505	350.3450	0.0036	1004.5887	80.2310	174.7493	0.0018	2.8674	160.8505	350.3450	0.0036	1004.5887
^{240}Pu	14.4205	0.0348	0.0001	0.1103	246.2180	0.5946	0.0009	3.1662	14.4205	0.0348	0.0001	0.1103
N	7.9826	0.0000	0.0000	0.0000	0.4049	0.0000	0.0000	0.0000	7.9826	0.0000	0.0000	0.0000
H + H (H_2O)	70.2027	0.0000	0.0000	0.0000	0.0627	0.0000	0.0000	0.0000	419.4590	0.0000	0.0000	0.0000
O	3.0556	0.0000	0.0000	0.0000	0.0050	0.0000	0.0000	0.0000	4.8009	0.0000	0.0000	0.0000
Fe	0.0260	0.0000	0.0000	0.0000	0.5048	0.0000	0.0000	0.0000	23.3268	0.0000	0.0010	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.5906	0.0000	0.0001	0.0000	7.5753	0.0000	0.0003	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.8612	0.0000	0.0000	0.0000	6.3946	0.0000	0.0001	0.0000
Total	256.5380	350.3798	0.0036	1004.6990					644.8103	350.3798	0.0051	1004.6990

[a]Energy region: from 1 to 299 groups.
Volume = 1.65972E+04.
Flux = 8.78085E+13.
[b]k_{eff} = 1.0047600.
Leakage = 4.754.

Table 5.25 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 11-4

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	158.8356	347.9718	0.0033	997.8308	83.8263	183.6439	0.0017	2.8676	158.8356	347.9718	0.0033	997.8308
^{240}Pu	13.8068	0.0324	0.0001	0.1024	249.4326	0.5845	0.0009	3.1645	13.8068	0.0324	0.0001	0.1024
N	16.4454	0.0000	0.0000	0.0000	0.4245	0.0000	0.0000	0.0000	16.4454	0.0000	0.0000	0.0000
H + H (H_2O)	76.1726	0.0000	0.0000	0.0000	0.0664	0.0000	0.0000	0.0000	417.9725	0.0000	0.0000	0.0000
O	3.2939	0.0000	0.0000	0.0000	0.0049	0.0000	0.0000	0.0000	5.0149	0.0000	0.0000	0.0000
Fe	0.0272	0.0000	0.0000	0.0000	0.5332	0.0000	0.0000	0.0000	22.5530	0.0000	0.0009	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.6241	0.0000	0.0001	0.0000	7.3228	0.0000	0.0003	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.9077	0.0000	0.0000	0.0000	6.1805	0.0000	0.0000	0.0000
Total	268.5815	348.0042	0.0033	997.9332					648.1315	348.0042	0.0046	997.9332

[a]Energy region: from 1 to 299 groups.
Volume = 2.00069E+04.
Flux = 7.83603E+13.
[b]k_{eff} = 0.9975180.
Leakage = 4.285.

Table 5.26. Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 11-5

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	158.2371	348.7899	0.0030	1000.2292	87.8549	193.6519	0.0017	2.8677	158.2371	348.7899	0.0030	1000.2292
^{240}Pu	13.3713	0.0301	0.0000	0.0953	254.1257	0.5727	0.0009	3.1620	13.3713	0.0301	0.0000	0.0953
N	25.9637	0.0000	0.0000	0.0000	0.4468	0.0000	0.0000	0.0000	25.9637	0.0000	0.0000	0.0000
H + H (H_2O)	84.4448	0.0000	0.0000	0.0000	0.0705	0.0000	0.0000	0.0000	410.6679	0.0000	0.0000	0.0000
O	3.5224	0.0000	0.0000	0.0000	0.0047	0.0000	0.0000	0.0000	5.1426	0.0000	0.0000	0.0000
Fe	0.0320	0.0000	0.0000	0.0000	0.5656	0.0000	0.0000	0.0000	21.0361	0.0000	0.0007	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.6624	0.0000	0.0001	0.0000	6.8294	0.0000	0.0003	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.9607	0.0000	0.0000	0.0000	5.7631	0.0000	0.0000	0.0000
Total	285.5712	348.8200	0.0031	1000.3245					647.0112	348.8200	0.0040	1000.3245

[a]Energy region: from 1 to 299 groups.
Volume = 2.63593E+04.
Flux = 6.38020E+13.
[b]k_{eff} = 0.9999750.
Leakage = 4.522.

Table 5.27 Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 11-6

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	165.2644	352.2131	0.0046	1009.7846	67.0852	142.9727	0.0019	2.8670	165.2644	352.2131	0.0046	1009.7846
^{240}Pu	17.1020	0.0458	0.0001	0.1452	233.4239	0.6253	0.0010	3.1695	17.1020	0.0458	0.0001	0.1452
N	6.2007	0.0000	0.0000	0.0000	0.3350	0.0000	0.0000	0.0000	6.2007	0.0000	0.0000	0.0000
H + H (H_2O)	51.0622	0.0000	0.0000	0.0000	0.0500	0.0000	0.0000	0.0000	413.3287	0.0000	0.0000	0.0000
O	2.9599	0.0000	0.0000	0.0000	0.0053	0.0000	0.0000	0.0000	4.7969	0.0000	0.0000	0.0000
Fe	0.0205	0.0000	0.0000	0.0000	0.4048	0.0000	0.0000	0.0000	22.8408	0.0000	0.0008	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.4726	0.0000	0.0001	0.0000	7.4188	0.0000	0.0003	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.6969	0.0000	0.0000	0.0000	6.2726	0.0000	0.0000	0.0000
Total	242.6097	352.2589	0.0047	1009.9298					643.2249	352.2589	0.0059	1009.9298

[a]Energy region: from 1 to 299 groups.
Volume = 1.39815E+04.
Flux = 9.40819E+13.
[b]k_{eff} = 1.0097700.
Leakage = 4.680.

Table 5.28. Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 11-7

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	160.4158	348.2868	0.0036	998.6587	78.2632	169.9213	0.0018	2.8673	160.4158	348.2868	0.0036	998.6587
^{240}Pu	14.8897	0.0365	0.0001	0.1155	244.2523	0.5985	0.0009	3.1662	14.8897	0.0365	0.0001	0.1155
N	9.0957	0.0000	0.0000	0.0000	0.3938	0.0000	0.0000	0.0000	9.0957	0.0000	0.0000	0.0000
H + H (H_2O)	66.6674	0.0000	0.0000	0.0000	0.0608	0.0000	0.0000	0.0000	420.2743	0.0000	0.0000	0.0000
O	3.0589	0.0000	0.0000	0.0000	0.0050	0.0000	0.0000	0.0000	4.8277	0.0000	0.0000	0.0000
Fe	0.0215	0.0000	0.0000	0.0000	0.4893	0.0000	0.0000	0.0000	23.5213	0.0000	0.0009	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.5723	0.0000	0.0001	0.0000	7.6408	0.0000	0.0003	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.8355	0.0000	0.0000	0.0000	6.4509	0.0000	0.0000	0.0000
Total	254.1490	348.3233	0.0037	998.7742					647.1161	348.3233	0.0049	998.7742

[a]Energy region: from 1 to 299 groups.
Volume = 1.59121E+04.
Flux = 9.07816E+13.
[b]k_{eff} = 0.9988990.
Leakage = 4.441.

Table 5.29. Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 12-1

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	161.2753	350.6272	0.0037	1005.3822	79.0459	171.8530	0.0018	2.8674	161.2753	350.6272	0.0037	1005.3822
^{240}Pu	14.8378	0.0363	0.0001	0.1148	244.5266	0.5977	0.0010	3.1666	14.8378	0.0363	0.0001	0.1148
N	7.6977	0.0000	0.0000	0.0000	0.3983	0.0000	0.0000	0.0000	7.6977	0.0000	0.0000	0.0000
H + H (H_2O)	68.2558	0.0000	0.0000	0.0000	0.0616	0.0000	0.0000	0.0000	416.9823	0.0000	0.0000	0.0000
O	3.0326	0.0000	0.0000	0.0000	0.0050	0.0000	0.0000	0.0000	4.7846	0.0000	0.0000	0.0000
Fe	0.0204	0.0000	0.0000	0.0000	0.4956	0.0000	0.0000	0.0000	24.3090	0.0000	0.0011	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.5797	0.0000	0.0001	0.0000	7.8962	0.0000	0.0004	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.8460	0.0000	0.0000	0.0000	6.6656	0.0000	0.0001	0.0000
Total	255.1196	350.6635	0.0037	1005.4971					644.4484	350.6635	0.0052	1005.4971

[a]Energy region: from 1 to 299 groups.
Volume = 1.63072E+04.
Flux = 8.80559E+13.
[b]k_{eff} = 1.0056400.
Leakage = 4.751.

Table 5.30. Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 12-2

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	159.8512	350.6451	0.0032	1005.5064	84.9907	186.4333	0.0017	2.8676	159.8512	350.6451	0.0032	1005.5064
^{240}Pu	13.9469	0.0325	0.0001	0.1030	249.3396	0.5817	0.0009	3.1644	13.9469	0.0325	0.0001	0.1030
N	9.6327	0.0000	0.0000	0.0000	0.4309	0.0000	0.0000	0.0000	9.6327	0.0000	0.0000	0.0000
H + H (H_2O)	78.5088	0.0000	0.0000	0.0000	0.0675	0.0000	0.0000	0.0000	417.9081	0.0000	0.0000	0.0000
O	3.1126	0.0000	0.0000	0.0000	0.0049	0.0000	0.0000	0.0000	4.8111	0.0000	0.0000	0.0000
Fe	0.0185	0.0000	0.0000	0.0000	0.5423	0.0000	0.0000	0.0000	24.0549	0.0000	0.0009	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.6348	0.0000	0.0001	0.0000	7.8144	0.0000	0.0003	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.9226	0.0000	0.0000	0.0000	6.5921	0.0000	0.0001	0.0000
Total	265.0707	350.6776	0.0033	1005.6094					644.6113	350.6776	0.0046	1005.6094

[a]Energy region: from 1 to 299 groups.
Volume = 1.84197E+04.
Flux = 8.28353E+13.
[b]k_{eff} = 1.0052400.
Leakage = 5.083.

Table 5.31. Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 12-3

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	158.9582	352.5169	0.0029	1010.9733	92.7646	205.7215	0.0017	2.8679	158.9582	352.5169	0.0029	1010.9733
^{240}Pu	13.0024	0.0287	0.0000	0.0907	255.1266	0.5626	0.0009	3.1630	13.0024	0.0287	0.0000	0.0907
N	9.4745	0.0000	0.0000	0.0000	0.4748	0.0000	0.0000	0.0000	9.4745	0.0000	0.0000	0.0000
H + H (H_2O)	94.1608	0.0000	0.0000	0.0000	0.0755	0.0000	0.0000	0.0000	418.6645	0.0000	0.0000	0.0000
O	3.1808	0.0000	0.0000	0.0000	0.0047	0.0000	0.0000	0.0000	4.8048	0.0000	0.0000	0.0000
Fe	0.0201	0.0000	0.0000	0.0000	0.6050	0.0000	0.0000	0.0000	23.6602	0.0000	0.0010	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.7087	0.0000	0.0001	0.0000	7.6857	0.0000	0.0003	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	1.0258	0.0000	0.0000	0.0000	6.4784	0.0000	0.0000	0.0000
Total	278.7968	352.5456	0.0029	1011.0640					642.7288	352.5456	0.0043	1011.0640

[a]Energy region: from 1 to 299 groups.
Volume = 2.07731E+04.
Flux = 7.71232E+13.
[b]k_{eff} = 1.0110000.
Leakage = 4.793.

Table 5.32. Balance table for KENO-derived parameters for PU-SOL-THERM-010, Case 12-4

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	156.7532	351.1338	0.0025	1007.1027	100.2651	224.5981	0.0016	2.8681	156.7532	351.1338	0.0025	1007.1027
^{240}Pu	12.1059	0.0253	0.0000	0.0799	260.3524	0.5434	0.0009	3.1607	12.1059	0.0253	0.0000	0.0799
N	11.7797	0.0000	0.0000	0.0000	0.5184	0.0000	0.0000	0.0000	11.7797	0.0000	0.0000	0.0000
H + H (H_2O)	110.7677	0.0000	0.0000	0.0000	0.0834	0.0000	0.0000	0.0000	421.9539	0.0000	0.0000	0.0000
O	3.2741	0.0000	0.0000	0.0000	0.0045	0.0000	0.0000	0.0000	4.8190	0.0000	0.0000	0.0000
Fe	0.0226	0.0000	0.0000	0.0000	0.6672	0.0000	0.0000	0.0000	23.1785	0.0000	0.0007	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.7822	0.0000	0.0001	0.0000	7.5278	0.0000	0.0003	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	1.1281	0.0000	0.0000	0.0000	6.3418	0.0000	0.0000	0.0000
Total	294.7033	351.1590	0.0026	1007.1826					644.4598	351.1590	0.0036	1007.1826

[a]Energy region: from 1 to 299 groups.
Volume = 2.43867E+04.
Flux = 7.05422E+13.
[b]k_{eff} = 1.0073100.
Leakage = 4.258.

5.4 HOMOGENOUS PuO_2-POLYSTYRENE AT LOW HYDROGEN CONTENT

The cores were rectangular parallelepipeds composed of PuO_2-polystyrene (Ref. 2). The hydrogen-to-plutonium (H/Pu) atomic ratio was equal to 5. The isotopic composition of plutonium was 11.5 wt % ^{240}Pu. A 15.25-cm-thick Plexiglas reflector was placed on each face of the core. Cases differ by dimensions of the core. Calculated and experimental multiplication factors are given in Table 5.33. Calculated values are shown in Fig. 5.2. Tables 5.34–5.37 contain reaction rate parameters calculated with the MCU computer program. Tables 5.39–5.41 contain weighted cross section data derived from the KENO-ABBN calculations.

Table 5.33. Multiplication factors for low moderation PuO_2 experiments

Case	Plutonium (kg)	Experiment	k_{eff} MCU	k_{eff} KENO-V.a (ABBN-90)
CS3-1	27.66	1.0000 ± 0.0006	0.9917(15)	0.99710 ± 0.00080
CS3-2	30.94	1.0000 ± 0.0015	0.9905(10)	0.99484 ± 0.00080
CS3-3	41.20	1.0000 ± 0.0009	0.9801(10)	0.99619 ± 0.00082
CS3-4	54.78	1.0000 ± 0.0008	0.9901(14)	0.99664 ± 0.00082
Averaged			0.9885	

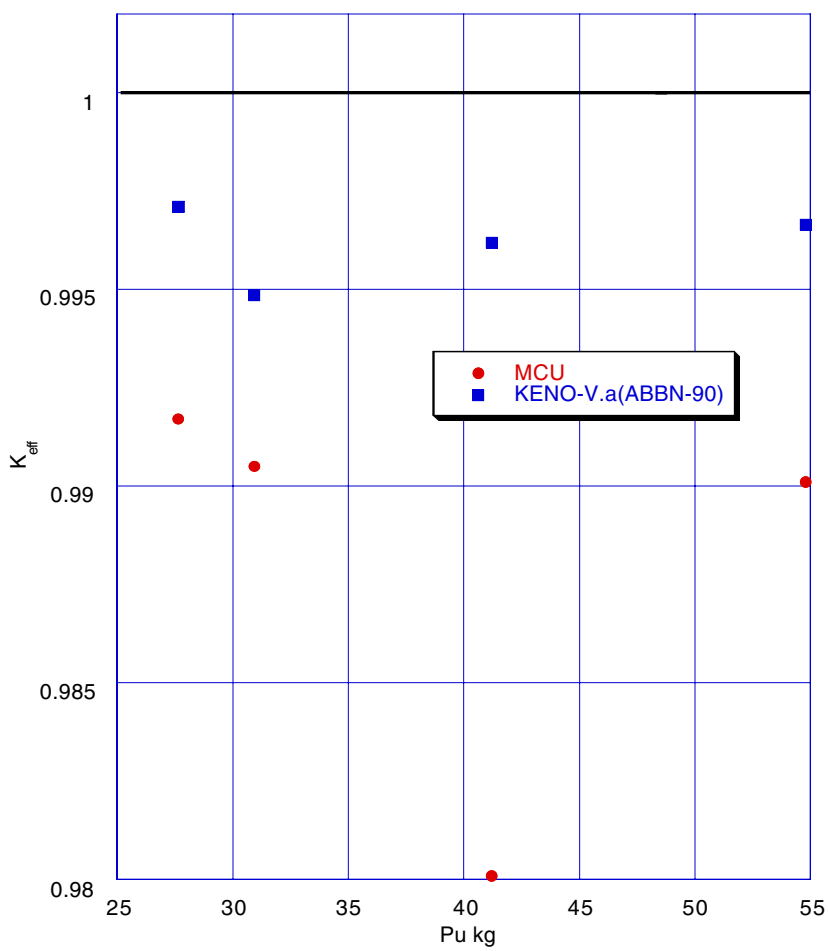

Fig. 5.2. K-effective vs critical mass for plutonium oxide powder experiments.

Table 5.34. Reaction rates for Case CS3-1

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3811E+0		
C	0.3041E–2		
O	0.2264E–2		
^{239}Pu	0.4468E+0	0.9210E+0	0.3144E+0
^{240}Pu	0.5910E–1	0.2157E–1	0.6673E–2
^{241}Pu	0.2152E–1	0.4903E–1	0.1654E–1
^{242}Pu	0.1326E–2	0.2378E–3	0.7492E–4
Leakage	0.0854		

Table 5.35. Reaction rates for Case CS3-2

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3828E+0		
C	0.3047E–2		
O	0.2274E–2		
^{239}Pu	0.4466E+0	0.9198E+0	0.3140E+0
^{240}Pu	0.5878E–1	0.2138E–1	0.6612E–2
^{241}Pu	0.2140E–1	0.4871E–1	0.1643E–1
^{242}Pu	0.1319E–2	0.2358E–3	0.7428E–4
Leakage	0.08421		

Table 5.36. Reaction rates for Case CS3-3

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3840E+0		
C	0.3057E–2		
O	0.2267E–2		
^{239}Pu	0.4465E+0	0.9185E+0	0.3137E+0
^{240}Pu	0.5813E–1	0.2083E–1	0.6441E–2
^{241}Pu	0.2127E–1	0.4844E–1	0.1634E–1
^{242}Pu	0.1295E–2	0.2298E–3	0.7237E–4
Leakage	0.08236		

Table 5.37. Reaction rates for Case CS3-4

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3852E+0		
C	0.3069E–2		
O	0.2267E–2		
^{239}Pu	0.4485E+0	0.9219E+0	0.3151E+0
^{240}Pu	0.5811E–1	0.2033E–1	0.6288E–2
^{241}Pu	0.2121E–1	0.4828E–1	0.1629E–1
^{242}Pu	0.1289E–2	0.2244E–3	0.7066E–4
Leakage	0.08001		

Table 5.38. KENO-ABBN balance table for CS3-1

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	140.6749	316.0042	0.1400	926.9898	2.3474	5.2730	0.0023	2.9335	140.6749	316.0042	0.1400	926.9898
^{240}Pu	50.7425	6.4555	0.0099	20.6197	6.3734	0.8108	0.0012	3.1941	50.7425	6.4555	0.0099	20.6197
^{241}Pu	4.2576	16.7726	0.0079	49.7019	2.5633	10.0979	0.0047	2.9633	4.2576	16.7726	0.0079	49.7019
^{242}Pu	1.2975	0.0806	0.0004	0.2543	10.5202	0.6531	0.0029	3.1565	1.2975	0.0806	0.0004	0.2543
O	0.9413	0.0000	0.0000	0.0000	0.0068	0.0000	0.0000	0.0000	1.9884	0.0000	0.0000	0.0000
C	0.2550	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	2.9604	0.0000	0.0000	0.0000
H + H (CH_2)	0.6384	0.0000	0.0000	0.0000	0.0018	0.0000	0.0000	0.0000	374.5536	0.0000	0.0000	0.0000
Total	198.8071	339.3129	0.1581	997.5657					576.4749	339.3129	0.1581	997.5657

[a]Energy region: from 1 to 299 groups.
Volume = 1.27525E+04.
Flux = 9.18646E+13.
[b]k_{eff} = 0.9970950.
Leakage = 84.843.

Table 5.39. KENO-ABBN balance table for CS3-2

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	140.6079	315.5526	0.1372	925.4215	2.3766	5.3337	0.0023	2.9327	140.6079	315.5526	0.1372	925.4215
^{240}Pu	50.2953	6.3782	0.0097	20.3716	6.4002	0.8116	0.0012	3.1940	50.2953	6.3782	0.0097	20.3716
^{241}Pu	4.2456	16.6815	0.0077	49.4288	2.5899	10.1758	0.0047	2.9631	4.2456	16.6815	0.0077	49.4288
^{242}Pu	1.2815	0.0796	0.0003	0.2512	10.5271	0.6538	0.0028	3.1562	1.2815	0.0796	0.0003	0.2512
O	0.9264	0.0000	0.0000	0.0000	0.0067	0.0000	0.0000	0.0000	1.9824	0.0000	0.0000	0.0000
C	0.2489	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	2.9656	0.0000	0.0000	0.0000
H + H (CH_2)	0.6381	0.0000	0.0000	0.0000	0.0018	0.0000	0.0000	0.0000	375.6223	0.0000	0.0000	0.0000
Total	198.2437	338.6918	0.1549	995.4731					577.0007	338.6918	0.1549	995.4731

[a]Energy region: from 1 to 299 groups.
Volume = 1.42854E+04.
Flux = 8.12131E+13.
[b]k_{eff} = 0.9948380.
Leakage = 85.102.

Table 5.40. KENO-ABBN balance table for CS3-3

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	140.8855	316.4325	0.1364	927.4680	2.4479	5.4981	0.0024	2.9310	140.8855	316.4325	0.1364	927.4680
^{240}Pu	50.7953	6.2265	0.0098	19.8929	6.6447	0.8145	0.0013	3.1949	50.7953	6.2265	0.0098	19.8929
^{241}Pu	4.2610	16.6528	0.0077	49.3352	2.6710	10.4391	0.0048	2.9626	4.2610	16.6528	0.0077	49.3352
^{242}Pu	1.2570	0.0778	0.0003	0.2455	10.6145	0.6566	0.0029	3.1572	1.2570	0.0778	0.0003	0.2455
O	0.9155	0.0000	0.0000	0.0000	0.0068	0.0000	0.0000	0.0000	2.0035	0.0000	0.0000	0.0000
C	0.2416	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	2.9646	0.0000	0.0000	0.0000
H + H (CH_2)	0.6457	0.0000	0.0000	0.0000	0.0019	0.0000	0.0000	0.0000	375.9114	0.0000	0.0000	0.0000
Total	199.0015	339.3896	0.1542	996.9415					578.0782	339.3896	0.1542	996.9415

[a]Energy region: from 1 to 299 groups.
Volume = 1.89686E+04.
Flux = 5.92112E+13.
[b]k_{eff} = 0.9961860.
Leakage = 83.445.

Table 5.41. KENO-ABBN balance table for CS3-4

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	141.5712	317.7511	0.1354	930.8930	2.5102	5.6341	0.0024	2.9296	141.5712	317.7511	0.1354	930.8930
^{240}Pu	51.0265	6.1146	0.0096	19.5399	6.8107	0.8161	0.0013	3.1956	51.0265	6.1146	0.0096	19.5399
^{241}Pu	4.2778	16.6521	0.0076	49.3260	2.7362	10.6511	0.0049	2.9622	4.2778	16.6521	0.0076	49.3260
^{242}Pu	1.2619	0.0764	0.0003	0.2412	10.8729	0.6580	0.0030	3.1580	1.2619	0.0764	0.0003	0.2412
O	0.9051	0.0000	0.0000	0.0000	0.0069	0.0000	0.0000	0.0000	2.0177	0.0000	0.0000	0.0000
C	0.2456	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	2.9909	0.0000	0.0000	0.0000
H + H (CH_2)	0.6537	0.0000	0.0000	0.0000	0.0020	0.0000	0.0000	0.0000	377.7050	0.0000	0.0000	0.0000
Total	199.9416	340.5941	0.1530	999.9999					580.8508	340.5941	0.1530	999.9999

[a]Energy region: from 1 to 299 groups.
Volume = 2.52023E+04.
Flux = 4.34883E+13.
[b]k_{eff} = 0.9966380.
Leakage = 82.082.

5.5 LOW-MODERATED MIXTURES OF PLUTONIUM AND URANIUM OXIDES WITH 8, 15, AND 30 wt % PLUTONIUM

The cores were rectangular parallelepipeds composed of mixtures of PuO_2 and UO_2 with polystyrene (Ref. 2, identified as PU-COMP-INTER-001). The isotopic composition of plutonium was 11.5 wt % ^{240}Pu, and that of uranium was 0.2 wt % ^{235}U. The fuel contained 8, 15, or 30 wt % plutonium. The H/(U + Pu) atomic ratios were equal to 2.8, 2.86, and 7.3. In all cases except two, the assemblies had thick Plexiglas reflectors. The size of the reflector was not described in the benchmark specifications; a 20-cm thickness was assumed for calculation. Multiplication factors for these experiments are provided in Table 5.42 and shown in Fig. 5.3. Calculated reaction rates from the MCU code are provided in Tables 5.43–5.59.

Table 5.42. Multiplication factors for low moderation MOX powder experiments

Case	Pu/(U + Pu) (wt %)	H/(U + Pu)	Reflector	Case	k_{eff} MCU	k_{eff} KENO-V.a (ABBN-90)
1	29.3	2.8	No	1	0.9944(10)	
2	29.3	2.8	No	2	0.9951(12)	
3	29.3	2.8	Yes	1	0.9886(14)	0.9887 ± 0.0007
4	29.3	2.8	Yes	2	0.9917(14)	0.9874 ± 0.0007
5	29.3	2.8	Yes	3	0.9974(11)	0.9966 ± 0.0007
6	29.3	2.8	Yes	4	0.9875(8)	0.9874 ± 0.0007
7	29.3	2.8	Yes	5	0.9912(15)	0.9861 ± 0.0007
8	29.3	2.8	Yes	6	0.9870(11	0.9874 ± 0.0007
9	29.3	2.8	Yes	7	0.9998(16)	0.9856 ± 0.0006
10	29.3	2.8	Yes	8	0.9870(7)	0.9848 ± 0.0007
11	29.3	2.8	Yes	9	0.9931(13)	0.9890 ± 0.0007
12	29.3	2.8	Yes	10	0.9933(14)	
13	15.0	2.86	Yes	1	0.9925(11)	0.9828 ± 0.0006
14	8.1	7.3	Yes	1	1.0080(12)	0.9950 ± 0.0007
15	8.1	7.3	Yes	2	1.0066(9)	0.9930 ± 0.0007
16	8.1	7.3	Yes	3	1.0090(11)	0.9949 ± 0.0007
17	8.1	7.3	Yes	4	1.0045(12)	0.9949 ± 0.0007
Averaged					0.9960	

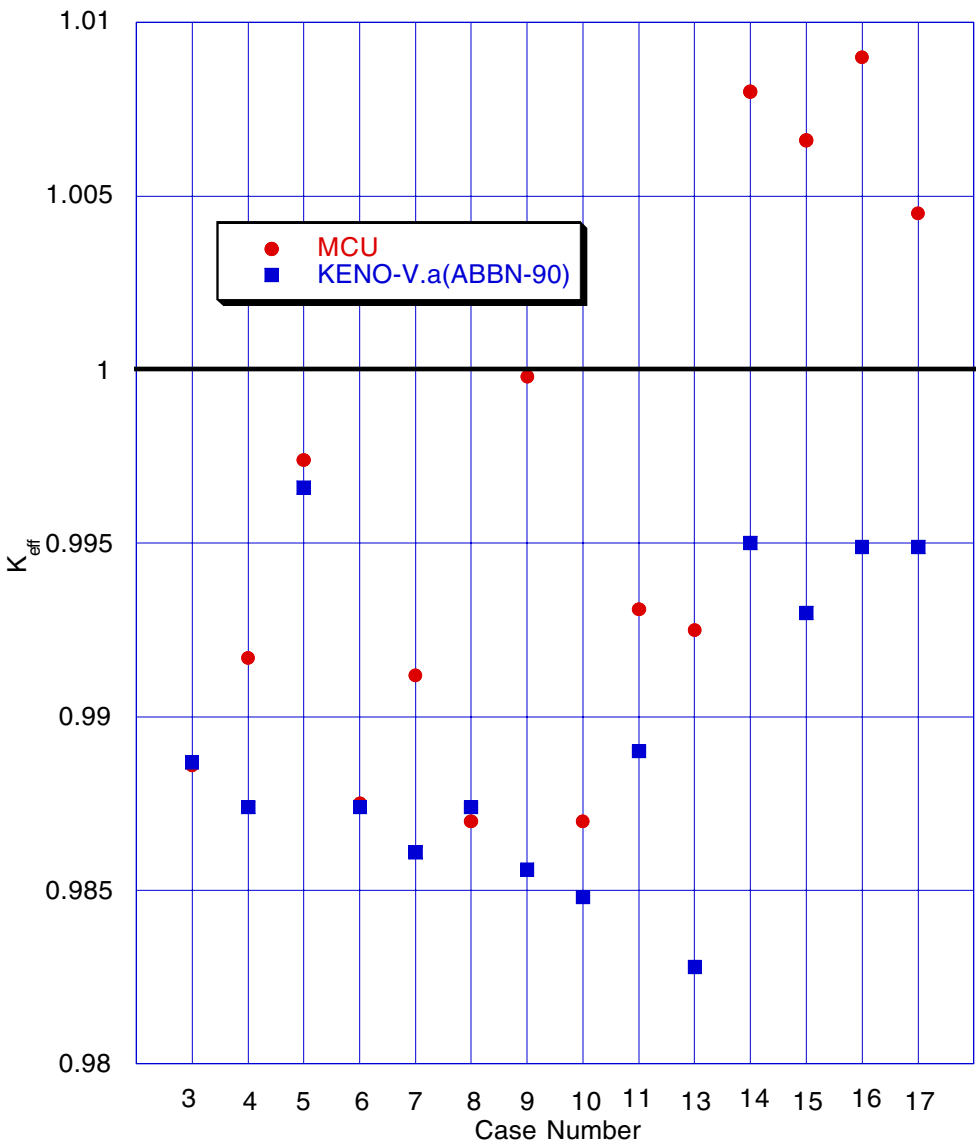

Fig. 5.3. K-effectives for low moderated MOX experiments.

Table 5.43. Reaction rates for Case 1

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.1032E–2		
C	0.4239E–3		
O	0.2787E–2		
^{235}U	0.1905E–2	0.3275E–2	0.1333E–2
^{238}U	0.1329E+0	0.6196E–1	0.2196E–1
^{238}Pu	0.4433E+0	0.8723E+0	0.2989E+0
^{239}Pu	0.7802E–1	0.1739E–1	0.5406E–2
^{240}Pu	0.1665E–1	0.3735E–1	0.1262E–1
^{241}Pu	0.3034E–3	0.2324E–3	0.7352E–4
^{242}Pu	0.1947E–2	0.6749E–3	0.1931E–3
^{241}Am	0.1818E–3	0.2501E–3	0.8126E–4

Table 5.44 Reaction rates for Case 2

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.1031E–2		
C	0.4248E–3		
O	0.2822E–2		
^{235}U	0.1910E–2	0.3286E–2	0.1338E–2
^{238}U	0.1338E+0	0.6224E–1	0.2205E–1
^{238}Pu	0.4442E+0	0.8737E+0	0.2994E+0
^{239}Pu	0.7820E–1	0.1745E–1	0.5423E–2
^{240}Pu	0.1665E–1	0.3739E–1	0.1263E–1
^{241}Pu	0.3042E–3	0.2332E–3	0.7374E–4
^{242}Pu	0.1950E–2	0.6771E–3	0.1937E–3
^{241}Am	0.1821E–3	0.2509E–3	0.8153E–4

Table 5.45. Reaction rates for Case 3

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3229E+0		
C	0.2578E–2		
O	0.2990E–2		
^{235}U	0.1688E–2	0.2977E–2	0.1214E–2
^{238}U	0.1035E+0	0.4729E–1	0.1677E–1
^{238}Pu	0.4531E+0	0.8891E+0	0.3061E+0
^{239}Pu	0.7083E–1	0.1323E–1	0.4114E–2
^{240}Pu	0.1582E–1	0.3521E–1	0.1191E–1
^{241}Pu	0.2280E–3	0.1771E–3	0.5602E–4
^{242}Pu	0.1498E–2	0.5151E–3	0.1474E–3
^{241}Am	1370E–3	1884E–3	0.6117E–4

Table 5.46. Reaction rates for Case 4

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3221E+0		
C	0.2572E–2		
O	0.2992E–2	0.0000E+0	0.0000E+0
^{235}U	0.1694E–2	0.2987E–2	0.1218E–2
^{238}U	0.1035E+0	0.4744E–1	0.1682E–1
^{238}Pu	0.1384E–3	0.1891E–3	0.6139E–4
^{239}Pu	0.4544E+0	0.8921E+0	0.3072E+0
^{240}Pu	0.7053E–1	0.1327E–1	0.4124E–2
^{241}Pu	0.1589E–1	0.3540E–1	0.1197E–1
^{242}Pu	0.2288E–3	0.1776E–3	0.5617E–4
^{241}Am	0.1503E–2	0.5165E–3	0.1478E–3

Table 5.47. Reaction rates for Case 5

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3168E+0	0.0000E+0	0.0000E+0
C	0.2545E–2	0.0000E+0	0.0000E+0
O	0.3006E–2	0.0000E+0	0.0000E+0
^{235}U	0.1703E–2	0.3000E–2	0.1223E–2
^{238}U	0.1042E+0	0.4773E–1	0.1693E–1
^{238}Pu	0.4562E+0	0.8954E+0	0.3083E+0
^{239}Pu	0.7170E–1	0.1334E–1	0.4148E–2
^{240}Pu	0.1592E–1	0.3548E–1	0.1200E–1
^{241}Pu	0.2311E–3	0.1786E–3	0.5648E–4
^{242}Pu	0.1516E–2	0.5195E–3	0.1486E–3
^{241}Am	0.1393E–3	0.1905E–3	0.6186E–4

Table 5.48. Reaction rates for Case 6

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3248E+0		
C	0.2587E–2		
O	0.2969E–2		
^{235}U	0.1677E–2	0.2961E–2	0.1207E–2
^{238}U	0.1025E+0	0.4692E–1	0.1664E–1
^{238}Pu	0.4522E+0	0.8877E+0	0.3057E+0
^{239}Pu	0.7004E–1	0.1311E–1	0.4076E–2
^{240}Pu	0.1574E–1	0.3508E–1	0.1186E–1
^{241}Pu	0.2259E–3	0.1756E–3	0.5555E–4
^{242}Pu	0.1479E–2	0.5107E–3	0.1461E–3
^{241}Am	0.1354E–3	0.1863E–3	0.6050E–4

Table 5.49. Reaction rates for Case 7

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3238E+0		
C	0.2588E–2		
O	0.2983E–2		
^{235}U	0.1687E–2	0.2975E–2	0.1213E–2
^{238}U	0.1023E+0	0.4702E–1	0.1667E–1
^{238}Pu	0.4552E+0	0.8929E+0	0.3075E+0
^{239}Pu	0.7103E–1	0.1314E–1	0.4084E–2
^{240}Pu	0.1582E–1	0.3526E–1	0.1192E–1
^{241}Pu	0.2265E–3	0.1760E–3	0.5565E–4
^{242}Pu	0.1488E–2	0.5118E–3	0.1464E–3
^{241}Am	0.1363E–3	0.1871E–3	0.6076E–4

Table 5.50. Reaction rates for Case 8

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3264E+0		
C	0.2603E–2		
O	0.2977E–2		
^{235}U	0.1675E–2	0.2956E–2	0.1206E–2
^{238}U	0.1015E+0	0.4666E–1	0.1654E–1
^{238}Pu	0.4525E+0	0.8881E+0	0.3058E+0
^{239}Pu	0.6992E–1	0.1304E–1	0.4053E–2
^{240}Pu	0.1572E–1	0.3501E–1	0.1184E–1
^{241}Pu	0.2240E–3	0.1746E–3	0.5521E–4
^{242}Pu	0.1471E–2	0.5077E–3	0.1453E–3
^{241}Am	0.1355E–3	0.1854E–3	0.6020E–4

Table 5.51. Reaction rates for Case 9

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3262E+0		
C	0.2600E–2		
O	0.2978E–2		
^{235}U	0.1671E–2	0.2953E–2	0.1204E–2
^{238}U	0.1012E+0	0.4650E–1	0.1649E–1
^{238}Pu	0.1335E–3	0.1843E–3	0.5984E–4
^{239}Pu	0.4527E+0	0.8890E+0	0.3062E+0
^{240}Pu	0.6984E–1	0.1299E–1	0.4038E–2
^{241}Pu	0.1575E–1	0.3507E–1	0.1186E–1
^{242}Pu	0.2231E–3	0.1740E–3	0.5504E–4
^{241}Am	0.1465E–2	0.5061E–3	0.1448E–3

Table 5.52. Reaction rates for Case 10

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3265E+0		
C	0.2605E–2		
O	0.2982E–2		
^{235}U	0.1668E–2	0.2948E–2	0.1202E–2
^{238}U	0.1010E+0	0.4653E–1	0.1650E–1
^{238}Pu	0.4536E+0	0.8906E+0	0.3067E+0
^{239}Pu	0.6985E–1	0.1299E–1	0.4038E–2
^{240}Pu	0.1573E–1	0.3503E–1	0.1185E–1
^{241}Pu	0.2222E–3	0.1740E–3	0.5504E–4
^{242}Pu	0.1462E–2	0.5061E–3	0.1448E–3
^{241}Am	0.1338E–3	0.1843E–3	0.5981E–4

Table 5.53. Reaction rates for Case 11

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3235E+0		
C	0.2590E–2		
O	0.3001E–2		
^{235}U	0.1678E–2	0.2965E–2	0.1209E–2
^{238}U	0.1016E+0	0.4680E–1	0.1659E–1
^{238}Pu	0.1350E–3	0.1854E–3	0.6020E–4
^{239}Pu	0.4550E+0	0.8935E+0	0.3077E+0
^{240}Pu	0.7037E–1	0.1305E–1	0.4056E–2
^{241}Pu	0.1579E–1	0.3517E–1	0.1190E–1
^{242}Pu	0.2236E–3	0.1749E–3	0.5531E–4
^{241}Am	0.1470E–2	0.5087E–3	0.1455E–3

Table 5.54. Reaction rates for Case 12

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3302E+0		
C	0.2638E–2		
O	0.2990E–2		
^{235}U	0.1646E–2	0.2923E–2	0.1192E–2
^{238}U	0.9714E–1	0.4529E–1	0.1605E–1
^{238}Pu	0.1281E–3	0.1772E–3	0.5750E–4
^{239}Pu	0.4567E+0	0.8975E+0	0.3093E+0
^{240}Pu	0.6934E–1	0.1258E–1	0.3910E–2
^{241}Pu	0.1569E–1	0.3493E–1	0.1181E–1
^{242}Pu	0.2123E–3	0.1688E–3	0.5337E–4
^{241}Am	0.1399E–2	0.4909E–3	0.1404E–3

Table 5.55. Reaction rates for Case 13

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.2336E+0		
C	0.1983E–2		
O	0.2976E–2		
^{235}U	0.4032E–2	0.7133E–2	0.2916E–2
^{238}U	0.1703E+0	0.6649E–1	0.2359E–1
^{238}Pu	0.6032E–4	0.7389E–4	0.2411E–4
^{239}Pu	0.4645E+0	0.8801E+0	0.3049E+0
^{240}Pu	0.8703E–1	0.7861E–2	0.2449E–2
^{241}Pu	0.1262E–1	0.2769E–1	0.9379E–2
^{242}Pu	0.1340E–3	0.8658E–4	0.2741E–4
^{241}Am	0.5896E–2	0.1641E–2	0.4705E–3

Table 5.56 Reaction rates for Case 14

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.2318E+0		
C	0.2098E–2		
O	0.2071E–2		
^{235}U	0.5903E–2	0.1129E–1	0.4630E–2
^{238}U	0.1466E+0	0.3776E–1	0.1337E–1
^{238}Pu	0.4981E+0	0.9309E+0	0.3248E+0
^{239}Pu	0.8379E–1	0.2278E–2	0.7096E–3
^{240}Pu	0.1193E–1	0.2576E–1	0.8740E–2
^{241}Pu	0.6080E–4	0.3692E–4	0.1166E–4
^{242}Pu	0.8144E–3	0.1737E–3	0.4984E–4
^{241}Am	0.3952E–4	0.4408E–4	0.1436E–4

Table 5.57. Reaction rates for Case 15

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.2329E+0		
C	0.2105E–2		
O	0.2055E–2		
^{235}U	0.5903E–2	0.1129E–1	0.4632E–2
^{238}U	0.1467E+0	0.3753E–1	0.1330E–1
^{238}Pu	0.3940E–4	0.4395E–4	0.1432E–4
^{239}Pu	0.4981E+0	0.9310E+0	0.3248E+0
^{240}Pu	0.8359E–1	0.2272E–2	0.7076E–3
^{241}Pu	0.1193E–1	0.2577E–1	0.8744E–2
^{242}Pu	0.6071E–4	0.3681E–4	0.1163E–4
^{241}Am	0.8120E–3	0.1730E–3	0.4967E–4

Table 5.58. Reaction rates for Case 16

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.2347E+0		
C	0.2118E–2		
O	0.2063E–2		
^{235}U	0.5912E–2	0.1131E–1	0.4641E–2
^{238}U	0.1450E+0	0.3757E–1	0.1330E–1
^{238}Pu	0.3925E–4	0.4383E–4	0.1428E–4
^{239}Pu	0.4985E+0	0.9321E+0	0.3252E+0
^{240}Pu	0.8318E–1	0.2268E–2	0.7063E–3
^{241}Pu	0.1195E–1	0.2582E–1	0.8759E–2
^{242}Pu	0.6038E–4	0.3677E–4	0.1161E–4
^{241}Am	0.8103E–3	0.1729E–3	0.4963E–4

Table 5.59. Reaction rates for Case 17

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.2360E+0		
C	0.2135E–2		
O	0.2070E–2		
^{235}U	0.5878E–2	0.1124E–1	0.4613E–2
^{238}U	0.1454E+0	0.3739E–1	0.1324E–1
^{238}Pu	0.3936E–4	0.4364E–4	0.1422E–4
^{239}Pu	0.4962E+0	0.9277E+0	0.3237E+0
^{240}Pu	0.8248E–1	0.2258E–2	0.7032E–3
^{241}Pu	0.1188E–1	0.2566E–1	0.8707E–2
^{242}Pu	0.6005E–4	0.3660E–4	0.1156E–4
^{241}Am	0.8046E–3	0.1720E–3	0.4937E–4

5.6. WATER-REFLECTED 11.5-, 12-, AND 13-in.-diam SPHERES OF PLUTONIUM NITRATE SOLUTION

The spherical, thin-walled, stainless-steel vessel was fully filled with $Pu(NO_3)_2$ solution and was surrounded with water (Ref. 2, identified as PU-SOL-THERM-01, -02, and -03). The water reflector was effectively infinite. The ^{240}Pu content was about 2, 3, or 4.5 wt %. Cases differed by diameter of vessel and by plutonium concentration. Multiplication factors for these experiments are reported in Table 5.60 and shown in Figs. 5.4 and 5.5. Reactions rates from the MCU code output are provided in Tables 5.61–5.69. Weighted cross section data derived from the KENO-ABBN calculations are reported in Tables 5.70–5.74.

Table 5.60. Multiplication factors

Assembly case	Diameter (in.)	Plutonium concentration (g/L)	k_{eff}			
			H/^{239}Pu	Experiment	MCU	KENO-V.a (ABBN-90)
			PU-SOL-THERM-001			
1	11.5	73.0	371	1.0000 ± 0.0050	0.9995(13)	0.99842 ± 0.00087
5	11.5	140.0	180	1.0000 ± 0.0050	1.0037(11)	1.00084 ± 0.00091
6	11.5	268.7	91	1.0000 ± 0.0050	1.0029(13)	0.99406 ± 0.00088
			PU-SOL-THERM-002			
1	12.0	49.84	524	1.0000 ± 0.0047	1.0007(12)	0.99923 ± 0.00088
4	12.0	59.64	421	1.0000 ± 0.0047	1.0013(14)	
7	12.0	77.09	340	1.0000 ± 0.0047	1.0043(10)	
			PU-SOL-THERM-003			
1	13.0	33.32	787	1.0000 ± 0.0035	1.0077(9)	0.99756 ± 0.00081
4	13.0	38.12	682	1.0000 ± 0.0035	1.0029(13)	
6	13.0	44.09	563	1.0000 ± 0.0035	1.0053(12)	
Averaged					1.0031	

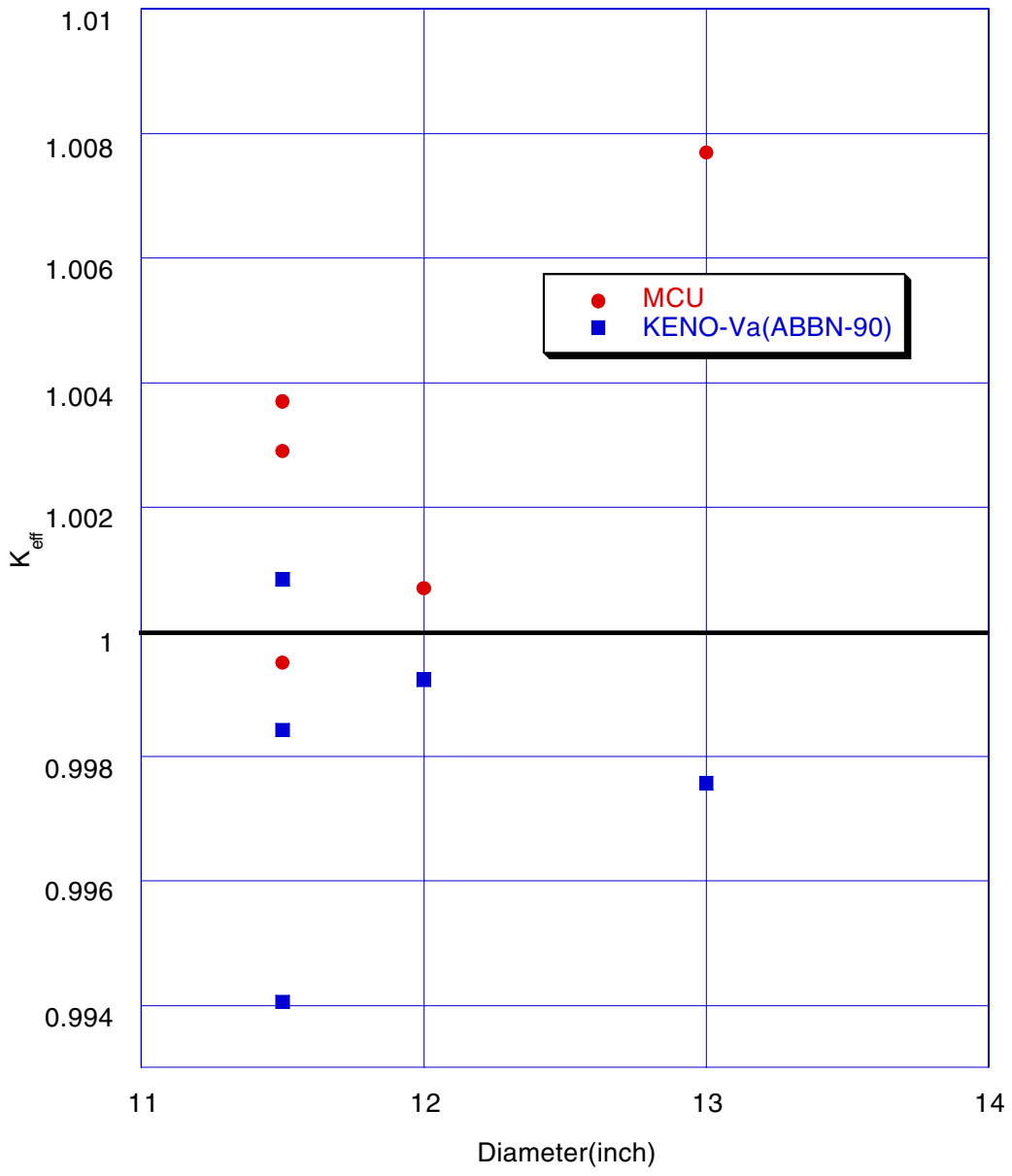

Fig. 5.4. K-effectives for water-reflected spheres of plutonium nitrate solution.

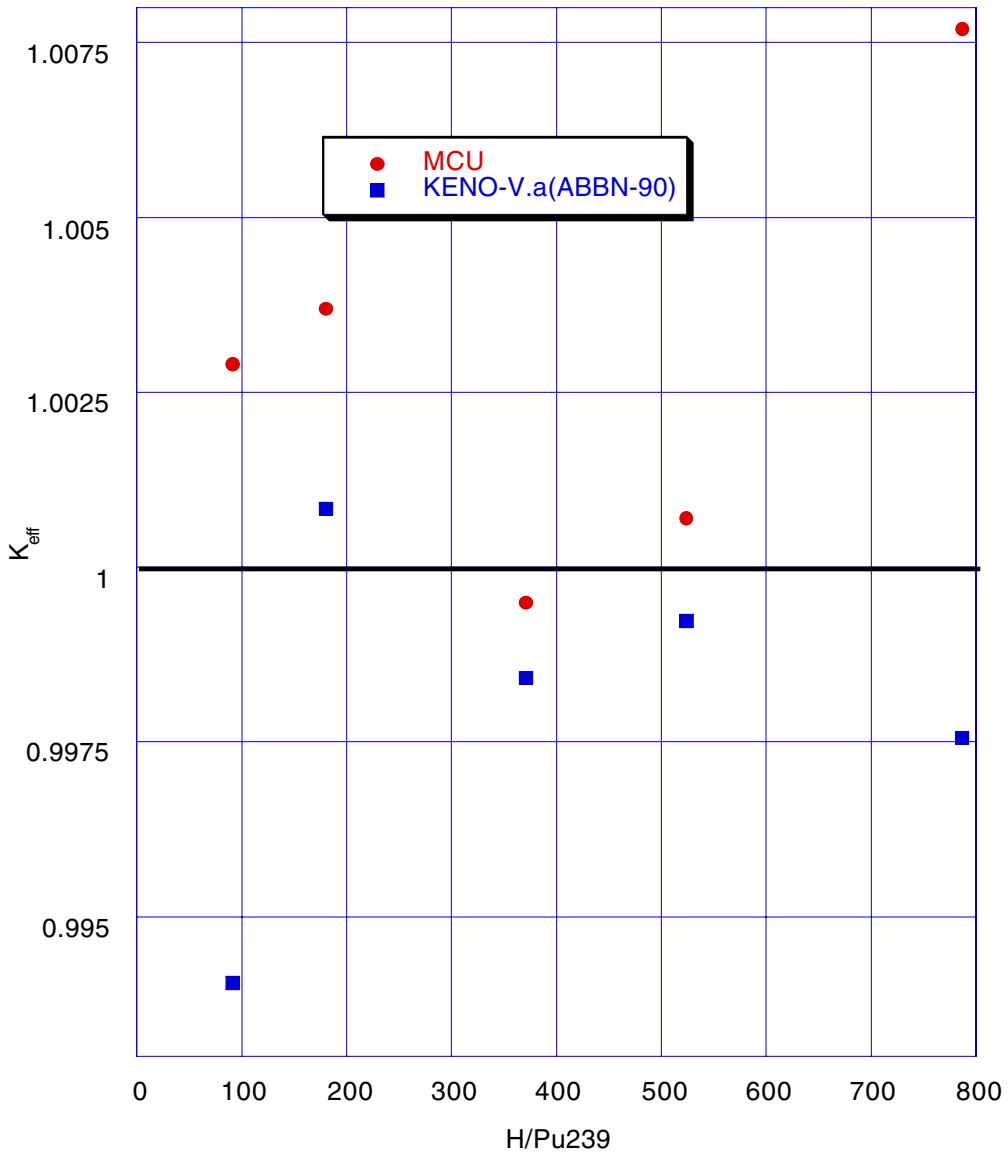

Fig. 5.5. Multiplication factors for water-reflected spheres of plutonium nitrate solution.

Table 5.61. Reaction rates for PU-SOL-THERM-001, Case 1

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4285E+0		
N	0.3939E–2		
O	0.4642E–2		
Cr	0.3755E–2		
Mn	0.1653E–2		
Fe	0.1087E–1		
Ni	0.2392E–2		
^{238}Pu	0.6791E–6	0.7548E–6	0.2445E–6
^{239}Pu	0.5152E+0	0.9966E+0	0.3478E+0
^{240}Pu	0.2700E–1	0.2709E–3	0.8453E–4
^{241}Pu	0.1841E–2	0.3985E–2	0.1353E–2
^{242}Pu	0.7671E–5	0.3430E–6	0.1081E–6

Table 5.62. Reaction rates for PU-SOL-THERM-001, Case 5

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4083E+0		
N	0.7350E–2		
O	0.4886E–2		
Cr	0.2812E–2		
Mn	0.1250E–2		
Fe	0.8147E–2		
Ni	0.1807E–2		
^{238}Pu	0.1307E–5	0.1472E–5	0.4771E–6
^{239}Pu	0.5259E+0	0.1000E+1	0.3491E+0
^{240}Pu	0.3755E–1	0.5204E–3	0.1621E–3
^{241}Pu	0.1823E–2	0.3943E–2	0.1338E–2
^{242}Pu	0.1369E–4	0.6698E–6	0.2111E–6

Table 5.63. Reaction rates for PU-SOL-THERM-001, Case 6

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3974E+0		
N	0.5929E–2		
O	0.4991E–2		
Cr	0.2120E–2		
Mn	0.9589E–3		
Fe	0.6160E–2		
Ni	0.1381E–2		
^{238}Pu	0.2421E–5	0.2786E–5	0.9026E–6
^{239}Pu	0.5299E+0	0.9968E+0	0.3476E+0
^{240}Pu	0.4878E–1	0.9751E–3	0.3034E–3
^{241}Pu	0.1862E–2	0.4034E–2	0.1369E–2
^{242}Pu	0.2457E–4	0.1272E–5	0.4010E–6

Table 5.64. Reaction rates for PU-SOL-THERM-002, Case 1

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4276E+0		
N	0.8752E–2		
O	0.4623E–2		
Cr	0.4414E–2		
Fe	0.1277E–1		
Ni	0.3643E–2		
^{239}Pu	0.5144E+0	0.1003E+1	0.3500E+0
^{240}Pu	0.1595E–1	0.1311E–3	0.4097E–4

Table 5.65. Reaction rates for PU-SOL-THERM-002, Case 4

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4208E+0		
N	0.1265E–1		
O	0.4791E–2		
Cr	0.3935E–2		
Fe	0.1214E–1		
Ni	0.3333E–2		
^{239}Pu	0.5163E+0	0.1002E+1	0.3496E+0
^{240}Pu	0.1771E–1	0.1581E–3	0.4938E–4

Table 5.66. Reaction rates for PU-SOL-THERM-002, Case 7

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4119E+0		
N	0.1525E–1		
O	0.4916E–2		
Cr	0.3475E–2		
Fe	0.1071E–1		
Ni	0.2955E–2		
^{239}Pu	0.5219E+0	0.1006E+1	0.3510E+0
^{240}Pu	0.2080E–1	0.2060E–3	0.6435E–4

Table 5.67. Reaction rates for PU-SOL-THERM-003, Case 1

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4423E+0		
N	0.8004E–2		
O	0.4568E–2		
Cr	0.4962E–2		
Fe	0.1432E–1		
Ni	0.4079E–2		
^{239}Pu	0.5099E+0	0.1003E+1	0.3497E+0
^{240}Pu	0.7581E–2	0.5192E–4	0.1625E–4

Table 5.68 Reaction rates for PU-SOL-THERM-003, Case 4

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4273E+0		0
N	0.1278E–1		
O	0.4675E–2		
Cr	0.4482E–2		
Fe	0.1381E–1		
Ni	0.3783E–2		
^{239}Pu	0.5114E+0	0.1002E+1	0.3497E+0
^{240}Pu	0.1409E–1	0.1055E–3	0.3299E–4

Table 5.69. Reaction rates for PU-SOL-THERM-003, Case 6

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4170E+0		
N	0.1920E–1		
O	0.4851E–2		
Cr	0.4212E–2		
Fe	0.1299E–1		
Ni	0.3559E–2		
^{239}Pu	0.5147E+0	0.1005E+1	0.3505E+0
^{240}Pu	0.1570E–1	0.1240E–3	0.3876E–4

Table 5.70. KENO-ABBN balance table for PU-SOL-THERM-001, Case 1

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{238}Pu	0.0118	0.0006	0.0000	0.0018	69.9766	3.5945	0.0004	2.9711	0.0118	0.0006	0.0000	0.0018
^{239}Pu	164.3077	346.8596	0.0051	994.3873	61.6481	130.1414	0.0019	2.8668	164.3077	346.8596	0.0051	994.3873
^{240}Pu	27.2237	0.0829	0.0001	0.2630	208.7648	0.6355	0.0010	3.1731	27.2237	0.0829	0.0001	0.2630
^{241}Pu	0.4685	1.3546	0.0000	3.9801	55.2155	159.6457	0.0038	2.9382	0.4685	1.3546	0.0000	3.9801
^{242}Pu	0.0078	0.0001	0.0000	0.0004	31.3142	0.4705	0.0024	3.1692	0.0078	0.0001	0.0000	0.0004
N	4.0162	0.0000	0.0000	0.0000	0.3077	0.0000	0.0000	0.0000	4.0162	0.0000	0.0000	0.0000
H + H (H_2O)	44.5780	0.0000	0.0000	0.0000	0.0450	0.0000	0.0000	0.0000	423.0325	0.0000	0.0000	0.0000
O	2.8850	0.0000	0.0000	0.0000	0.0054	0.0000	0.0000	0.0000	4.7342	0.0000	0.0000	0.0000
Fe	0.0000	0.0000	0.0000	0.0000	0.3656	0.0000	0.0001	0.0000	11.1588	0.0000	0.0007	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.4263	0.0000	0.0001	0.0000	3.8556	0.0000	0.0003	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.6324	0.0000	0.0000	0.0000	2.4576	0.0000	0.0000	0.0000
Mn	0.0000	0.0000	0.0000	0.0000	2.0483	0.0000	0.0001	0.0000	1.6958	0.0000	0.0000	0.0000
Total	243.4988	348.2977	0.0053	998.6326					642.9703	348.2977	0.0063	998.6326

[a]Energy region: from 1 to 299 groups.
Volume = 1.28200E+04.
Flux = 1.00514E+14.
[b]k_{eff} = 0.9984220.
Leakage = 8.949.

Table 5.71. KENO-ABBN balance table for PU-SOL-THERM-002, Case 1

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	160.6093	348.4378	0.0037	999.0924	77.1939	167.4704	0.0018	2.8673	160.6093	348.4378	0.0037	999.0924
^{240}Pu	16.1212	0.0401	0.0001	0.1269	241.6076	0.6008	0.0009	3.1665	16.1212	0.0401	0.0001	0.1269
N	8.9460	0.0000	0.0000	0.0000	0.3888	0.0000	0.0000	0.0000	8.9460	0.0000	0.0000	0.0000
H + H (H_2O)	65.2876	0.0000	0.0000	0.0000	0.0599	0.0000	0.0000	0.0000	431.7457	0.0000	0.0000	0.0000
O	3.0319	0.0000	0.0000	0.0000	0.0050	0.0000	0.0000	0.0000	4.7910	0.0000	0.0000	0.0000
Fe	0.0168	0.0000	0.0000	0.0000	0.4821	0.0000	0.0000	0.0000	13.3459	0.0000	0.0006	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.5638	0.0000	0.0001	0.0000	4.3329	0.0000	0.0002	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.8237	0.0000	0.0000	0.0000	3.6683	0.0000	0.0000	0.0000
Total	254.0126	348.4779	0.0038	999.2194					643.5602	348.4779	0.0047	999.2194

[a]Energy region: from 1 to 299 groups.
Volume = 1.51202E+04.
Flux = 9.55097E+13.
[b]k_{eff} = 0.9992300.
Leakage = 7.956.

Table 5.72. KENO-ABBN balance table for PU-SOL-THERM-003, Case 1

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	155.8756	347.6679	0.0026	997.1226	96.8499	216.0159	0.0016	2.8680	155.8756	347.6679	0.0026	997.1226
^{240}Pu	7.6259	0.0159	0.0000	0.0504	265.5768	0.5553	0.0009	3.1610	7.6259	0.0159	0.0000	0.0504
N	8.1995	0.0000	0.0000	0.0000	0.4989	0.0000	0.0000	0.0000	8.1995	0.0000	0.0000	0.0000
H + H (H_2O)	101.2174	0.0000	0.0000	0.0000	0.0798	0.0000	0.0000	0.0000	444.0695	0.0000	0.0000	0.0000
O	3.1248	0.0000	0.0000	0.0000	0.0046	0.0000	0.0000	0.0000	4.7590	0.0000	0.0000	0.0000
Fe	0.0167	0.0000	0.0000	0.0000	0.6391	0.0000	0.0000	0.0000	15.1139	0.0000	0.0005	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.7490	0.0000	0.0001	0.0000	4.9079	0.0000	0.0002	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	1.0820	0.0000	0.0000	0.0000	4.1403	0.0000	0.0000	0.0000
Total	276.0599	347.6838	0.0026	997.1730					644.6916	347.6838	0.0034	997.1730

[a]Energy region: from 1 to 299 groups.
Volume = 1.88700E+04.
Flux = 8.75057E+13.
[b]k_{eff} = 0.9975640.
Leakage = 7.236.

Table 5.73. KENO-ABBN balance table for PU-SOL-THERM-001, Case 6

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{238}Pu	0.0098	0.0012	0.0000	0.0036	18.1442	2.1801	0.0004	3.0398	0.0098	0.0012	0.0000	0.0036
^{239}Pu	181.2462	345.9948	0.0182	992.6516	21.2515	40.5686	0.0021	2.8690	181.2462	345.9948	0.0182	992.6516
^{240}Pu	48.8568	0.2970	0.0005	0.9459	117.0854	0.7119	0.0011	3.1844	48.8568	0.2970	0.0005	0.9459
^{241}Pu	0.4478	1.3778	0.0001	4.0527	16.4942	50.7459	0.0043	2.9415	0.4478	1.3778	0.0001	4.0527
^{242}Pu	0.0245	0.0004	0.0000	0.0014	30.7233	0.5464	0.0026	3.1661	0.0245	0.0004	0.0000	0.0014
N	5.8958	0.0000	0.0000	0.0000	0.1320	0.0000	0.0000	0.0000	5.8958	0.0000	0.0000	0.0000
H + H (H_2O)	10.0663	0.0000	0.0000	0.0000	0.0129	0.0000	0.0000	0.0000	389.7049	0.0000	0.0000	0.0000
O	3.1692	0.0000	0.0000	0.0000	0.0061	0.0000	0.0000	0.0000	5.1285	0.0000	0.0000	0.0000
Fe	0.0000	0.0000	0.0000	0.0000	0.1136	0.0000	0.0001	0.0000	6.2898	0.0000	0.0006	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.1290	0.0000	0.0001	0.0000	2.1715	0.0000	0.0002	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.2185	0.0000	0.0000	0.0000	1.4143	0.0000	0.0000	0.0000
Mn	0.0000	0.0000	0.0000	0.0000	0.7925	0.0000	0.0001	0.0000	0.9726	0.0000	0.0000	0.0000
Total	249.7164	347.6713	0.0188	997.6552					642.1625	347.6713	0.0198	997.6552

[a]Energy region: from 1 to 299 groups.
Volume = 1.28300E+04.
Flux = 8.74663E+13.
[b]k_{eff} = 0.9982800.
Leakage = 9.560.

Table 5.74. KENO-ABBN balance table for PU-SOL-THERM-001, Case 5

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{238}Pu	0.0107	0.0008	0.0000	0.0024	35.5076	2.6452	0.0004	3.0079	0.0107	0.0008	0.0000	0.0024
^{239}Pu	174.3937	347.7003	0.0098	996.7137	36.8320	73.4344	0.0021	2.8666	174.3937	347.7003	0.0098	996.7137
^{240}Pu	37.8948	0.1583	0.0003	0.5032	163.5776	0.6832	0.0011	3.1791	37.8948	0.1583	0.0003	0.5032
^{241}Pu	0.4534	1.3403	0.0001	3.9397	30.0824	88.9244	0.0042	2.9394	0.4534	1.3403	0.0001	3.9397
^{242}Pu	0.0140	0.0002	0.0000	0.0007	31.6889	0.5157	0.0025	3.1675	0.0140	0.0002	0.0000	0.0007
N	7.3955	0.0000	0.0000	0.0000	0.1914	0.0000	0.0000	0.0000	7.3955	0.0000	0.0000	0.0000
H + H (H_2O)	20.3947	0.0000	0.0000	0.0000	0.0239	0.0000	0.0000	0.0000	401.7777	0.0000	0.0000	0.0000
O	3.0958	0.0000	0.0000	0.0000	0.0058	0.0000	0.0000	0.0000	4.9913	0.0000	0.0000	0.0000
Fe	0.0000	0.0000	0.0000	0.0000	0.1995	0.0000	0.0001	0.0000	8.2593	0.0000	0.0007	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.2305	0.0000	0.0001	0.0000	2.8526	0.0000	0.0003	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.3594	0.0000	0.0000	0.0000	1.8360	0.0000	0.0000	0.0000
Mn	0.0000	0.0000	0.0000	0.0000	1.2216	0.0000	0.0001	0.0000	1.2659	0.0000	0.0000	0.0000
Total	243.6526	349.1999	0.0102	1001.1597					641.1450	349.1999	0.0112	1001.1597

[a]Energy region: from 1 to 299 groups.
Volume = 1.28500E+04.
Flux = 9.26785E+13.
[b]k_{eff} = 1.0008399.
Leakage = 9.986.

5.7 PLUTONIUM NITRATE SOLUTION WITH A HIGH ^{240}Pu CONTENT

Multiplication factors and reaction rates are given in Table 5.75 for the plutonium nitrate solution sphere and cylinders, which were bare or surrounded by water reflectors [Ref. 3, identified as CSWG BNL-19302.1974, T(24-30)]. These values are also shown in Fig. 5.6. Three of these experiments were members of sets of experiments conducted in the same or similar vessels. Tables 5.76–5.78 contain calculated k-effectives (KENO-ABBN) for three of the experiments in Table 5.75 as well as values for other experiments conducted in the same or similar vessels. These calculated values are also presented in Figs. 5.7–5.10. Tables 5.79–5.83 contain reaction rate data generated by the MCU program. Tables 5.84–5.86 contain weighted cross section data and reaction rates from the KENO-ABBN system.

Table 5.75. Multiplication factors

Assembly	Plutonium concentration (g/L)	H/Pu	^{240}Pu (wt %)	Geometry	k_{eff}, MCU
PNL- 7	26.3	980	0.54	Sphere with reflector	0.9991(20)
PNL- 6	172.3	125	4.57	Sphere without reflector	0.9975(19)
PNL-10	28.5	210	8.4	Cylinder without reflector	0.9963(15)
PNL- 9	11.6	910	13.9	Cylinder without reflector	0.9932(11)
PNL-11	40.6	623	42.9	Cylinder with reflector	0.9993(17)
Averaged					0.9980

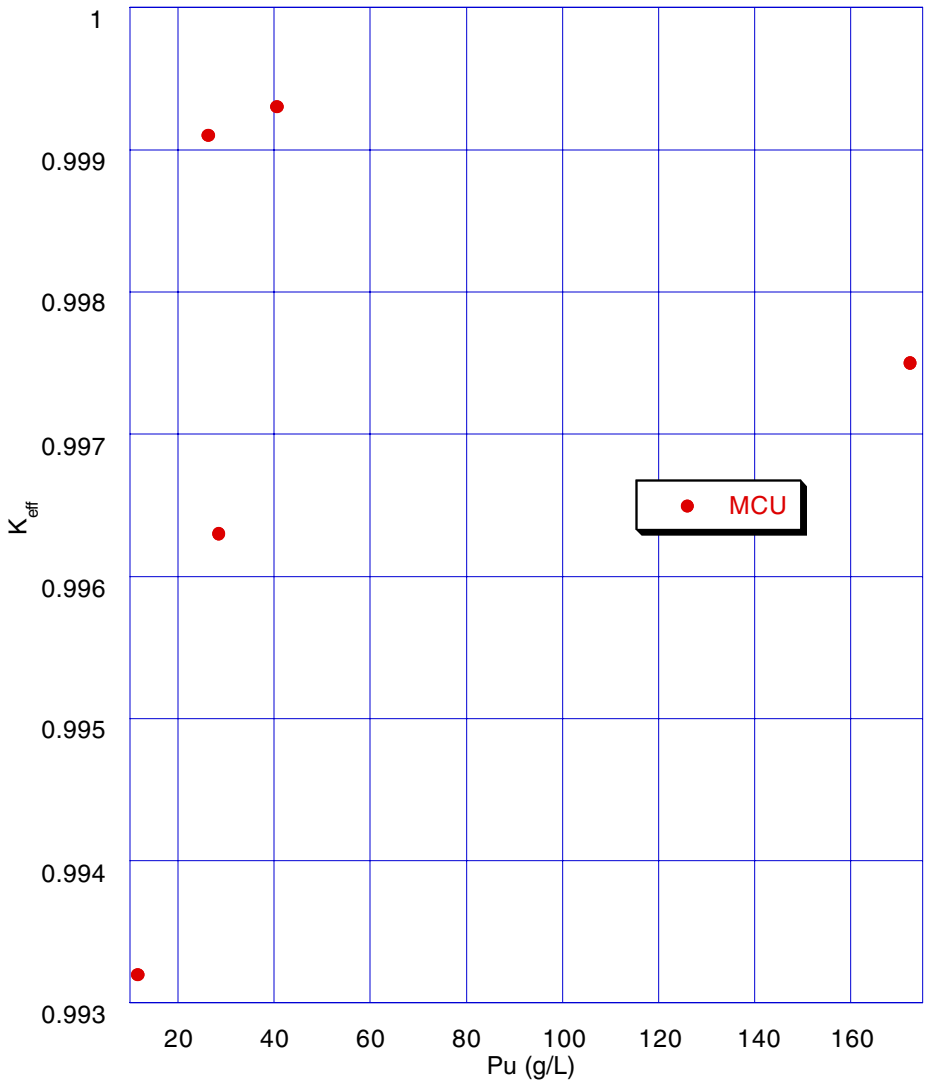

Fig. 5.6. K-effective vs plutonium concentration for plutonium nitrate solution spheres and cylinders.

Table 5.76. Calculation results of k_{eff} for gadolinium-poisoned plutonium nitrate solutions in 24-in.-diam water-reflected cylinder

Variant	KENO-V.a (ABBN-90)
116-1 (PNL-10)	0.9940 ± 0.0018
116-2	0.9953 ± 0.0015
116-3	0.9931 ± 0.0013
116-4	0.9919 ± 0.0012
116-5	0.9914 ± 0.0011
116-6	0.9905 ± 0.0011
363-1	0.9875 ± 0.0013
363-2	0.9910 ± 0.0014
363-3	0.9920 ± 0.0013
363-4	0.9890 ± 0.0013
363-5	0.9901 ± 0.0013
363-6	0.9916 ± 0.0012
363-7	0.9904 ± 0.0012
363-8	0.9905 ± 0.0010
363-9	0.9889 ± 0.0011

Table 5.77. Calculation results of k_{eff} for unreflected plutonium nitrate solution in 13.4-in. and 17.9-in.-diam cylinders

Variant	KENO-V.a (ABBN-90)
5-13-1	0.9994 ± 0.0009
5-13-2	1.0000 ± 0.0009
5-13-3	0.9956 ± 0.0009
5-13-4	0.9992 ± 0.0009
5-13-5	1.0006 ± 0.0009
5-13-6	1.0033 ± 0.0009
5-13-7	1.0038 ± 0.0008
5-18-1	0.9915 ± 0.0009
14-13-1	0.9978 ± 0.0009
14-13-2	0.9959 ± 0.0009
14-13-3	0.9988 ± 0.0009
14-13-4	0.9998 ± 0.0009
14-13-5	0.9995 ± 0.0008
14-18-1	0.9927 ± 0.0008
14-18-2	0.9920 ± 0.0009
14-18-3	0.9878 ± 0.0009
14-18-4	0.9876 ± 0.0009
14-18-5	0.9902 ± 0.0009
14-18-6	0.9844 ± 0.0009
14-18-7	0.9906 ± 0.0008
14-18-8 (PNL-9)	0.9964 ± 0.0007
14-18-9	0.9953 ± 0.0007

Table 5.78. Calculation results of k_{eff} for plutonium nitrate solutions in 24-in.-diam water-reflected cylinder

Variant	KENO-V.a (ABBN-90)
1 (PNL-11)	0.9975 ± 0.0006
2	1.0003 ± 0.0006
3	1.0016 ± 0.0006
4	1.0063 ± 0.0006
5	1.0084 ± 0.0006
6	1.0119 ± 0.0006
7	1.0164 ± 0.0006
8	1.0219 ± 0.0007
9	1.0221 ± 0.0007

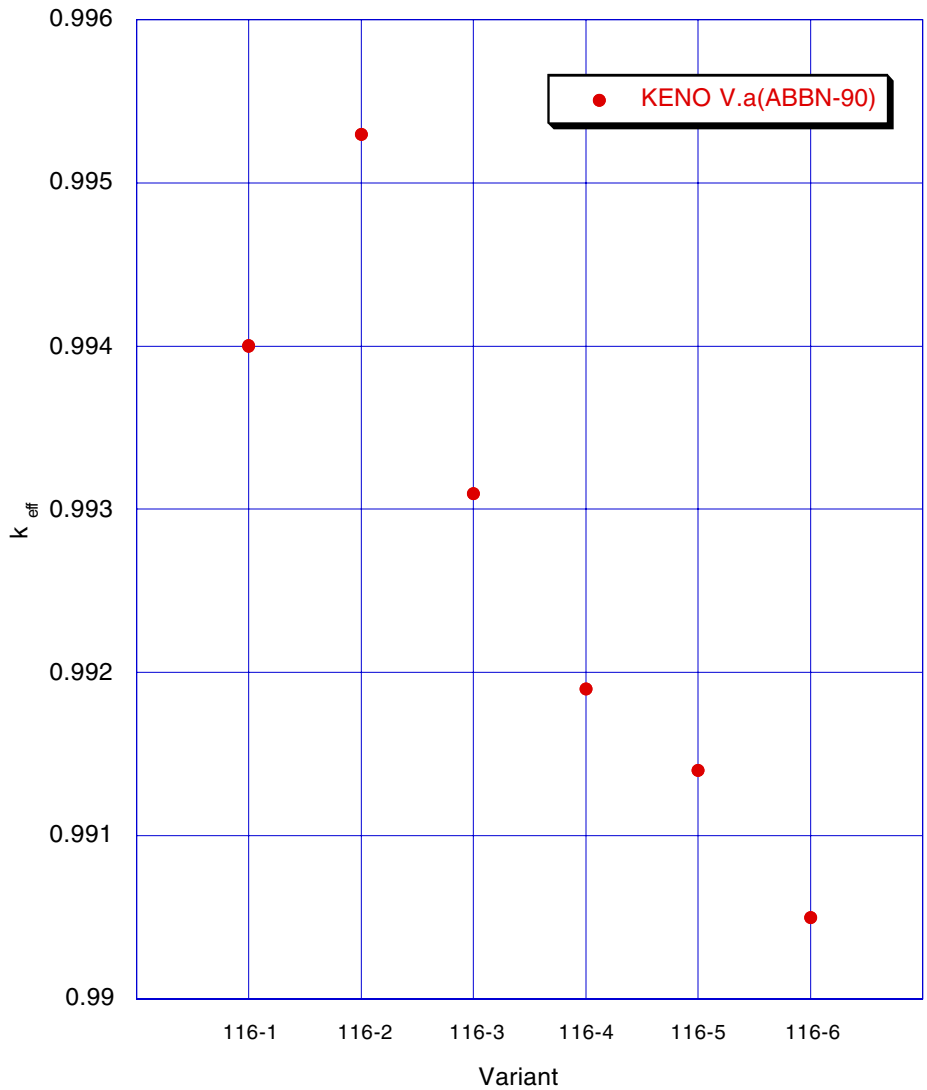

Fig. 5.7. K-effectives for gadolinium-poisoned, plutonium nitrate solutions with a high ^{240}Pu content (116 g/L of plutonium).

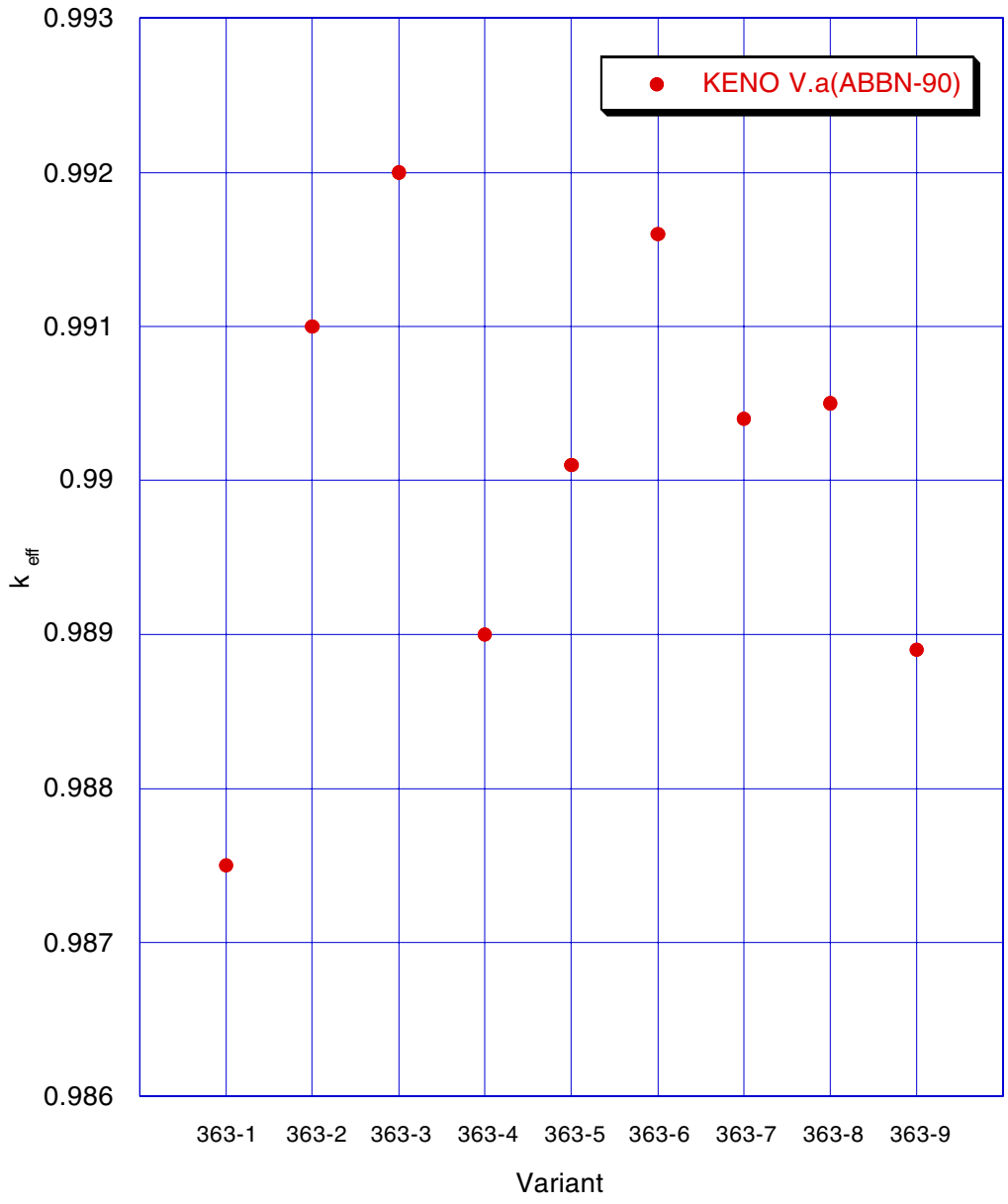

Fig. 5.8. K-effectives for gadolinium-poisoned, plutonium nitrate solutions with a high ^{240}Pu content and high plutonium concentration (363 g/L).

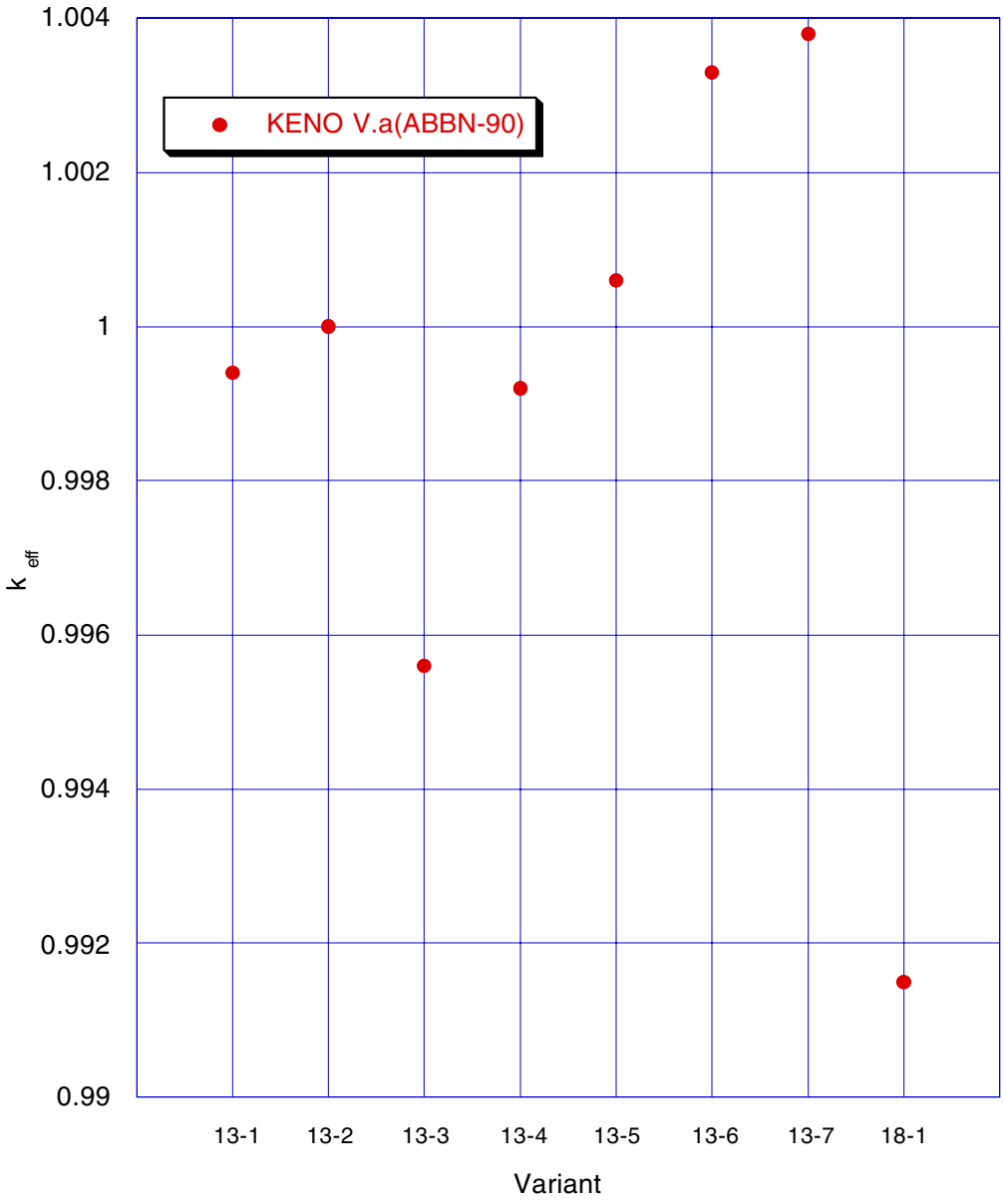

Fig. 5.9. Unreflected plutonium nitrate solution cylinders of 13.4 in. and 17.9 in. diameter (4.88 wt % ^{240}Pu).

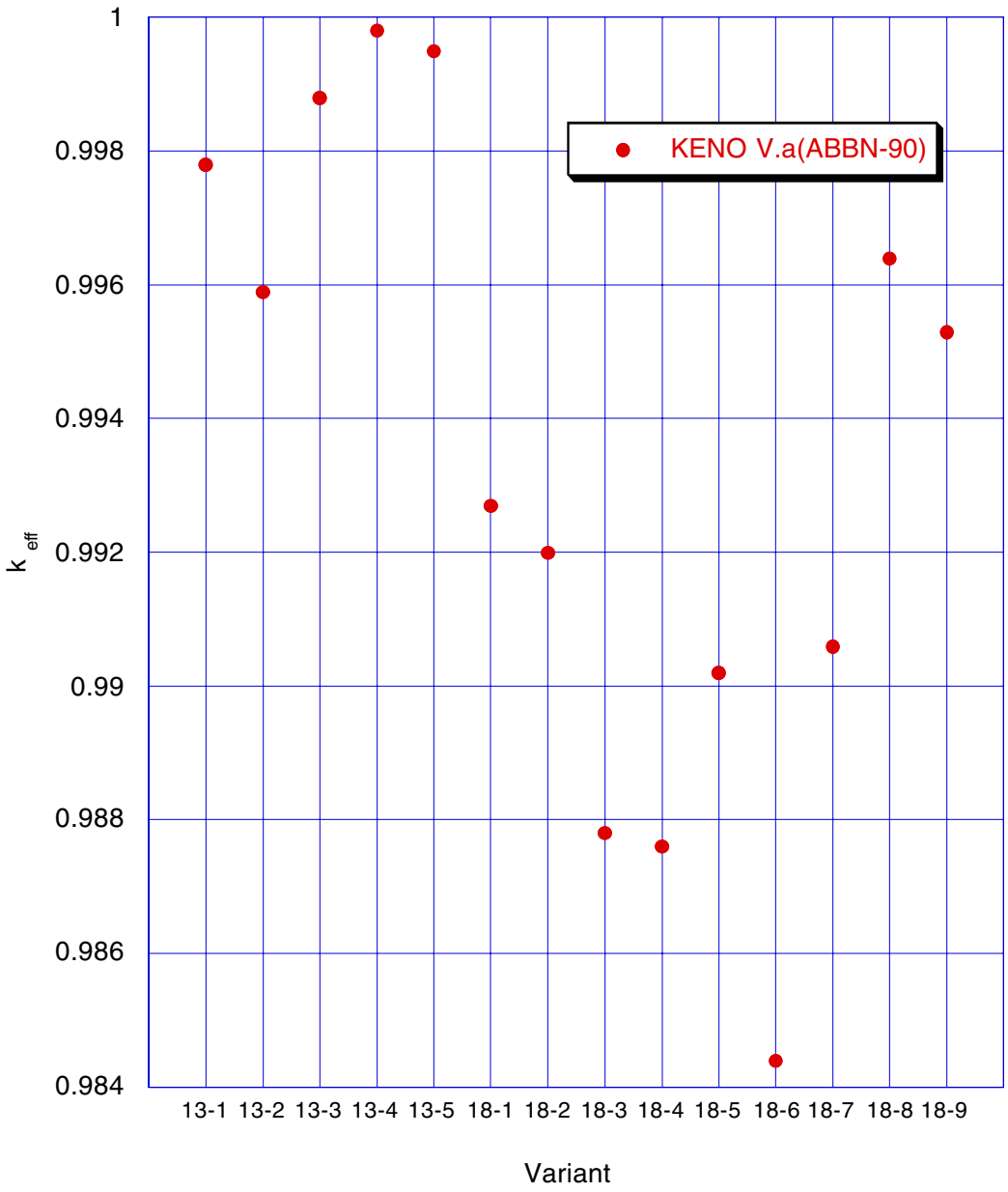

Fig. 5.10. Unreflected plutonium nitrate solution cylinders of 13.4 in. and 17.9 in. diameter (13.74 wt % ^{240}Pu).

Table 5.79. Reaction rates for PNL-6

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.1359E–1		
N	0.1169E–1		
O	0.4046E–2		
Cr	0.9979E–4		
Fe	0.3188E–3		
Ni	0.7682E–4		
^{239}Pu	0.5295E+0	0.9913E+0	0.3459E+0
^{240}Pu	0.4812E–1	0.8061E–3	0.2511E–3
^{241}Pu	0.1812E–2	0.3915E–2	0.1328E–2
^{242}Pu	0.1369E–4	0.6882E–6	0.2170E–6

Table 5.80. Reaction rates for PNL-7

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4487E+0		
N	0.8921E–2		
O	0.4529E–2		
Cr	0.5238E–2		
Fe	0.1558E–1		
Ni	0.3587E–2		
^{239}Pu	0.5076E+0	0.1002E+1	0.3495E+0
^{240}Pu	0.2095E–2	0.1318E–4	0.4129E–5

Table 5.81. Reaction rates for PNL-9

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.1321E+0		
N	0.7743E–2		
O	0.3888E–2		
Cr	0.4339E–3		
Fe	0.1342E–2		
Ni	0.2608E–3		
^{239}Pu	0.4892E+0	0.9641E+0	0.3363E+0
^{240}Pu	0.5134E–1	0.4146E–3	0.1293E–3
^{241}Pu	0.1346E–1	0.2918E–1	0.9907E–2

Table 5.82. Reaction rates for PNL-10

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3073E+0		
N	0.7516E–2		
O	0.4683E–2		
Cr	0.9137E–2		
Fe	0.2706E–1		
Ni	0.6354E–2		
^{239}Pu	0.5173E+0	0.9858E+0	0.3441E+0
^{240}Pu	0.5536E–1	0.8501E–3	0.2646E–3
^{241}Pu	0.5251E–2	0.1135E–1	0.3853E–2
^{242}Pu	0.6978E–4	0.3309E–5	0.1042E–5

Table 5.83. Reaction rates for PNL-11

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.2565E+0		
N	0.1787E–1		
O	0.7185E–2		
Cr	0.2794E–2		
Fe	0.8940E–2		
Ni	0.1548E–2		
Gd	0.3996E–5		
^{239}Pu	0.3787E+0	0.7457E+0	0.2601E+0
^{240}Pu	0.1850E+0	0.2133E–2	0.6579E–3
^{241}Pu	0.1153E+0	0.2499E+0	0.8485E–1
^{242}Pu	0.3740E–2	0.1551E–3	0.4823E–4

Table 5.84. KENO-ABBN balance table for PNL-9

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	155.3180	349.4264	0.0024	1002.2528	103.6760	233.2449	0.0016	2.8683	155.3180	349.4264	0.0024	1002.2528
^{240}Pu	52.7581	0.1258	0.0002	0.3984	221.1900	0.5274	0.0009	3.1670	52.7581	0.1258	0.0002	0.3984
N	0.0808	0.0000	0.0000	0.0000	0.5386	0.0000	0.0000	0.0000	0.0808	0.0000	0.0000	0.0000
O	3.7600	0.0000	0.0000	0.0000	0.0045	0.0000	0.0000	0.0000	3.7600	0.0000	0.0000	0.0000
H + H (H_2O)	137.5302	0.0000	0.0000	0.0000	0.0870	0.0000	0.0000	0.0000	137.5302	0.0000	0.0000	0.0000
Fe	0.0000	0.0000	0.0000	0.0000	0.6959	0.0000	0.0000	0.0000	1.1423	0.0000	0.0003	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.8159	0.0000	0.0001	0.0000	0.3496	0.0000	0.0001	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	1.1754	0.0000	0.0000	0.0000	0.2147	0.0000	0.0000	0.0000
Total	349.4471	349.5522	0.0026	1002.6512					351.1537	349.5522	0.0031	1002.6512

[a]Energy region: from 1 to 299 groups.
Volume = 5.91018E+04.
Flux = 3.54961E+13.
[b]k_{eff} = 1.0028350.
Leakage = 299.114.

Table 5.85. KENO-ABBN balance table for PNL-10

Nuclide	Zone 1[a]								Over all reactor (3 zones)[b]			
	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{238}Pu	0.0080	0.0006	0.0000	0.0017	39.8763	2.7660	0.0004	3.0020	0.0080	0.0006	0.0000	0.0017
^{239}Pu	170.6339	341.9000	0.0087	979.9825	40.8223	81.7958	0.0021	2.8663	170.6339	341.9000	0.0087	979.9825
^{240}Pu	56.5098	0.2584	0.0004	0.8223	146.9095	0.6718	0.0011	3.1820	56.5098	0.2584	0.0004	0.8223
^{241}Pu	1.3068	3.8359	0.0002	11.2744	33.5819	98.5722	0.0042	2.9391	1.3068	3.8359	0.0002	11.2744
^{242}Pu	0.0711	0.0011	0.0000	0.0036	32.0850	0.5092	0.0025	3.1692	0.0711	0.0011	0.0000	0.0036
N	7.5441	0.0000	0.0000	0.0000	0.2062	0.0000	0.0000	0.0000	7.5441	0.0000	0.0000	0.0000
O	3.4030	0.0000	0.0000	0.0000	0.0058	0.0000	0.0000	0.0000	4.8065	0.0000	0.0000	0.0000
H + H (H_2O)	25.6694	0.0000	0.0000	0.0000	0.0266	0.0000	0.0000	0.0000	309.7148	0.0000	0.0000	0.0000
Fe	0.0000	0.0000	0.0000	0.0000	0.2206	0.0000	0.0001	0.0000	26.8962	0.0000	0.0025	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.2554	0.0000	0.0001	0.0000	8.5013	0.0000	0.0008	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.3943	0.0000	0.0000	0.0000	6.0739	0.0000	0.0001	0.0000
Total	265.1462	345.9960	0.0093	992.0845					592.0663	345.9960	0.0127	992.0845

[a]Energy region: from 1 to 299 groups.
Volume = 4.51643E+04.
Flux = 2.98199E+13.
[b]k_{eff} = 0.9931150.
Leakage = 60.913.

Table 5.86. KENO-ABBN balance table for PNL-11

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{241}Am	5.7987	0.0461	0.0000	0.1485	198.2387	1.5773	0.0005	3.2186	5.7987	0.0461	0.0000	0.1485
^{238}Pu	0.7456	0.0298	0.0000	0.0875	135.8557	5.4302	0.0003	2.9360	0.7456	0.0298	0.0000	0.0875
^{239}Pu	115.8421	259.2249	0.0019	743.4845	102.3775	229.0947	0.0017	2.8681	115.8421	259.2249	0.0019	743.4845
^{240}Pu	188.9541	0.5983	0.0010	1.9002	161.8244	0.5124	0.0009	3.1761	188.9541	0.5983	0.0010	1.9002
^{241}Pu	29.7460	84.7703	0.0010	249.0169	101.6073	289.5616	0.0033	2.9375	29.7460	84.7703	0.0010	249.0169
^{242}Pu	3.8906	0.0480	0.0003	0.1524	30.6640	0.3785	0.0021	3.1742	3.8906	0.0480	0.0003	0.1524
N	18.0842	0.0000	0.0000	0.0000	0.5258	0.0000	0.0000	0.0000	18.0842	0.0000	0.0000	0.0000
O	4.3109	0.0000	0.0000	0.0000	0.0046	0.0000	0.0000	0.0000	4.8971	0.0000	0.0000	0.0000
H + H (H_2O)	144.0317	0.0000	0.0000	0.0000	0.0848	0.0000	0.0000	0.0000	253.5502	0.0000	0.0000	0.0000
Gd	4.0097	0.0000	0.0000	0.0000	********	0.0000	0.0034	0.0000	4.0097	0.0000	0.0000	0.0000
Fe	0.0000	0.0000	0.0000	0.0000	0.6788	0.0000	0.0000	0.0000	7.5100	0.0000	0.0005	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.7958	0.0000	0.0001	0.0000	2.3094	0.0000	0.0001	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	1.1469	0.0000	0.0000	0.0000	1.3022	0.0000	0.0000	0.0000
Total	515.4135	344.7175	0.0042	994.7900					636.6398	344.7175	0.0048	994.7900

[a]Energy region: from 1 to 299 groups.
Volume = 2.36703E+05.
Flux = 9.61926E+12.
[b]k_{eff} = 0.9943800.
Leakage = 19.060.

5.8 MIXED PLUTONIUM AND URANIUM SOLUTION AT A PLUTONIUM FRACTION OF 0.2 AND 0.5

A large cylindrical vessel was filled with mixed plutonium-uranium nitrate solution (Ref. 2, identified as MIX-SOL-THERM-002). The critical height of the solution was detected. The vessel had a water reflector, and the ^{240}Pu content was equal to 8 wt %.

Calculated multiplication factors are provided in Table 5.87. Reaction rate data from the MCU program are reported in Tables 5.88–5.90. Weighted cross section and reaction rate data from the KENO-ABBN program are reported in Tables 5.91–5.93.

Table 5.87. Multiplication factors for mixed uranium/plutonium nitrate solution experiments

Experiment No.	Plutonium concentration (g/L)	Uranium concentration (g/L)	k_{eff}		
			Experiment	MCU	KENO-ABBN-90
58	11.88	11.05	1.0000 ± 0.0024	1.0005(10)	0.99446 ± 0.00052
59	11.73	10.78	1.0000 ± 0.0024	1.0012(11)	0.99627 ± 0.00050
61	12.19	41.04	1.0000 ± 0.0024	1.0013(12)	0.99627 ± 0.00051
Averaged				1.0010	

Table 5.88. MCU reaction rates for Case 58

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4162E+0		
^{10}B	0.3643E–3		
N	0.1374E–1		
O	0.4606E–2		
Cr	0.3254E–2		
Mn	0.1409E–2		
Fe	0.9428E–2		
Ni	0.2055E–2		
Cd	0.2083E–3		
^{234}U	0.5238E–5	0.1475E–6	0.5829E–7
^{235}U	0.1952E–2	0.4036E–2	0.1659E–2
^{236}U	0.2073E–5	0.1490E–6	0.5674E–7
^{238}U	0.5723E–2	0.2139E–3	0.7552E–4
^{238}Pu	0.8102E–6	0.8447E–6	0.2741E–6
^{239}Pu	0.4964E+0	0.9909E+0	0.3455E+0
^{240}Pu	0.2400E–1	0.1192E–3	0.3742E–4
^{241}Pu	0.3069E–2	0.6662E–2	0.2262E–2
^{242}Pu	0.1324E–5	0.8096E–6	0.2544E–6
^{241}Am	0.3480E–4	0.9468E–5	0.2680E–5

Table 5.89 Reaction rates for Case 59

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4187E+0		
^{10}B	0.3651E–3		
N	0.1367E–1		
O	0.4657E–2		
Cr	0.3017E–2		
Mn	0.1307E–2		
Fe	0.8734E–2		
Ni	0.1906E–2		
Cd	0.2088E–3		
^{234}U	0.5171E–5	0.1452E–6	0.5740E–7
^{235}U	0.1932E–2	0.3995E–2	0.1643E–2
^{236}U	0.2019E–5	0.1456E–6	0.5544E–7
^{238}U	0.5604E–2	0.2097E–3	0.7404E–4
^{238}Pu	0.8013E–6	0.8367E–6	0.2715E–6
^{239}Pu	0.4967E+0	0.9918E+0	0.3458E+0
^{240}Pu	0.2401E–1	0.1184E–3	0.3717E–4
^{241}Pu	0.3074E–2	0.6674E–2	0.2266E–2
^{242}Pu	0.1309E–5	0.8032E–6	0.2523E–6
^{241}Am	0.3453E–4	0.9399E–5	0.2660E–5

Table 5.90 MCU reaction rates for Case 61

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4002E+0		
^{10}B	0.3613E–3		
N	0.1825E–1		
O	0.4670E–2		
Cr	0.3085E–2		
Mn	0.1342E–2		
Fe	0.8945E–2		
Ni	0.1951E–2		
Cd	0.6099E–7		
^{234}U	0.1761E–5	0.1271E–6	0.4735E–7
^{235}U	0.4347E–2	0.8987E–2	0.3695E–2
^{236}U	0.4416E–5	0.3026E–6	0.1087E–6
^{238}U	0.1829E–1	0.8032E–3	0.2836E–3
^{238}Pu	0.8363E–6	0.8744E–6	0.2838E–6
^{239}Pu	0.4936E+0	0.9849E+0	0.3434E+0
^{240}Pu	0.2426E–1	0.1231E–3	0.3864E–4
^{241}Pu	0.3047E–2	0.6615E–2	0.2246E–2
^{242}Pu	0.1366E–5	0.8381E–6	0.2634E–6
^{241}Am	0.3599E–4	0.9827E–5	0.2781E–5

Table 5.91. KENO-ABBN balance table for MIX-SOL-THERM-002, Case 58

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
H + H (H_2O)	323.4378	0.0000	0.0000	0.0000	0.1375	0.0000	0.0000	0.0000	419.5228	0.0000	0.0000	0.0000
N	14.0751	0.0000	0.0000	0.0000	0.8167	0.0000	0.0000	0.0000	14.0751	0.0000	0.0000	0.0000
O	4.2110	0.0000	0.0000	0.0000	0.0034	0.0000	0.0000	0.0000	4.7037	0.0000	0.0000	0.0000
^{238}Pu	0.0674	0.0024	0.0000	0.0069	223.2033	7.8754	0.0002	2.9160	0.0674	0.0024	0.0000	0.0069
^{239}Pu	145.7910	342.6649	0.0012	983.2972	148.9118	349.9998	0.0012	2.8696	145.7910	342.6649	0.0012	983.2972
^{240}Pu	24.1414	0.0368	0.0001	0.1157	271.3974	0.4133	0.0007	3.1476	24.1414	0.0368	0.0001	0.1157
^{241}Pu	0.7955	2.2561	0.0000	6.6267	160.5303	455.2475	0.0025	2.9373	0.7955	2.2561	0.0000	6.6267
^{242}Pu	0.0277	0.0003	0.0000	0.0009	28.0197	0.2824	0.0015	3.1733	0.0277	0.0003	0.0000	0.0009
^{234}U	0.0055	0.0001	0.0000	0.0001	53.5282	0.5112	0.0005	2.5470	0.0055	0.0001	0.0000	0.0001
^{235}U	0.3016	1.6961	0.0000	4.1254	42.0221	236.3114	0.0036	2.4323	0.3016	1.6961	0.0000	4.1254
^{236}U	0.0018	0.0002	0.0000	0.0005	7.2705	0.8915	0.0020	2.4279	0.0018	0.0002	0.0000	0.0005
^{238}U	5.5637	0.0752	0.0047	0.2146	5.5840	0.0755	0.0047	2.8531	5.5637	0.0752	0.0047	0.2146
^{241}Am	1.5508	0.0106	0.0000	0.0337	283.6700	1.9442	0.0004	3.1677	1.5508	0.0106	0.0000	0.0337
^{10}B	0.3701	0.0000	0.0000	0.0000	1587.768	0.0000	0.0000	0.0000	0.3701	0.0000	0.0000	0.0000
Cd	0.1312	0.0000	0.0000	0.0000	1007.469	0.0000	0.0005	0.0000	0.1312	0.0000	0.0000	0.0000
Fe	0.0148	0.0000	0.0000	0.0000	1.0928	0.0000	0.0000	0.0000	9.4624	0.0000	0.0004	0.0000
Gd	0.3526	0.0000	0.0000	0.0000	19621.174	0.0000	0.0025	0.0000	0.3526	0.0000	0.0000	0.0000
^{6}Li	0.0033	0.0000	0.0000	0.0000	390.4182	0.0000	0.0004	0.0000	0.0033	0.0000	0.0000	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	1.2842	0.0000	0.0000	0.0000	3.2659	0.0000	0.0001	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	1.8281	0.0000	0.0000	0.0000	2.0637	0.0000	0.0000	0.0000
Mn	0.0000	0.0000	0.0000	0.0000	5.6885	0.0000	0.0001	0.0000	1.4279	0.0000	0.0000	0.0000
Total	520.8423	346.7426	0.0060	994.4219					633.6251	346.7426	0.0065	994.4219

[a]Energy region: from 1 to 299 groups.
Volume = 2.84519E+05.
Flux = 1.07169E+13.
[b]k_{eff} = 0.9944650.
Leakage = 19.595.

Table 5.92. KENO-ABBN balance table for MIX-SOL-THERM-002, Case 59

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
H + H (H_2O)	328.5159	0.0000	0.0000	0.0000	0.1384	0.0000	0.0000	0.0000	421.7103	0.0000	0.0000	0.0000
N	14.0190	0.0000	0.0000	0.0000	0.8217	0.0000	0.0000	0.0000	14.0190	0.0000	0.0000	0.0000
O	4.2300	0.0000	0.0000	0.0000	0.0034	0.0000	0.0000	0.0000	4.7017	0.0000	0.0000	0.0000
^{238}Pu	0.0676	0.0024	0.0000	0.0069	224.7025	7.9172	0.0002	2.9158	0.0676	0.0024	0.0000	0.0069
^{239}Pu	145.9875	343.3176	0.0012	985.1757	149.7084	352.0680	0.0012	2.8696	145.9875	343.3176	0.0012	985.1757
^{240}Pu	24.0710	0.0364	0.0001	0.1146	271.6816	0.4111	0.0007	3.1474	24.0710	0.0364	0.0001	0.1146
^{241}Pu	0.7974	2.2611	0.0000	6.6415	161.5511	458.1025	0.0025	2.9373	0.7974	2.2611	0.0000	6.6415
^{242}Pu	0.0279	0.0003	0.0000	0.0009	28.3544	0.2806	0.0015	3.1736	0.0279	0.0003	0.0000	0.0009
^{234}U	0.0054	0.0001	0.0000	0.0001	53.7835	0.5104	0.0005	2.5462	0.0054	0.0001	0.0000	0.0001
^{235}U	0.2986	1.6800	0.0000	4.0863	42.2813	237.8526	0.0036	2.4323	0.2986	1.6800	0.0000	4.0863
^{236}U	0.0017	0.0002	0.0000	0.0005	7.2647	0.8949	0.0020	2.4274	0.0017	0.0002	0.0000	0.0005
^{238}U	5.5014	0.0736	0.0046	0.2100	5.6106	0.0751	0.0047	2.8533	5.5014	0.0736	0.0046	0.2100
^{241}Am	1.5536	0.0106	0.0000	0.0337	285.1280	1.9502	0.0004	3.1670	1.5536	0.0106	0.0000	0.0337
^{10}B	0.3711	0.0000	0.0000	0.0000	1598.164	0.0000	0.0000	0.0000	0.3711	0.0000	0.0000	0.0000
Cd	0.1316	0.0000	0.0000	0.0000	1014.192	0.0000	0.0005	0.0000	0.1316	0.0000	0.0000	0.0000
Fe	0.0148	0.0000	0.0000	0.0000	1.0999	0.0000	0.0000	0.0000	8.7198	0.0000	0.0003	0.0000
Gd	0.3536	0.0000	0.0000	0.0000	19756.109	0.0000	0.0025	0.0000	0.3536	0.0000	0.0000	0.0000
^{6}Li	0.0033	0.0000	0.0000	0.0000	392.9802	0.0000	0.0004	0.0000	0.0033	0.0000	0.0000	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	1.2926	0.0000	0.0000	0.0000	3.0085	0.0000	0.0001	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	1.8398	0.0000	0.0000	0.0000	1.9012	0.0000	0.0000	0.0000
Mn	0.0000	0.0000	0.0000	0.0000	5.7238	0.0000	0.0001	0.0000	1.3141	0.0000	0.0000	0.0000
Total	525.9512	347.3823	0.0060	996.2703					634.5461	347.3823	0.0064	996.2703

[a]Energy region: from 1 to 299 groups.
Volume = 3.08007E+05.
Flux = 9.96847E+12.
[b]k_{eff} = 0.9962660.
Leakage = 18.082.

Table 5.93. KENO-ABBN balance table for MIX-SOL-THERM-002, Case 61

	Zone 1[a]								Over all reactor (3 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
H + H (H_2O)	309.9466	0.0000	0.0000	0.0000	0.1345	0.0000	0.0000	0.0000	403.8245	0.0000	0.0000	0.0000
N	18.7462	0.0000	0.0000	0.0000	0.8006	0.0000	0.0000	0.0000	18.7462	0.0000	0.0000	0.0000
O	4.2933	0.0000	0.0000	0.0000	0.0035	0.0000	0.0000	0.0000	4.7760	0.0000	0.0000	0.0000
^{238}Pu	0.0670	0.0024	0.0000	0.0069	218.3345	7.7395	0.0003	2.9168	0.0670	0.0024	0.0000	0.0069
^{239}Pu	145.5381	341.3869	0.0013	979.6086	146.3969	343.4014	0.0013	2.8695	145.5381	341.3869	0.0013	979.6086
^{240}Pu	24.4398	0.0379	0.0001	0.1194	270.5812	0.4197	0.0007	3.1487	24.4398	0.0379	0.0001	0.1194
^{241}Pu	0.7916	2.2444	0.0000	6.5923	157.3119	446.0039	0.0025	2.9373	0.7916	2.2444	0.0000	6.5923
^{242}Pu	0.0287	0.0003	0.0000	0.0009	28.6131	0.2876	0.0016	3.1735	0.0287	0.0003	0.0000	0.0009
^{234}U	0.0079	0.0001	0.0000	0.0002	52.7429	0.5131	0.0005	2.5500	0.0079	0.0001	0.0000	0.0002
^{235}U	0.6739	3.7852	0.0001	9.2069	41.1787	231.2901	0.0036	2.4323	0.6739	3.7852	0.0001	9.2069
^{236}U	0.0054	0.0007	0.0000	0.0016	7.3115	0.8803	0.0021	2.4296	0.0054	0.0007	0.0000	0.0016
^{238}U	17.9304	0.2823	0.0176	0.8055	4.8827	0.0769	0.0048	2.8531	17.9304	0.2823	0.0176	0.8055
^{241}Am	1.5553	0.0107	0.0000	0.0340	279.0644	1.9243	0.0004	3.1700	1.5553	0.0107	0.0000	0.0340
^{10}B	0.3678	0.0000	0.0000	0.0000	1553.937	0.0000	0.0000	0.0000	0.3678	0.0000	0.0000	0.0000
Cd	0.1304	0.0000	0.0000	0.0000	985.7294	0.0000	0.0005	0.0000	0.1304	0.0000	0.0000	0.0000
Fe	0.0147	0.0000	0.0000	0.0000	1.0698	0.0000	0.0000	0.0000	8.8858	0.0000	0.0003	0.0000
Gd	0.3500	0.0000	0.0000	0.0000	19182.232	0.0000	0.0026	0.0000	0.3500	0.0000	0.0000	0.0000
^{6}Li	0.0032	0.0000	0.0000	0.0000	382.1139	0.0000	0.0004	0.0000	0.0032	0.0000	0.0000	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	1.2571	0.0000	0.0000	0.0000	3.0655	0.0000	0.0001	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	1.7903	0.0000	0.0000	0.0000	1.9374	0.0000	0.0000	0.0000
Mn	0.0000	0.0000	0.0000	0.0000	5.5741	0.0000	0.0001	0.0000	1.3415	0.0000	0.0000	0.0000
Total	524.8904	347.7508	0.0190	996.3762					634.4666	347.7508	0.0195	996.3762

[a]Energy region: from 1 to 299 groups.
Volume = 3.02746E+05.
Flux = 9.94102E+12.
[b]k_{eff} = 0.9962730.
Leakage = 17.906.

5.9 MIXED PLUTONIUM AND URANIUM NITRATE SOLUTION IN ANNULAR CYLINDRICAL GEOMETRY

This assembly is typical of a storage configuration for fissile materials. A mix of plutonium (8 wt % ^{240}Pu) and uranium nitrate solution filled the annular cylindrical vessel and was surrounded with a water reflector (Ref. 2, identified as MIX-SOL-THERM-001). The annular cylindrical inset was placed in the central region of the annular tank. In most of the experiments, the inset was fabricated from borate concrete. Interior to the inserts was a stainless steel bottle containing an additional plutonium-uranium nitrate solution. In Case 99 cadmium-covered polyethylene inserts were used. In cases considered here, the critical height changed from 27.5 to 79.2 cm. Multiplication factors are reported in Table 5.94. Calculated k-effectives reported in Tables 5.87 and 5.94 are shown in Fig. 5.11. Reaction rates from the MCU program are provided in Tables 5.95–5.99. Weighted cross section and reaction rate data are provided in Tables 5.100–5.104.

Table 5.94. Multiplication factors for annular geometry uranium/plutonium solution experiments

Experiment No.	Plutonium concentration (g/L)	Uranium concentration (g/L)	k_{eff}		
			Experiment	MCU	KENO-ABBN-90
87	102.19	365.20	1.0000 ± 0.0016	0.9931(14)	0.98415 ± 0.00082
95	195.61	6.5	1.0000 ± 0.0016	0.9998(13)	0.98778 ± 0.00087
97	58.3	2.3	1.0000 ± 0.0016	0.9988(12)	0.98878 ± 0.00084
99	73.64	250.30	1.0000 ± 0.0052	0.9968(12)	1.00028 ± 0.00083 (CH_3) 1.00250 ± 0.00083 (H_2O)
108	47.08	161.7	1.0000 ± 0.0052	0.9977(10)	0.98659 ± 0.00079
Averaged				0.9979	

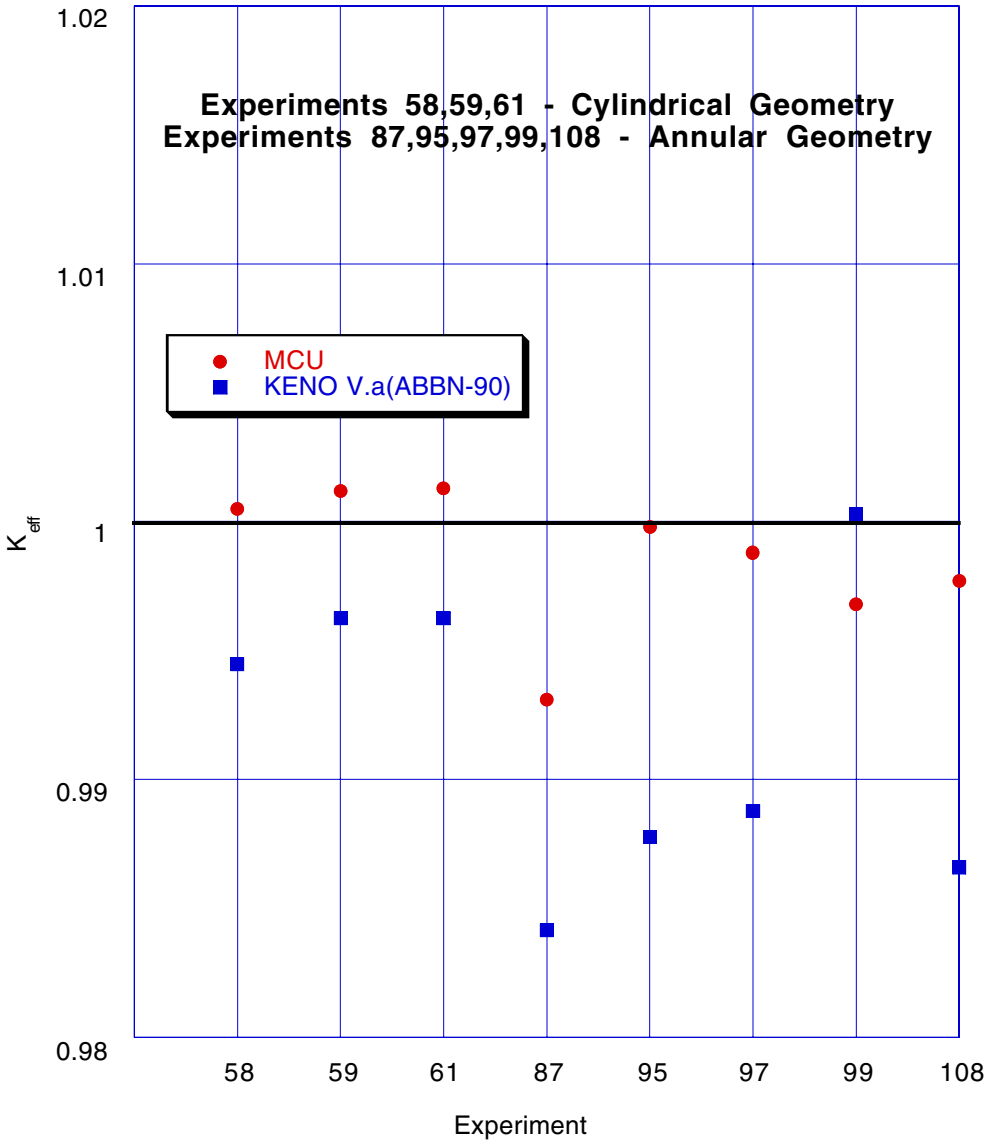

Fig. 5.11. Calculated k-effectives for mixed plutonium and uranium nitrate solution experiments.

Table 5.95. MCU reaction rates for Case 87

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.2625E+0		
^{6}Li	0.9903E–5		
^{7}Li	0.6684E–7		
^{10}B	0.6154E–1		
^{11}B	0.2265E–4		
C	0.6201E–6		
N	0.1210E–1		
O	0.5275E–2		
Na	0.2797E–4		
Mg	0.3225E–5		
Al	0.5020E–4		
Si	0.2744E–3		
P	0.6199E–9		
S	0.1373E–7		
K	0.1014E–3		
Ca	0.7600E–3		
Ti	0.5086E–4		
Cr	0.2489E–2		
Mn	0.1157E–2		
Fe	0.7428E–2		
Ni	0.1606E–2		
Cu	0.9146E–6		
Sr	0.5936E–6		
Zr	0.1829E–5		
Ba	0.6985E–5		
Cd	0.4118E–6		
^{234}U	0.1988E–4	0.1686E–5	0.6305E–6
^{235}U	0.6401E–2	0.1275E–1	0.5236E–2
^{236}U	0.7454E–4	0.5997E–5	0.2163E–5
^{238}U	0.4925E–1	0.5946E–2	0.2109E–2
^{238}Pu	0.5784E–5	0.6381E–5	0.2072E–5
^{239}Pu	0.5088E+0	0.9689E+0	0.3382E+0
^{240}Pu	0.5481E–1	0.8083E–3	0.2521E–3
^{241}Pu	0.2701E–2	0.5838E–2	0.1981E–2
^{242}Pu	0.9341E–5	0.5988E–5	0.1887E–5
^{241}Am	0.2361E–3	0.6984E–4	0.1976E–4

Table 5.96. MCU reaction rates for Case 95

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.2654E+0		
^{6}Li	0.1232E–4		
^{7}Li	0.8342E–7		
^{10}B	0.7646E–1		
^{11}B	0.2509E–4		
C	0.7155E–6		
N	0.9163E–2		
O	0.5259E–2		
Na	0.3349E–4		
Mg	0.3821E–5		
Al	0.5819E–4		
Si	0.3144E–3		
K	0.1195E–3		
Ca	0.8689E–3		
Ti	0.6159E–4		
Cr	0.2990E–2		
Mn	0.1404E–2		
Fe	0.8894E–2		
Ni	0.1949E–2		
Cu	0.1041E–5		
Sr	0.6787E–6		
Zr	0.1982E–5		
Ba	0.4543E–6		
Cd	0.7492E–5		
^{234}U	0.6356E–5	0.5449E–6	0.2037E–6
^{235}U	0.1980E–3	0.3822E–3	0.1568E–3
^{236}U	0.1082E–4	0.8681E–6	0.3131E–6
^{238}U	0.1894E–2	0.9562E–4	0.3390E–4
^{238}Pu	0.9471E–5	0.1059E–4	0.3435E–5
^{239}Pu	0.5289E+0	0.9941E+0	0.3469E+0
^{240}Pu	0.6747E–1	0.1374E–2	0.4277E–3
^{241}Pu	0.2436E–2	0.5269E–2	0.1788E–2
^{242}Pu	0.1197E–4	0.7896E–5	0.2488E–5
^{241}Am	0.3876E–3	0.1167E–3	0.3300E–4

Table 5.97. MCU reaction rates for Case 97

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.2931E+0		
^{6}Li	0.1371E–4		
^{7}Li	0.9324E–7		
^{10}B	0.8536E–1		
^{11}B	0.2336E–4		
C	0.6818E–6		
N	0.7907E–2		
O	0.4864E–2		
Na	0.3550E–4		
Mg	0.3945E–5		
Al	0.5964E–4		
Si	0.3117E–3		
K	0.1226E–3		
Ca	0.8414E–3		
Ti	0.6674E–4		
Cr	0.4209E–2		
Mn	0.1919E–2		
Fe	0.1245E–1		
Ni	0.2703E–2		
Cu	0.1045E–5		
Sr	0.6835E–6		
Zr	0.1849E–5		
Ba	0.1685E–6		
Cd	0.7185E–5		
^{234}U	0.2699E–5	0.2145E–6	0.8012E–7
^{235}U	0.2367E–3	0.4797E–3	0.1971E–3
^{236}U	0.4587E–5	0.3430E–6	0.1236E–6
^{238}U	0.8403E–3	0.3785E–4	0.1340E–4
^{238}Pu	0.3479E–5	0.3808E–5	0.1236E–5
^{239}Pu	0.5144E+0	0.9945E+0	0.3470E+0
^{240}Pu	0.4354E–1	0.5018E–3	0.1566E–3
^{241}Pu	0.2462E–2	0.5329E–2	0.1809E–2
^{242}Pu	0.4394E–5	0.2815E–5	0.8863E–6
^{241}Am	0.1461E–3	0.4214E–4	0.1193E–4

Table 5.98. MCU reaction rates for Case 99

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.2686E+0		
^{10}B	0.3089E–3		
C	0.1913E–5		
N	0.1115E–1		
O	0.4626E–2		
Si	0.4969E–8		
S	0.2744E–8		
P	0.1258E–9		
Cr	0.2054E–2		
Mn	0.9276E–3		
Fe	0.5971E–2		
Ni	0.1322E–2		
Cd	0.8202E–1		
^{234}U	0.1369E–4	0.1151E–5	0.4294E–6
^{235}U	0.6218E–2	0.1254E–1	0.5154E–2
^{236}U	0.5178E–4	0.4126E–5	0.1485E–5
^{238}U	0.3997E–1	0.4106E–2	0.1452E–2
^{238}Pu	0.5503E–3	0.4505E–5	0.1460E–5
^{239}Pu	0.5065E+0	0.9739E+0	0.3399E+0
^{240}Pu	0.4805E–1	0.5847E–3	0.1822E–3
^{241}Pu	0.2570E–2	0.5558E–2	0.1887E–2
^{242}Pu	0.6625E–5	0.4335E–5	0.1364E–5
^{241}Am	0.1759E–3	0.5236E–4	0.1479E–4

Table 5.99. MCU reaction rates for Case 108

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.2814E+0	0.0000E+0	0.0000E+0
^{6}Li	0.1304E–4	0.0000E+0	0.0000E+0
^{7}Li	0.8866E–7	0.0000E+0	0.0000E+0
^{10}B	0.8137E–1	0.0000E+0	0.0000E+0
^{11}B	0.2244E–4	0.0000E+0	0.0000E+0
C	0.6968E–6	0.0000E+0	0.0000E+0
N	0.1170E–1	0.0000E+0	0.0000E+0
O	0.5030E–2	0.0000E+0	0.0000E+0
Na	0.3397E–4	0.0000E+0	0.0000E+0
Mg	0.3822E–5	0.0000E+0	0.0000E+0
Al	0.5750E–4	0.0000E+0	0.0000E+0
Si	0.3047E–3	0.0000E+0	0.0000E+0
K	0.1169E–3	0.0000E+0	0.0000E+0
Ca	0.8028E–3	0.0000E+0	0.0000E+0
Ti	0.6364E–4	0.0000E+0	0.0000E+0
Cr	0.3369E–2	0.0000E+0	0.0000E+0
Mn	0.1543E–2	0.0000E+0	0.0000E+0
Fe	0.9985E–2	0.0000E+0	0.0000E+0
Ni	0.2158E–2	0.0000E+0	0.0000E+0
Cu	0.1001E–5	0.0000E+0	0.0000E+0
Sr	0.7032E–5	0.0000E+0	0.0000E+0
Zr	0.1797E–5	0.0000E+0	0.0000E+0
Ba	0.2140E–6	0.0000E+0	0.0000E+0
Cd	0.7032E–5	0.0000E+0	0.0000E+0
^{234}U	0.1025E–4	0.8226E–6	0.3073E–6
^{235}U	0.6482E–2	0.1319E–1	0.5419E–2
^{236}U	0.3937E–4	0.2937E–5	0.1058E–5
^{238}U	0.3476E–1	0.2918E–2	0.1033E–2
^{238}Pu	0.2989E–5	0.3247E–5	0.1054E–5
^{239}Pu	0.5028E+0	0.9761E+0	0.3406E+0
^{240}Pu	0.4141E–1	0.4181E–3	0.1306E–3
^{241}Pu	0.2615E–2	0.5660E–2	0.1921E–2
^{242}Pu	0.4872E–5	0.3060E–5	0.9636E–6
^{241}Am	0.1317E–3	0.3772E–4	0.1068E–4

Table 5.100. KENO-ABBN balance table for MIX-SOL-THERM-001, Experiment 87

	Zone 1[a]								Over all reactor (5 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
H + H (H_2O)	25.5293	0.0000	0.0000	0.0000	0.0266	0.0000	0.0000	0.0000	265.2697	0.0000	0.0000	0.0000
N	12.0507	0.0000	0.0000	0.0000	0.2043	0.0000	0.0000	0.0000	12.0507	0.0000	0.0000	0.0000
O	3.7785	0.0000	0.0000	0.0000	0.0055	0.0000	0.0000	0.0000	5.5227	0.0000	0.0000	0.0000
^{238}Pu	0.0525	0.0036	0.0000	0.0109	40.0162	2.7680	0.0004	2.9983	0.0525	0.0036	0.0000	0.0109
^{239}Pu	166.4044	334.3029	0.0079	958.2521	40.5590	81.4821	0.0019	2.8664	166.4044	334.3029	0.0079	958.2521
^{240}Pu	55.0364	0.2452	0.0004	0.7790	147.7080	0.6581	0.0010	3.1770	55.0364	0.2452	0.0004	0.7790
^{241}Pu	0.6742	1.9723	0.0001	5.7968	33.5524	98.1572	0.0039	2.9391	0.6742	1.9723	0.0001	5.7968
^{242}Pu	0.1301	0.0021	0.0000	0.0065	31.4594	0.4963	0.0024	3.1647	0.1301	0.0021	0.0000	0.0065
^{234}U	0.0277	0.0007	0.0000	0.0018	24.1017	0.6007	0.0008	2.6378	0.0277	0.0007	0.0000	0.0018
^{235}U	1.1742	5.3307	0.0006	12.9784	10.1911	46.2673	0.0055	2.4347	1.1742	5.3307	0.0006	12.9784
^{236}U	0.0769	0.0041	0.0000	0.0105	8.9035	0.4772	0.0031	2.5446	0.0769	0.0041	0.0000	0.0105
^{238}U	44.8190	2.0981	0.1161	5.9618	2.7950	0.1308	0.0072	2.8416	44.8190	2.0981	0.1161	5.9618
^{241}Am	2.1993	0.0265	0.0000	0.0880	93.5145	1.1265	0.0006	3.3205	2.1993	0.0265	0.0000	0.0880
^{10}B	0.3001	0.0000	0.0000	0.0000	307.3042	0.0000	0.0000	0.0000	37.8505	0.0000	0.0000	0.0000
Cd	0.0971	0.0000	0.0000	0.0000	177.9420	0.0000	0.0007	0.0000	0.0971	0.0000	0.0000	0.0000
Fe	0.0125	0.0000	0.0000	0.0000	0.2207	0.0000	0.0001	0.0000	7.5743	0.0000	0.0009	0.0000
Gd	0.1866	0.0000	0.0000	0.0000	********	0.0000	0.0027	0.0000	27.6610	0.0000	0.0026	0.0000
^{6}Li									0.0738	0.0000	0.0000	0.0000
C									0.0000	0.0000	0.0000	0.0000
Al									0.0369	0.0000	0.0000	0.0000
^{11}B									0.0003	0.0000	0.0000	0.0000
Ba									0.0062	0.0000	0.0000	0.0000
Ca									0.7120	0.0000	0.0000	0.0000
Cu									0.0009	0.0000	0.0000	0.0000
K									0.0980	0.0000	0.0000	0.0000
^{7}Li									0.0000	0.0000	0.0000	0.0000
Mg									0.0045	0.0000	0.0000	0.0000
Mn									1.1657	0.0000	0.0001	0.0000
Na									0.0206	0.0000	0.0000	0.0000
Si									0.1979	0.0000	0.0000	0.0000
Sr									0.0020	0.0000	0.0000	0.0000
Ti									0.0285	0.0000	0.0000	0.0000
Zr									0.0017	0.0000	0.0000	0.0000
Cr									2.5260	0.0000	0.0002	0.0000
Ni									1.6378	0.0000	0.0000	0.0000
S									0.0001	0.0000	0.0000	0.0000
P	0.0000	0.0000	0.0000	0.0000	5.5741	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
Total	312.5522	343.9861	0.1252	983.8857					633.1339	343.9861	0.1292	983.8857

[a]Energy region: from 1 to 299 groups.
Volume = 8.29995E+04.
Flux = 1.87397E+13.
[b]k_{eff} = 0.9841540.
Leakage = 22.739.

Table 5.101. KENO-ABBN balance table for MIX-SOL-THERM-001, Experiment 95

Nuclide	Zone 1[a]								Over all reactor (6 zones)[b]			
	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
H + H (H_2O)	12.1434	0.0000	0.0000	0.0000	0.0156	0.0000	0.0000	0.0000	264.6926	0.0000	0.0000	0.0000
N	8.0635	0.0000	0.0000	0.0000	0.1448	0.0000	0.0000	0.0000	8.9680	0.0000	0.0000	0.0000
O	3.1932	0.0000	0.0000	0.0000	0.0059	0.0000	0.0000	0.0000	5.4620	0.0000	0.0000	0.0000
^{238}Pu	0.0411	0.0042	0.0000	0.0128	22.2628	2.2876	0.0004	3.0283	0.0453	0.0047	0.0000	0.0143
^{239}Pu	160.6698	308.2954	0.0128	884.0273	25.7668	49.4416	0.0021	2.8675	178.8319	342.0312	0.0144	980.7532
^{240}Pu	59.5658	0.3718	0.0006	1.1833	110.6313	0.6905	0.0011	3.1831	67.0853	0.4181	0.0007	1.3306
^{241}Pu	0.5314	1.6069	0.0001	4.7253	20.0220	60.5498	0.0041	2.9406	0.5888	1.7819	0.0001	5.2401
^{242}Pu	0.1454	0.0024	0.0000	0.0077	31.7877	0.5292	0.0025	3.1649	0.1639	0.0027	0.0000	0.0086
^{234}U	0.0069	0.0002	0.0000	0.0005	21.5110	0.6224	0.0008	2.6463	0.0075	0.0002	0.0000	0.0006
^{235}U	0.0374	0.1455	0.0000	0.3545	7.0912	27.5782	0.0059	2.4368	0.0408	0.1577	0.0000	0.3842
^{236}U	0.0099	0.0005	0.0000	0.0012	9.2141	0.4442	0.0033	2.5695	0.0109	0.0005	0.0000	0.0013
^{238}U	1.6540	0.0308	0.0017	0.0876	7.4963	0.1397	0.0077	2.8411	1.8287	0.0338	0.0019	0.0961
^{241}Am	2.3040	0.0342	0.0000	0.1149	69.6308	1.0338	0.0006	3.3580	2.5767	0.0384	0.0000	0.1288
^{10}B	0.1194	0.0000	0.0000	0.0000	180.0069	0.0000	0.0000	0.0000	44.4194	0.0000	0.0000	0.0000
Cd	0.0492	0.0000	0.0000	0.0000	94.3189	0.0000	0.0007	0.0000	0.0540	0.0000	0.0000	0.0000
Fe	0.0101	0.0000	0.0000	0.0000	0.1341	0.0000	0.0001	0.0000	8.7618	0.0000	0.0015	0.0000
Gd	0.1113	0.0000	0.0000	0.0000	********	0.0000	0.0028	0.0000	36.9520	0.0000	0.0028	0.0000
^{6}Li									0.0863	0.0000	0.0000	0.0000
C									0.0000	0.0000	0.0000	0.0000
Al									0.0415	0.0000	0.0000	0.0000
^{11}B									0.0003	0.0000	0.0000	0.0000
Ba									0.0066	0.0000	0.0000	0.0000
Ca									0.8126	0.0000	0.0000	0.0000
Cu									0.0010	0.0000	0.0000	0.0000
K									0.1116	0.0000	0.0000	0.0000
^{7}Li									0.0000	0.0000	0.0000	0.0000
Mg									0.0052	0.0000	0.0000	0.0000
Mn									1.3629	0.0000	0.0001	0.0000
Na									0.0233	0.0000	0.0000	0.0000
Si									0.2252	0.0000	0.0000	0.0000
Sr									0.0024	0.0000	0.0000	0.0000
Ti									0.0332	0.0000	0.0000	0.0000
Zr									0.0018	0.0000	0.0000	0.0000
Cr									2.9161	0.0000	0.0004	0.0000
Ni									1.9152	0.0000	0.0001	0.0000
S									0.0001	0.0000	0.0000	0.0000
P	0.0000	0.0000	0.0000	0.0000	5.5741	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
Total	248.6579	310.4919	0.0153	890.5151					628.0349	344.4692	0.0221	987.9578

[a]Energy region: from 1 to 299 groups.
Volume = 4.70302E+04.
Flux = 2.61037E+13.
[b]k_{eff} = 0.9877820.
Leakage = 27.696.

Table 5.102. KENO-ABBN balance table for MIX-SOL-THERM-001, Experiment 97

Nuclide	Zone 1[a]								Over all reactor (6 zones)[b]			
	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
H + H (H_2O)	51.8749	0.0000	0.0000	0.0000	0.0511	0.0000	0.0000	0.0000	293.7039	0.0000	0.0000	0.0000
N	6.9966	0.0000	0.0000	0.0000	0.3399	0.0000	0.0000	0.0000	7.8615	0.0000	0.0000	0.0000
O	2.9339	0.0000	0.0000	0.0000	0.0052	0.0000	0.0000	0.0000	5.0840	0.0000	0.0000	0.0000
^{238}Pu	0.0503	0.0024	0.0000	0.0072	79.9071	3.8683	0.0004	2.9627	0.0543	0.0029	0.0000	0.0087
^{239}Pu	145.5769	310.5116	0.0040	890.2267	68.4106	145.9180	0.0019	2.8670	162.8737	342.6175	0.0055	982.2811
^{240}Pu	36.6189	0.1120	0.0002	0.3554	199.2883	0.6097	0.0010	3.1724	43.7235	0.1564	0.0003	0.4965
^{241}Pu	0.5658	1.6277	0.0000	4.7821	62.4733	179.7179	0.0037	2.9380	0.6204	1.7946	0.0000	5.2731
^{242}Pu	0.0497	0.0007	0.0000	0.0022	31.8729	0.4505	0.0023	3.1690	0.0680	0.0010	0.0000	0.0031
^{234}U	0.0041	0.0001	0.0000	0.0002	31.3547	0.5815	0.0007	2.6227	0.0047	0.0001	0.0000	0.0002
^{235}U	0.0368	0.1877	0.0000	0.4568	17.2310	87.8516	0.0054	2.4333	0.0401	0.1993	0.0000	0.4851
^{236}U	0.0039	0.0002	0.0000	0.0006	8.9328	0.5739	0.0030	2.5050	0.0049	0.0003	0.0000	0.0007
^{238}U	0.6587	0.0107	0.0006	0.0304	7.3684	0.1196	0.0070	2.8468	0.8294	0.0136	0.0008	0.0386
^{241}Am	1.5908	0.0151	0.0000	0.0494	140.8803	1.3380	0.0006	3.2681	1.8498	0.0191	0.0000	0.0627
^{10}B	0.1335	0.0000	0.0000	0.0000	590.0875	0.0000	0.0000	0.0000	45.7624	0.0000	0.0000	0.0000
Cd	0.0643	0.0000	0.0000	0.0000	361.5906	0.0000	0.0007	0.0000	0.0690	0.0000	0.0000	0.0000
Fe	0.0106	0.0000	0.0000	0.0000	0.4131	0.0000	0.0000	0.0000	12.3585	0.0000	0.0020	0.0000
Gd	0.1728	0.0000	0.0000	0.0000	********	0.0000	0.0026	0.0000	45.2455	0.0000	0.0031	0.0000
^{6}Li									0.0888	0.0000	0.0000	0.0000
C									0.0000	0.0000	0.0000	0.0000
Al									0.0409	0.0000	0.0000	0.0000
^{11}B									0.0004	0.0000	0.0000	0.0000
Ba									0.0063	0.0000	0.0000	0.0000
Ca									0.7764	0.0000	0.0000	0.0000
Cu									0.0009	0.0000	0.0000	0.0000
K									0.1084	0.0000	0.0000	0.0000
^{7}Li									0.0001	0.0000	0.0000	0.0000
Mg									0.0051	0.0000	0.0000	0.0000
Mn									1.8921	0.0000	0.0001	0.0000
Na									0.0233	0.0000	0.0000	0.0000
Si									0.2240	0.0000	0.0000	0.0000
Sr									0.0023	0.0000	0.0000	0.0000
Ti									0.0339	0.0000	0.0000	0.0000
Zr									0.0017	0.0000	0.0000	0.0000
Cr									4.1647	0.0000	0.0005	0.0000
Ni									2.6811	0.0000	0.0001	0.0000
S									0.0001	0.0000	0.0000	0.0000
P	0.0000	0.0000	0.0000	0.0000	5.5741	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
Total	247.3454	312.4682	0.0049	895.9112					630.2039	344.8048	0.0126	988.6500

[a]Energy region: from 1 to 299 groups.
Volume = 4.94749E+04.
Flux = 2.84809E+13.
[b]k_{eff} = 0.9887800.
Leakage = 24.872.

Table 5.103. KENO-ABBN balance table for MIX-SOL-THERM-001, Experiment 99

Nuclide	Zone 1[a]								Over all reactor (6 zones)[b]			
	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
H + H (H_2O)	38.9662	0.0000	0.0000	0.0000	0.0386	0.0000	0.0000	0.0000	79.7335	0.0000	0.0000	0.0000
N	10.8711	0.0000	0.0000	0.0000	0.2714	0.0000	0.0000	0.0000	10.8717	0.0000	0.0000	0.0000
O	3.4950	0.0000	0.0000	0.0000	0.0054	0.0000	0.0000	0.0000	3.5591	0.0000	0.0000	0.0000
^{238}Pu	0.0550	0.0031	0.0000	0.0091	59.5494	3.3068	0.0004	2.9785	0.0550	0.0031	0.0000	0.0091
^{239}Pu	158.4943	329.3112	0.0056	943.9905	54.8769	114.0203	0.0019	2.8666	158.5023	329.3293	0.0056	944.0425
^{240}Pu	46.4786	0.1676	0.0003	0.5324	176.5985	0.6369	0.0010	3.1757	46.4800	0.1676	0.0003	0.5324
^{241}Pu	0.6357	1.8376	0.0001	5.3997	47.9216	138.5283	0.0039	2.9384	0.6357	1.8377	0.0001	5.4000
^{242}Pu	0.0935	0.0014	0.0000	0.0044	31.7853	0.4757	0.0024	3.1681	0.0935	0.0014	0.0000	0.0044
^{234}U	0.0212	0.0005	0.0000	0.0012	27.5709	0.5929	0.0008	2.6317	0.0212	0.0005	0.0000	0.0012
^{235}U	1.0516	5.1435	0.0004	12.5184	13.6321	66.6766	0.0056	2.4338	1.0517	5.1439	0.0004	12.5192
^{236}U	0.0513	0.0030	0.0000	0.0077	8.8747	0.5255	0.0031	2.5245	0.0513	0.0030	0.0000	0.0077
^{238}U	35.5410	1.3540	0.0782	3.8531	3.3102	0.1261	0.0073	2.8458	35.5421	1.3540	0.0782	3.8532
^{241}Am	2.0403	0.0215	0.0000	0.0706	117.7838	1.2384	0.0006	3.2927	2.0404	0.0215	0.0000	0.0706
^{10}B	0.3070	0.0000	0.0000	0.0000	446.4596	0.0000	0.0000	0.0000	0.3070	0.0000	0.0000	0.0000
Cd	0.1032	0.0000	0.0000	0.0000	268.4604	0.0000	0.0007	0.0000	79.1445	0.0000	0.0020	0.0000
Fe	0.0126	0.0000	0.0000	0.0000	0.3153	0.0000	0.0001	0.0000	5.9621	0.0000	0.0006	0.0000
Gd	0.2076	0.0000	0.0000	0.0000	********	0.0000	0.0027	0.0000	0.2076	0.0000	0.0000	0.0000
^{6}Li									0.0027	0.0000	0.0000	0.0000
C									0.1886	0.0000	0.0000	0.0000
Al									0.0000	0.0000	0.0000	0.0000
^{11}B									0.0000	0.0000	0.0000	0.0000
Ba									0.0000	0.0000	0.0000	0.0000
Ca									0.0000	0.0000	0.0000	0.0000
Cu									0.0000	0.0000	0.0000	0.0000
K									0.0000	0.0000	0.0000	0.0000
^{7}Li									0.0000	0.0000	0.0000	0.0000
Mg									0.0000	0.0000	0.0000	0.0000
Mn									0.9183	0.0000	0.0000	0.0000
Na									0.0000	0.0000	0.0000	0.0000
Si									0.0000	0.0000	0.0000	0.0000
Sr									0.0000	0.0000	0.0000	0.0000
Ti									0.0000	0.0000	0.0000	0.0000
Zr									0.0000	0.0000	0.0000	0.0000
Cr									2.0553	0.0000	0.0002	0.0000
Ni									1.3267	0.0000	0.0000	0.0000
S									0.0000	0.0000	0.0000	0.0000
P	0.0000	0.0000	0.0000	0.0000	5.5741	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
Total	298.4276	337.8433	0.0847	966.3870					428.7502	337.8619	0.0876	966.4403

[a]Energy region: from 1 to 299 groups.
Volume = 1.35363E+05.
Flux = 1.14473E+13.
[b]k_{eff} = 1.0002800.
Leakage = 199.645.

Table 5.104. KENO-ABBN balance table for MIX-SOL-THERM-001, Experiment 108

Nuclide	Zone 1[a]								Over all reactor (6 zones)[b]			
	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
H + H (H_2O)	62.5259	0.0000	0.0000	0.0000	0.0570	0.0000	0.0000	0.0000	280.5864	0.0000	0.0000	0.0000
N	10.7555	0.0000	0.0000	0.0000	0.3720	0.0000	0.0000	0.0000	11.7045	0.0000	0.0000	0.0000
O	3.2028	0.0000	0.0000	0.0000	0.0049	0.0000	0.0000	0.0000	5.1400	0.0000	0.0000	0.0000
^{238}Pu	0.0553	0.0026	0.0000	0.0075	89.7599	4.1438	0.0003	2.9557	0.0592	0.0029	0.0000	0.0085
^{239}Pu	143.5310	309.8234	0.0034	888.3380	74.4260	160.6547	0.0018	2.8672	157.1476	336.2774	0.0041	964.1494
^{240}Pu	36.1208	0.1040	0.0002	0.3297	205.5429	0.5921	0.0009	3.1687	41.0569	0.1269	0.0002	0.4022
^{241}Pu	0.6147	1.7612	0.0000	5.1743	69.3975	198.8452	0.0035	2.9379	0.6637	1.9057	0.0000	5.5990
^{242}Pu	0.0613	0.0009	0.0000	0.0027	31.2080	0.4349	0.0021	3.1668	0.0740	0.0010	0.0000	0.0033
^{234}U	0.0169	0.0003	0.0000	0.0008	32.5182	0.5725	0.0007	2.6161	0.0194	0.0004	0.0000	0.0009
^{235}U	0.9845	5.1066	0.0003	12.4249	18.9130	98.1022	0.0050	2.4331	1.0791	5.5067	0.0003	13.3993
^{236}U	0.0338	0.0023	0.0000	0.0058	8.6501	0.5913	0.0028	2.4957	0.0413	0.0027	0.0000	0.0067
^{238}U	28.2613	0.8338	0.0478	2.3718	3.9009	0.1151	0.0066	2.8445	32.6474	1.0230	0.0581	2.9088
^{241}Am	1.7621	0.0161	0.0000	0.0523	150.7593	1.3750	0.0005	3.2564	1.9596	0.0186	0.0000	0.0606
^{10}B	0.3023	0.0000	0.0000	0.0000	658.5232	0.0000	0.0000	0.0000	44.2750	0.0000	0.0000	0.0000
Cd	0.1043	0.0000	0.0000	0.0000	406.3950	0.0000	0.0006	0.0000	0.1114	0.0000	0.0000	0.0000
Fe	0.0122	0.0000	0.0000	0.0000	0.4597	0.0000	0.0001	0.0000	9.8289	0.0000	0.0009	0.0000
Gd	0.2190	0.0000	0.0000	0.0000	********	0.0000	0.0024	0.0000	40.4277	0.0000	0.0028	0.0000
^{6}Li									0.0857	0.0000	0.0000	0.0000
C									0.0000	0.0000	0.0000	0.0000
Al									0.0392	0.0000	0.0000	0.0000
^{11}B									0.0003	0.0000	0.0000	0.0000
Ba									0.0062	0.0000	0.0000	0.0000
Ca									0.7385	0.0000	0.0000	0.0000
Cu									0.0009	0.0000	0.0000	0.0000
K									0.1039	0.0000	0.0000	0.0000
^{7}Li									0.0000	0.0000	0.0000	0.0000
Mg									0.0048	0.0000	0.0000	0.0000
Mn									1.5000	0.0000	0.0001	0.0000
Na									0.0225	0.0000	0.0000	0.0000
Si									0.2123	0.0000	0.0000	0.0000
Sr									0.0022	0.0000	0.0000	0.0000
Ti									0.0326	0.0000	0.0000	0.0000
Zr									0.0017	0.0000	0.0000	0.0000
Cr									3.2983	0.0000	0.0003	0.0000
Ni									2.1194	0.0000	0.0000	0.0000
S									0.0001	0.0000	0.0000	0.0000
P	0.0000	0.0000	0.0000	0.0000	5.5741	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
Total	288.5663	317.6512	0.0516	908.7077					634.9909	344.8653	0.0670	986.5388

[a]Energy region: from 1 to 299 groups.
Volume = 7.70844E+04.
Flux = 2.05917E+13.
[b]k_{eff} = 0.9865940.
Leakage = 20.156.

5.10 SQUARE LATTICE OF (PuO_2 + UO_2) RODS IN A WATER TANK WITH 20 wt % PLUTONIUM

A square lattice of plutonium oxide–uranium oxide fuel rods was placed within a large tank which was filled with water (Ref. 2, identified as MIX-COMP-THERM-001). The MOX fuel contained ~20 wt % plutonium (11.5 wt % ^{240}Pu) and natural uranium. The fuel pins were ~0.58 cm in diameter and ~2.4 m in length. The clad was fabricated from stainless steel. The fuel region was fully reflected by water (>15 cm). Critical configurations were determined for four-lattice spacing. Multiplication factors for these experiments are provided in Table 5.105 and shown in Fig. 5.12. Reaction rates from the MCU program are given in Tables 5.106–5.109. Weighted cross section and reaction rate data from the KENO-ABBN package are given in Tables 5.110–5.113.

Table 5.105. Multiplication factors for MOX pins with 20 wt % plutonium in MOX

Case	Lattice pitch (cm)	V_M/V_F	$H/^{239}Pu$	k_{eff} Experiment	k_{eff} MCU	k_{eff} KENO-ABBN-90
1	0.9525	1.52	24	1.0000 ± 0.0025	1.0035(10)	0.99055 ± 0.00109
2	1.258	3.69	59	1.0000 ± 0.0026	0.9985(10)	0.99089 ± 0.00116
3	1.5342	6.18	98	1.0000 ± 0.0032	0.9982(10)	0.98547 ± 0.00117
4	1.9050	10.28	163	1.0000 ± 0.0039	0.9997(10)	0.98956 ± 0.00117
Averaged					1.0012	

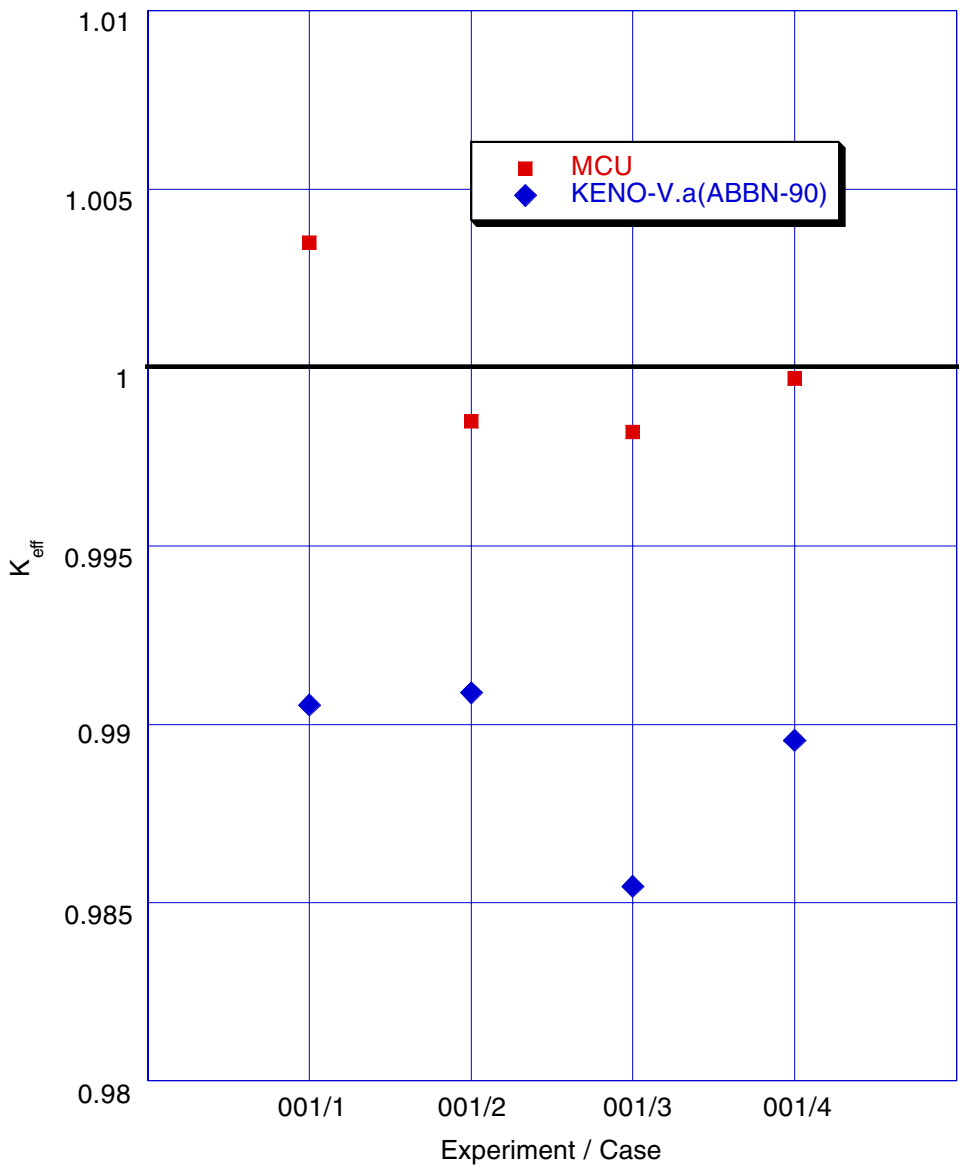

Fig. 5.12. Calculated k-effectives for water-reflected MOX pins (20 wt % plutonium).

Table 5.106. MCU reaction rates for Case 1

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3425E+0		
C	0.1158E–4		
N	0.4156E–5		
O	0.4730E–2		
Na	0.8558E–7		
Mg	0.7897E–7		
Al	0.4968E–5		
Si	0.1881E–4		
K	0.1209E–5		
Ca	0.1679E–5		
Cr	0.4102E–2		
Mn	0.1687E–2		
Fe	0.1113E–1		
Ni	0.7641E–2		
Cu	0.1175E–6		
Mo	0.5426E–5		
^{234}U	0.7553E–6	0.5927E–7	0.2216E–7
^{235}U	0.9020E–2	0.1712E–1	0.7014E–2
^{238}U	0.6021E–1	0.2451E–1	0.8684E–2
^{238}Pu	0.1025E–3	0.1317E–3	0.4258E–4
^{239}Pu	0.4818E+0	0.9283E+0	0.3228E+0
^{240}Pu	0.6225E–1	0.4568E–2	0.1417E–2
^{241}Pu	0.1286E–1	0.2810E–1	0.9526E–2
^{242}Pu	0.1250E–3	0.9649E–4	0.3043E–4
^{241}Am	0.1024E–2	0.3841E–3	0.1090E–3

Table 5.107. MCU reaction rates for Case 2

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3842E+0		
C	0.1704E–4		
N	0.3259E–5		
O	0.4725E–2		
Na	0.4536E–7		
Mg	0.4307E–7		
Al	0.3124E–5		
Si	0.1410E–4		
K	0.6395E–6		
Ca	0.8583E–6		
Cr	0.3878E–2		
Mn	0.1519E–2		
Fe	0.1109E–1		
Ni	0.6039E–2		
Cu	0.7656E–7		
Mo	0.3354E–5		
^{234}U	0.1062E–5	0.3848E–7	0.1501E–7
^{235}U	0.8261E–2	0.1627E–1	0.6675E–2
^{238}U	0.3673E–1	0.1484E–1	0.5250E–2
^{238}Pu	0.1521E–3	0.7577E–4	0.2454E–4
^{239}Pu	0.4812E+0	0.9365E+0	0.3261E+0
^{240}Pu	0.4631E–1	0.2702E–2	0.8367E–3
^{241}Pu	0.1240E–1	0.2705E–1	0.9174E–2
^{242}Pu	0.6824E–4	0.5743E–4	0.1807E–4
^{241}Am	0.5639E–3	0.2273E–3	0.6441E–4

Table 5.108. MCU reaction rates for Case 3

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4041E+0		
C	0.1536E–4		
N	0.3757E–5		
O	0.4759E–2		
Na	0.7189E–7		
Mg	0.6691E–7		
Al	0.4629E–5		
Si	0.1373E–4		
K	0.1010E–5		
Ca	0.1318E–5		
Cr	0.3854E–2		
Mn	0.1480E–2		
Fe	0.1125E–1		
Ni	0.5490E–2		
Cu	0.1085E–6		
Mo	0.2250E–5		
^{234}U	0.7568E–6	0.2970E–7	0.1156E–7
^{235}U	0.8075E–2	0.1617E–1	0.6636E–2
^{238}U	0.2758E–1	0.1140E–1	0.4029E–2
^{238}Pu	0.1326E–3	0.5577E–4	0.1804E–4
^{239}Pu	0.4803E+0	0.9415E+0	0.3279E+0
^{240}Pu	0.3866E–1	0.2048E–2	0.6336E–3
^{241}Pu	0.1237E–1	0.2698E–1	0.9153E–2
^{242}Pu	0.4789E–4	0.4367E–4	0.1373E–4
^{241}Am	0.3987E–3	0.1713E–3	0.4845E–4

Table 5.109. MCU reaction rates for Case 4

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.4169E+0		
C	0.1809E–4		
N	0.4559E–5		
O	0.4747E–2		
Na	0.9416E–7		
Mg	0.7940E–7		
Al	0.3811E–5		
Si	0.1372E–4		
K	0.1331E–5		
Ca	0.1845E–5		
Cr	0.3787E–2		
Mn	0.1448E–2		
Fe	0.1134E–1		
Ni	0.4925E–2		
Cu	0.7863E–7		
Mo	0.1524E–5		
^{234}U	0.6770E–6	0.2157E–7	0.8455E–8
^{235}U	0.8002E–2	0.1619E–1	0.6649E–2
^{238}U	0.2144E–1	0.9166E–2	0.3239E–2
^{238}Pu	0.1140E–3	0.4268E–4	0.1378E–4
^{239}Pu	0.4790E+0	0.9452E+0	0.3293E+0
^{240}Pu	0.3275E–1	0.1622E+0	0.5014E–3
^{241}Pu	0.1240E–1	0.2704E–1	0.9176E–2
^{242}Pu	0.3495E–4	0.3480E–4	0.1093E–4
^{241}Am	0.2866E–3	0.1352E–3	0.3819E–4

Table 5.110. KENO-ABBN balance table for MIX-COMP-THERM-001, Case 1

	Zone 1[a]								Over all reactor (9 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{238}Pu	0.2895	0.0502	0.0000	0.1536	11.6582	2.0219	0.0004	3.0589	0.2895	0.0502	0.0000	0.1536
^{239}Pu	157.8122	317.0687	0.0310	912.6603	11.1715	22.4453	0.0022	2.8784	157.8122	317.0687	0.0310	912.6603
^{240}Pu	59.5918	1.3755	0.0022	4.3915	31.6192	0.7299	0.0012	3.1926	59.5918	1.3755	0.0022	4.3915
^{241}Pu	2.9378	9.5600	0.0013	28.1477	9.9843	32.4902	0.0045	2.9443	2.9378	9.5600	0.0013	28.1477
^{242}Pu	1.4109	0.0330	0.0002	0.1044	24.7271	0.5789	0.0027	3.1611	1.4109	0.0330	0.0002	0.1044
^{234}U	0.0000	0.0000	0.0000	0.0000	15.4075	0.6701	0.0009	0.0000	0.0016	0.0000	0.0000	0.0001
^{235}U	1.8402	6.3363	0.0026	15.4689	4.4782	15.4196	0.0063	2.4413	1.9684	7.0161	0.0026	17.1229
^{238}U	50.2585	8.5369	0.4674	24.2505	0.8858	0.1505	0.0082	2.8407	51.2285	8.6247	0.4725	24.5010
^{241}Am	4.4673	0.1074	0.0001	0.3664	38.7885	0.9324	0.0007	3.4115	4.4673	0.1074	0.0001	0.3664
O	0.9261	0.0000	0.0000	0.0000	0.0063	0.0000	0.0000	0.0000	4.7208	0.0000	0.0000	0.0000
H + H (H_2O)	0.0000	0.0000	0.0000	0.0000	0.0081	0.0000	0.0000	0.0000	338.4148	0.0000	0.0000	0.0000
Fe	0.0000	0.0000	0.0000	0.0000	0.0758	0.0000	0.0001	0.0000	9.8159	0.0000	0.0041	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.0846	0.0000	0.0001	0.0000	3.7927	0.0000	0.0013	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.1574	0.0000	0.0000	0.0000	8.1983	0.0000	0.0003	0.0000
Mo	0.0000	0.0000	0.0000	0.0000	0.7359	0.0000	0.0005	0.0000	1.2319	0.0000	0.0012	0.0000
Mn	0.0000	0.0000	0.0000	0.0000	0.5918	0.0000	0.0001	0.0000	1.5275	0.0000	0.0003	0.0000
C	0.0000	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000	0.0109	0.0000	0.0000	0.0000
Si	0.0000	0.0000	0.0000	0.0000	0.0114	0.0000	0.0000	0.0000	0.0145	0.0000	0.0000	0.0000
Total	279.5344	343.0680	0.5047	985.5432					647.4352	343.8358	0.5171	987.4477

[a]Energy region: from 1 to 299 groups.
Volume = 1.06044E+04.
Flux = 2.71245E+13.
[b]k_{eff} = 0.9905500.
Leakage = 6.119.

Table 5.111. KENO-ABBN balance table for MIX-COMP-THERM-001, Case 2

	Zone 1[a]								Over all reactor (9 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{238}Pu	0.3178	0.0332	0.0000	0.1010	22.2621	2.3240	0.0005	3.0445	0.3178	0.0332	0.0000	0.1010
^{239}Pu	153.3880	324.2440	0.0198	931.8005	18.8845	39.9197	0.0024	2.8738	153.3880	324.2440	0.0198	931.8005
^{240}Pu	45.5915	0.8145	0.0014	2.6061	42.0719	0.7516	0.0013	3.1997	45.5915	0.8145	0.0014	2.6061
^{241}Pu	2.9499	9.2497	0.0008	27.2084	17.4362	54.6723	0.0049	2.9415	2.9499	9.2497	0.0008	27.2084
^{242}Pu	0.8568	0.0196	0.0001	0.0623	26.1169	0.5989	0.0030	3.1686	0.8568	0.0196	0.0001	0.0623
^{234}U	0.0000	0.0000	0.0000	0.0000	17.5532	0.6974	0.0009	0.0000	0.0011	0.0000	0.0000	0.0000
^{235}U	1.4839	6.2370	0.0017	15.2041	6.2803	26.3973	0.0070	2.4377	1.5798	6.7651	0.0017	16.4888
^{238}U	31.0815	5.1846	0.3008	14.7496	0.9528	0.1589	0.0092	2.8449	31.6663	5.2270	0.3030	14.8701
^{241}Am	3.5280	0.0690	0.0000	0.2340	53.2753	1.0413	0.0007	3.3938	3.5280	0.0690	0.0000	0.2340
O	0.5741	0.0000	0.0000	0.0000	0.0068	0.0000	0.0000	0.0000	4.7006	0.0000	0.0000	0.0000
H + H (H_2O)	0.0000	0.0000	0.0000	0.0000	0.0148	0.0000	0.0000	0.0000	380.0767	0.0000	0.0000	0.0000
Fe	0.0000	0.0000	0.0000	0.0000	0.1280	0.0000	0.0001	0.0000	9.9620	0.0000	0.0023	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.1460	0.0000	0.0001	0.0000	3.5958	0.0000	0.0008	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.2468	0.0000	0.0000	0.0000	6.5226	0.0000	0.0002	0.0000
Mo	0.0000	0.0000	0.0000	0.0000	0.7504	0.0000	0.0005	0.0000	0.8149	0.0000	0.0007	0.0000
Mn	0.0000	0.0000	0.0000	0.0000	0.8336	0.0000	0.0001	0.0000	1.4425	0.0000	0.0001	0.0000
C	0.0000	0.0000	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	0.0185	0.0000	0.0000	0.0000
Si	0.0000	0.0000	0.0000	0.0000	0.0151	0.0000	0.0000	0.0000	0.0118	0.0000	0.0000	0.0000
Total	239.7716	345.8515	0.3246	991.9659					647.0248	346.4221	0.3310	993.3712

[a]Energy region: from 1 to 299 groups.
Volume = 4.89032E+03.
Flux = 3.35745E+13.
[b]k_{eff} = 0.9908900.
Leakage = 9.391.

Table 5.112. KENO-ABBN balance table for MIX-COMP-THERM-001, Case 3

	Zone 1[a]								Over all reactor (9 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{238}Pu	0.3330	0.0274	0.0000	0.0830	31.5804	2.5944	0.0005	3.0330	0.3330	0.0274	0.0000	0.0830
^{239}Pu	148.2926	323.5297	0.0152	929.4325	24.7169	53.9248	0.0025	2.8728	148.2926	323.5297	0.0152	929.4325
^{240}Pu	38.1592	0.6135	0.0011	1.9654	47.6724	0.7664	0.0013	3.2038	38.1592	0.6135	0.0011	1.9654
^{241}Pu	2.9473	9.1385	0.0006	26.8717	23.5841	73.1265	0.0051	2.9405	2.9473	9.1385	0.0006	26.8717
^{242}Pu	0.6215	0.0149	0.0001	0.0471	25.6481	0.6130	0.0031	3.1724	0.6215	0.0149	0.0001	0.0471
^{234}U	0.0000	0.0000	0.0000	0.0000	18.8104	0.7189	0.0010	0.0000	0.0009	0.0000	0.0000	0.0000
^{235}U	1.3560	6.2567	0.0013	15.2435	7.7695	35.8500	0.0073	2.4363	1.4403	6.7268	0.0013	16.3870
^{238}U	23.5210	3.9589	0.2297	11.2704	0.9761	0.1643	0.0095	2.8468	23.9890	3.9894	0.2320	11.3573
^{241}Am	3.0803	0.0546	0.0000	0.1848	62.9730	1.1170	0.0008	3.3828	3.0803	0.0546	0.0000	0.1848
O	0.4443	0.0000	0.0000	0.0000	0.0071	0.0000	0.0000	0.0000	4.8318	0.0000	0.0000	0.0000
H + H (H_2O)	0.0000	0.0000	0.0000	0.0000	0.0205	0.0000	0.0000	0.0000	403.7354	0.0000	0.0000	0.0000
Fe	0.0000	0.0000	0.0000	0.0000	0.1724	0.0000	0.0001	0.0000	10.3274	0.0000	0.0014	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.1983	0.0000	0.0001	0.0000	3.6502	0.0000	0.0005	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.3223	0.0000	0.0000	0.0000	6.1636	0.0000	0.0001	0.0000
Mo	0.0000	0.0000	0.0000	0.0000	0.7544	0.0000	0.0005	0.0000	0.6693	0.0000	0.0005	0.0000
Mn	0.0000	0.0000	0.0000	0.0000	1.0424	0.0000	0.0001	0.0000	1.4253	0.0000	0.0001	0.0000
C	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000	0.0000	0.0000	0.0152	0.0000	0.0000	0.0000
Si	0.0000	0.0000	0.0000	0.0000	0.0181	0.0000	0.0000	0.0000	0.0110	0.0000	0.0000	0.0000
Total	218.7554	343.5942	0.2480	985.0986					649.6934	344.0948	0.2529	986.3289

[a]Energy region: from 1 to 299 groups.
Volume = 3.59324E+03.
Flux = 3.39545E+13.
[b]k_{eff} = 0.9854700.
Leakage = 7.340.

Table 5.113. KENO-ABBN balance table for MIX-COMP-THERM-001, Case 4

	Zone 1[a]								Over all reactor (9 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{238}Pu	0.3481	0.0238	0.0000	0.0719	42.5972	2.9095	0.0005	3.0218	0.3481	0.0238	0.0000	0.0719
^{239}Pu	145.5821	325.9165	0.0124	936.1460	31.3092	70.0923	0.0027	2.8723	145.5821	325.9165	0.0124	936.1460
^{240}Pu	32.4978	0.4853	0.0009	1.5567	52.3854	0.7823	0.0014	3.2076	32.4978	0.4853	0.0009	1.5567
^{241}Pu	2.9800	9.1572	0.0005	26.9200	30.7679	94.5473	0.0053	2.9398	2.9800	9.1572	0.0005	26.9200
^{242}Pu	0.4407	0.0118	0.0001	0.0375	23.4656	0.6282	0.0032	3.1756	0.4407	0.0118	0.0001	0.0375
^{234}U	0.0000	0.0000	0.0000	0.0000	19.7661	0.7424	0.0010	0.0000	0.0007	0.0000	0.0000	0.0000
^{235}U	1.2829	6.3558	0.0010	15.4791	9.4850	46.9898	0.0076	2.4354	1.3520	6.7455	0.0010	16.4268
^{238}U	18.1850	3.1777	0.1863	9.0485	0.9738	0.1702	0.0100	2.8475	18.5273	3.1976	0.1874	9.1049
^{241}Am	2.7801	0.0455	0.0000	0.1533	73.3340	1.1993	0.0008	3.3718	2.7801	0.0455	0.0000	0.1533
O	0.3592	0.0000	0.0000	0.0000	0.0074	0.0000	0.0000	0.0000	4.7950	0.0000	0.0000	0.0000
H + H (H_2O)	0.0000	0.0000	0.0000	0.0000	0.0272	0.0000	0.0000	0.0000	417.1896	0.0000	0.0000	0.0000
Fe	0.0000	0.0000	0.0000	0.0000	0.2244	0.0000	0.0001	0.0000	10.3543	0.0000	0.0012	0.0000
Cr	0.0000	0.0000	0.0000	0.0000	0.2597	0.0000	0.0001	0.0000	3.5580	0.0000	0.0004	0.0000
Ni	0.0000	0.0000	0.0000	0.0000	0.4105	0.0000	0.0000	0.0000	5.5080	0.0000	0.0001	0.0000
Mo	0.0000	0.0000	0.0000	0.0000	0.7581	0.0000	0.0006	0.0000	0.5772	0.0000	0.0004	0.0000
Mn	0.0000	0.0000	0.0000	0.0000	1.2866	0.0000	0.0002	0.0000	1.4181	0.0000	0.0001	0.0000
C	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000	0.0000	0.0000	0.0208	0.0000	0.0000	0.0000
Si	0.0000	0.0000	0.0000	0.0000	0.0215	0.0000	0.0000	0.0000	0.0104	0.0000	0.0000	0.0000
Total	204.4559	345.1736	0.2012	989.4128					647.9402	345.5831	0.2045	990.4170

[a]Energy region: from 1 to 299 groups.
Volume = 2.83954E+03.
Flux = 3.31691E+13.
[b]k_{eff} = 0.9895550.
Leakage = 7.554.

5.11 SQUARE LATTICE OF (PuO_2 + UO_2) RODS IN A WATER TANK WITH 2 wt % PLUTONIUM

A square lattice of fuel rods was placed within a large tank that filled with water (Ref. 3). The fuel consisted of UO_2 and 2 wt % PuO_2 (8 wt % ^{240}Pu). The fuel rods were ~1.28 cm in diameter and ~87 cm in length. The clad was fabricated from zirconium. Critical configurations were determined for three-lattice spacings in pure or borated water. The fuel region was fully reflected by water (>15 cm). Multiplication factors are provided in Table 5.114 and shown in Fig. 5.13. Reaction rate parameters generated by the MCU program are given in Tables 5.115–5.120. Weighted cross section and reaction rate data from the KENO-ABBN calculations are provided in Tables 5.121–5.126.

Table 5.114. Multiplication factors for MOX pin arrays with low plutonium content

Case	Lattice pitch (cm)	Boron	V_M/V_F	$H/^{239}Pu$	MCU k_{eff}	KENO-ABBN-90 k_{eff}
PNL-30	1.778	No	2.13	357	1.000(2)	0.99406 ± 0.00103
PNL-31	1.778	Yes	2.13	357	1.000(2)	0.99915 ± 0.00100
PNL-32	2.209	No	7.15	1200	1.001(2)	1.00092 ± 0.00076
PNL-33	2.209	Yes	7.15	1200	1.005(2)	1.00423 ± 0.00082
PNL-34	2.514	No	8.13	1365	1.002(1)	1.00208 ± 0.00102
PNL-35	2.514	Yes	8.13	1365	1.008(2)	1.00406 ± 0.00089
Averaged					1.003	

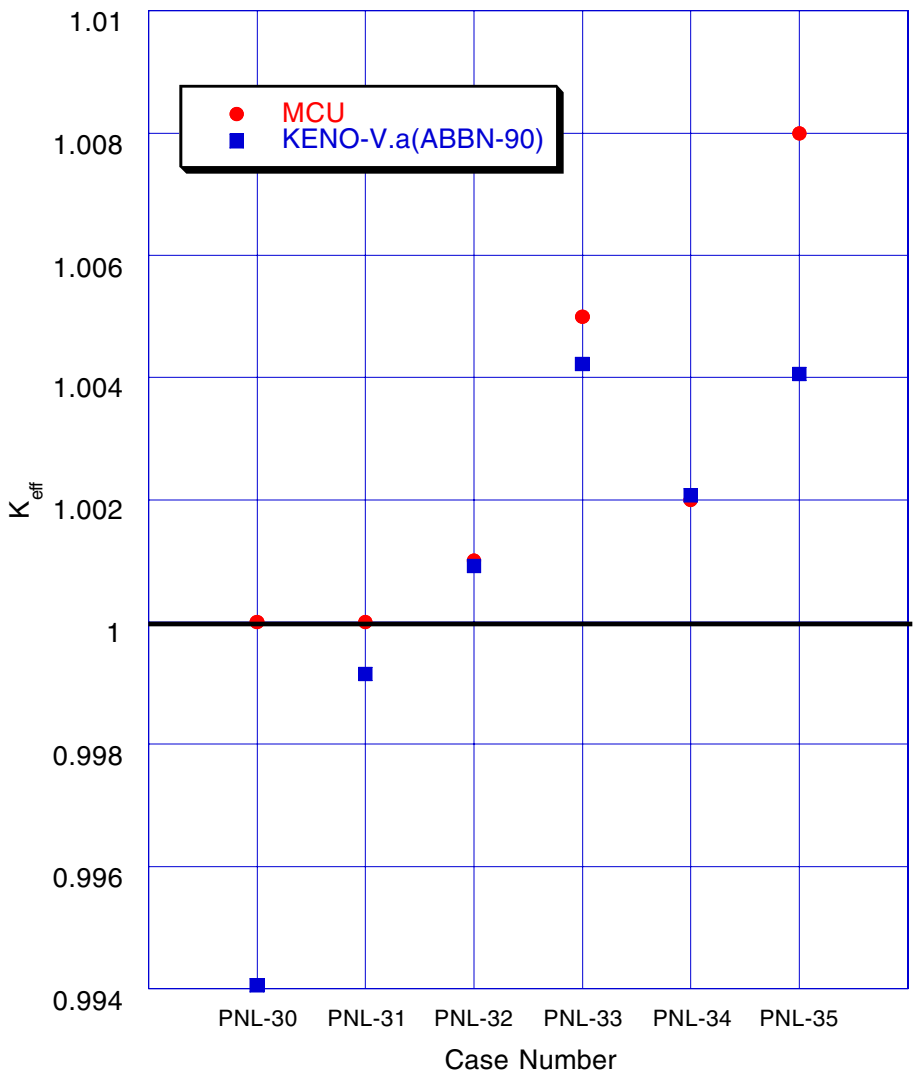

Fig. 5.13. K-effectives for low plutonium content MOX fuel rods.

Table 5.115. MCU reaction rates for assembly PNL-30

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.2565E+0		
^{10}B	0.8327E–3		
O	0.4792E–2		
Al	0.3499E–2		
Zr	0.5059E–2		
Pb	0.2830E–3		
^{234}U	0.5544E–6	0.2974E–7	0.1149E–7
^{235}U	0.7322E–1	0.1456E+0	0.5978E–1
^{238}U	0.1916E+0	0.7202E–1	0.2563E–1
^{239}Pu	0.4068E+0	0.7784E+0	0.2716E+0
^{240}Pu	0.3479E–1	0.7291E–3	0.2280E–3
^{241}Pu	0.1845E–2	0.3991E–2	0.1355E–2
^{242}Pu	0.3872E–4	0.1759E–5	0.5582E–6

Table 5.116. MCU reaction rates for assembly PNL-31

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.1088E+0		
^{10}B	0.1416E+0		
O	0.4810E–2		
Al	0.1886E–2		
Zr	0.5475E–2		
Pb	0.1554E–3		
^{234}U	0.3863E–6	0.3361E–7	0.1285E–7
^{235}U	0.7163E–1	0.1413E+0	0.5801E–1
^{238}U	0.2094E+0	0.7805E–1	0.2778E–1
^{239}Pu	0.4087E+0	0.7755E+0	0.2706E+0
^{240}Pu	0.3785E–1	0.7944E–3	0.2485E–3
^{241}Pu	0.1820E–2	0.3934E–2	0.1335E–2
^{242}Pu	0.4205E–4	0.1912E–5	0.6071E–6

Table 5.117. MCU reaction rates for assembly PNL-32

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3286E+0		
^{10}B	0.5647E–3		
O	0.4770E–2		
Al	0.2543E–2		
Zr	0.3607E–2		
Pb	0.3398E–3		
^{234}U	0.3773E–6	0.1899E–7	0.7366E–8
^{235}U	0.7649E–1	0.1555E+0	0.6389E–1
^{238}U	0.1291E+0	0.4606E–1	0.1634E–1
^{239}Pu	0.4090E+0	0.7964E+0	0.2778E+0
^{240}Pu	0.2528E–1	0.4416E–3	0.1376E–3
^{241}Pu	0.1919E–2	0.4164E–2	0.1413E–2
^{242}Pu	0.2153E–4	0.1076E–5	0.3402E–6

Table 5.118. MCU reaction rates for assembly PNL-33

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.1019E+0		
^{10}B	0.2125E+0		
O	0.4651E–2		
Al	0.1191E–2		
Zr	0.3987E–2		
Pb	0.1373E–3		
^{234}U	0.3608E–6	0.2051E–7	0.7868E–8
^{235}U	0.7428E–1	0.1498E+0	0.6152E–1
^{238}U	0.1502E+0	0.5352E–1	0.1901E–1
^{239}Pu	0.4133E+0	0.7964E+0	0.2779E+0
^{240}Pu	0.3021E–1	0.5202E–3	0.1623E–3
^{241}Pu	0.1890E–2	0.4094E–2	0.1390E–2
^{242}Pu	0.2713E–4	0.1260E–5	0.3986E–6

Table 5.119. MCU reaction rates for assembly PNL-34

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.3409E+0		
^{10}B	0.1041E–2		
O	0.4682E–2		
Al	0.3376E–2		
Zr	0.3163E–2		
Pb	0.2095E–3		
^{234}U	0.3085E–6	0.1313E–7	0.5085E–8
^{235}U	0.7802E–1	0.1595E+0	0.6556E–1
^{238}U	0.1110E+0	0.3808E–1	0.1350E–1
^{239}Pu	0.4079E+0	0.7997E+0	0.2789E+0
^{240}Pu	0.2190E–1	0.3598E–3	0.1120E–3
^{241}Pu	0.1945E–2	0.4223E–2	0.1434E–2
^{242}Pu	0.1745E–4	0.8800E–6	0.2779E–6

Table 5.120. MCU reaction rates for assembly PNL-35

Nuclide	R(abs)	R(ν · fis)	R(fis)
H	0.1381E+0		
^{10}B	0.2025E+0		
O	0.4613E–2		
Al	0.1551E–2		
Zr	0.3456E–2		
Pb	0.1815E–3		
^{234}U	0.3662E–6	0.1534E–7	0.5940E–8
^{235}U	0.7651E–1	0.1556E+0	0.6394E–1
^{238}U	0.1263E+0	0.4338E–1	0.1539E–1
^{239}Pu	0.4133E+0	0.8036E+0	0.2803E+0
^{240}Pu	0.2543E–1	0.4140E–3	0.1290E–3
^{241}Pu	0.1930E–2	0.4188E–2	0.1422E–2
^{242}Pu	0.2198E–4	0.1008E–5	0.3185E–6

Table 5.121. KENO-ABBN balance table for PNL-30

Nuclide	Zone 1[a]								Over all reactor (7 zones)[b]			
	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	132.1745	268.2834	0.0067	769.4094	30.9110	62.7421	0.0016	2.8679	132.1745	268.2834	0.0067	769.4094
^{240}Pu	36.1619	0.2223	0.0003	0.7028	100.5027	0.6180	0.0008	3.1607	36.1619	0.2223	0.0003	0.7028
^{241}Pu	0.4494	1.3426	0.0001	3.9465	26.1029	77.9872	0.0032	2.9394	0.4494	1.3426	0.0001	3.9465
^{242}Pu	0.0383	0.0006	0.0000	0.0019	29.6501	0.4674	0.0019	3.1407	0.0383	0.0006	0.0000	0.0019
^{234}U	0.0000	0.0000	0.0000	0.0000	19.9259	0.5700	0.0006	0.0000	0.0006	0.0000	0.0000	0.0000
^{235}U	13.4348	60.3473	0.0073	146.9446	8.3019	37.2909	0.0045	2.4350	13.4820	60.5975	0.0074	147.5534
^{238}U	166.1233	25.5917	1.3221	72.4382	0.7448	0.1147	0.0059	2.8305	166.4739	25.6315	1.3242	72.5503
Zr	0.0000	0.0000	0.0000	0.0000	0.0462	0.0000	0.0006	0.0000	3.5140	0.0000	0.0614	0.0000
O	2.1491	0.0000	0.0000	0.0000	0.0045	0.0000	0.0000	0.0000	4.9487	0.0000	0.0000	0.0000
H + H (H_2O)	0.0000	0.0000	0.0000	0.0000	0.0213	0.0000	0.0000	0.0000	273.2384	0.0000	0.0000	0.0000
^{10}B	0.0000	0.0000	0.0000	0.0000	246.7813	0.0000	0.0000	0.0000	0.8861	0.0000	0.0000	0.0000
Al	0.0000	0.0000	0.0000	0.0000	0.0183	0.0000	0.0000	0.0000	1.1542	0.0000	0.0000	0.0000
Pb	0.0000	0.0000	0.0000	0.0000	0.0142	0.0000	0.0020	0.0000	0.1590	0.0000	0.0041	0.0000
Total	350.5313	355.7880	1.3365	993.4433					632.6810	356.0780	1.4041	994.1642

[a]Energy region: from 1 to 299 groups.
Volume = 5.51233E+04.
Flux = 1.62782E+13.
[b]k_{eff} = 0.9940600.
Leakage = 12.758.

Table 5.122. KENO-ABBN balance table for PNL-31

Nuclide	Zone 1[a]								Over all reactor (7 zones)[b]			
	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	135.5679	269.2025	0.0074	771.9124	28.9019	57.3917	0.0016	2.8674	135.5679	269.2025	0.0074	771.9124
^{240}Pu	39.2528	0.2417	0.0003	0.7637	99.4495	0.6123	0.0008	3.1603	39.2528	0.2417	0.0003	0.7637
^{241}Pu	0.4444	1.3341	0.0001	3.9217	23.5313	70.6412	0.0032	2.9396	0.4444	1.3341	0.0001	3.9217
^{242}Pu	0.0443	0.0007	0.0000	0.0021	31.3111	0.4619	0.0019	3.1410	0.0443	0.0007	0.0000	0.0021
^{234}U	0.0000	0.0000	0.0000	0.0000	19.6564	0.5612	0.0006	0.0000	0.0005	0.0000	0.0000	0.0000
^{235}U	13.6625	59.1254	0.0081	143.9887	7.6963	33.3061	0.0046	2.4353	13.6994	59.3129	0.0081	144.4449
^{238}U	182.1193	27.6595	1.4434	78.3554	0.7443	0.1130	0.0059	2.8329	182.4389	27.6994	1.4452	78.4678
Zr	0.0000	0.0000	0.0000	0.0000	0.0460	0.0000	0.0006	0.0000	3.6605	0.0000	0.0689	0.0000
O	2.3685	0.0000	0.0000	0.0000	0.0046	0.0000	0.0000	0.0000	5.0663	0.0000	0.0000	0.0000
H + H (H_2O)	0.0000	0.0000	0.0000	0.0000	0.0190	0.0000	0.0000	0.0000	111.6856	0.0000	0.0000	0.0000
^{10}B	0.0000	0.0000	0.0000	0.0000	219.9299	0.0000	0.0000	0.0000	145.1337	0.0000	0.0000	0.0000
Al	0.0000	0.0000	0.0000	0.0000	0.0167	0.0000	0.0000	0.0000	0.8669	0.0000	0.0000	0.0000
Pb	0.0000	0.0000	0.0000	0.0000	0.0131	0.0000	0.0021	0.0000	0.1165	0.0000	0.0030	0.0000
Total	373.4598	357.5638	1.4593	998.9439					637.9778	357.7912	1.5331	999.5126

[a]Energy region: from 1 to 299 groups.
Volume = 8.94432E+04.
Flux = 1.09501E+13.
[b]k_{eff} = 0.9991500.
Leakage = 6.128.

Table 5.123. KENO-ABBN balance table for PNL-32

	Zone 1[a]								Over all reactor (7 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	127.6404	276.1311	0.0043	792.0707	50.5395	109.3347	0.0017	2.8685	127.6404	276.1311	0.0043	792.0707
^{240}Pu	26.2835	0.1340	0.0002	0.4251	123.6767	0.6306	0.0009	3.1718	26.2835	0.1340	0.0002	0.4251
^{241}Pu	0.4784	1.4111	0.0000	4.1464	47.0476	138.7754	0.0035	2.9384	0.4784	1.4111	0.0000	4.1464
^{242}Pu	0.0222	0.0004	0.0000	0.0012	29.0495	0.4804	0.0021	3.1533	0.0222	0.0004	0.0000	0.0012
^{234}U	0.0000	0.0000	0.0000	0.0000	24.8782	0.6036	0.0007	0.0000	0.0004	0.0000	0.0000	0.0000
^{235}U	12.8391	65.4163	0.0048	159.2044	13.4325	68.4398	0.0050	2.4337	12.8792	65.6372	0.0048	159.7417
^{238}U	113.7014	16.1232	0.8466	45.7250	0.8631	0.1224	0.0064	2.8360	113.9388	16.1442	0.8477	45.7846
Zr	0.0000	0.0000	0.0000	0.0000	0.0514	0.0000	0.0006	0.0000	2.7626	0.0000	0.0378	0.0000
O	1.4117	0.0000	0.0000	0.0000	0.0050	0.0000	0.0000	0.0000	4.8488	0.0000	0.0000	0.0000
H + H (H_2O)	0.0000	0.0000	0.0000	0.0000	0.0398	0.0000	0.0000	0.0000	337.1051	0.0000	0.0000	0.0000
^{10}B	0.0000	0.0000	0.0000	0.0000	460.2616	0.0000	0.0000	0.0000	0.5788	0.0000	0.0000	0.0000
Al	0.0000	0.0000	0.0000	0.0000	0.0309	0.0000	0.0000	0.0000	1.1358	0.0000	0.0000	0.0000
Pb	0.0000	0.0000	0.0000	0.0000	0.0234	0.0000	0.0022	0.0000	0.1516	0.0000	0.0021	0.0000
Total	282.3767	359.2161	0.8559	1001.5728					627.8255	359.4580	0.8969	1002.1697

[a]Energy region: from 1 to 299 groups.
Volume = 2.29191E+04.
Flux = 2.29221E+13.
[b]k_{eff} = 1.0009151.
Leakage = 14.866.

Table 5.124. KENO-ABBN balance table for PNL-33

	Zone 1[a]								Over all reactor (7 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	132.3559	276.1497	0.0053	791.8440	44.1779	92.1736	0.0018	2.8674	132.3559	276.1497	`0.0053	791.8440
^{240}Pu	31.3159	0.1579	0.0002	0.5005	124.2193	0.6262	0.0009	3.1702	31.3159	0.1579	0.0002	0.5005
^{241}Pu	0.4679	1.3854	0.0000	4.0711	38.7872	114.8502	0.0035	2.9387	0.4679	1.3854	0.0000	4.0711
^{242}Pu	0.0284	0.0004	0.0000	0.0014	31.3898	0.4743	0.0022	3.1535	0.0284	0.0004	0.0000	0.0014
^{234}U	0.0000	0.0000	0.0000	0.0000	23.6592	0.5873	0.0007	0.0000	0.0004	0.0000	0.0000	0.0000
^{235}U	12.8958	62.7075	0.0058	152.6361	11.3734	55.3046	0.0051	2.4341	12.9290	62.8844	0.0058	153.0666
^{238}U	132.3947	18.8390	1.0296	53.4679	0.8472	0.1205	0.0066	2.8381	132.6435	18.8633	1.0308	53.5366
Zr	0.0000	0.0000	0.0000	0.0000	0.0493	0.0000	0.0006	0.0000	2.9059	0.0000	0.0478	0.0000
O	1.6642	0.0000	0.0000	0.0000	0.0050	0.0000	0.0000	0.0000	4.8689	0.0000	0.0000	0.0000
H + H (H_2O)	0.0000	0.0000	0.0000	0.0000	0.0322	0.0000	0.0000	0.0000	103.2835	0.0000	0.0000	0.0000
^{10}B	0.0000	0.0000	0.0000	0.0000	371.7129	0.0000	0.0000	0.0000	215.0013	0.0000	0.0000	0.0000
Al	0.0000	0.0000	0.0000	0.0000	0.0257	0.0000	0.0000	0.0000	0.8610	0.0000	0.0000	0.0000
Pb	0.0000	0.0000	0.0000	0.0000	0.0195	0.0000	0.0024	0.0000	0.1226	0.0000	0.0029	0.0000
Total	311.1228	359.2398	1.0409	1002.5209					636.7841	359.4410	1.0928	1003.0201

[a]Energy region: from 1 to 299 groups.
Volume = 8.94432E+04.
Flux = 6.96194E+12.
[b]k_{eff} = 1.0042350.
Leakage = 3.653.

Table 5.125. KENO-ABBN balance table for PNL-34

	Zone 1[a]								Over all reactor (7 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	124.8879	276.9523	0.0036	794.5574	60.7553	134.7314	0.0018	2.8689	124.8879	276.9523	0.0036	794.5574
^{240}Pu	22.3492	0.1086	0.0002	0.3448	129.2076	0.6277	0.0009	3.1757	22.3492	0.1086	0.0002	0.3448
^{241}Pu	0.4866	1.4306	0.0000	4.2034	58.7960	172.8622	0.0036	2.9381	0.4866	1.4306	0.0000	4.2034
^{242}Pu	0.0180	0.0003	0.0000	0.0009	29.0268	0.4798	0.0022	3.1573	0.0180	0.0003	0.0000	0.0009
^{234}U	0.0000	0.0000	0.0000	0.0000	27.4602	0.6152	0.0007	0.0000	0.0003	0.0000	0.0000	0.0000
^{235}U	12.7358	67.2513	0.0040	163.6470	16.3708	86.4459	0.0051	2.4334	12.7664	67.4209	0.0040	164.0596
^{238}U	98.7527	13.2482	0.7154	37.6047	0.9210	0.1236	0.0067	2.8385	98.9245	13.2634	0.7162	37.6476
Zr	0.0000	0.0000	0.0000	0.0000	0.0548	0.0000	0.0007	0.0000	2.5555	0.0000	0.0319	0.0000
O	1.1745	0.0000	0.0000	0.0000	0.0052	0.0000	0.0000	0.0000	4.8059	0.0000	0.0000	0.0000
H + H (H_2O)	0.0000	0.0000	0.0000	0.0000	0.0504	0.0000	0.0000	0.0000	352.4196	0.0000	0.0000	0.0000
^{10}B	0.0000	0.0000	0.0000	0.0000	582.8132	0.0000	0.0000	0.0000	1.0757	0.0000	0.0000	0.0000
Al	0.0000	0.0000	0.0000	0.0000	0.0382	0.0000	0.0000	0.0000	1.3961	0.0000	0.0000	0.0000
Pb	0.0000	0.0000	0.0000	0.0000	0.0287	0.0000	0.0024	0.0000	0.1065	0.0000	0.0020	0.0000
Total	260.4048	358.9913	0.7232	1000.3581					621.7922	359.1761	0.7579	1000.8137

[a]Energy region: from 1 to 299 groups.
Volume = 1.89229E+04.
Flux = 2.26246E+13.
[b]k_{eff} = 1.0020750.
Leakage = 18.529.

Table 5.126. KENO-ABBN balance table for PNL-35

	Zone 1[a]								Over all reactor (7 zones)[b]			
Nuclide	Capture	Fission	(n,2n)	Product	σ_c	σ_f	σ_{2n}	ν	Capture	Fission	(n,2n)	Product
^{239}Pu	128.7503	277.3965	0.0044	795.5985	54.0661	116.4869	0.0019	2.8681	128.7503	277.3965	0.0044	795.5985
^{240}Pu	26.2369	0.1257	0.0002	0.3991	130.9331	0.6272	0.0010	3.1754	26.2369	0.1257	0.0002	0.3991
^{241}Pu	0.4783	1.4116	0.0000	4.1477	49.8861	147.2282	0.0037	2.9383	0.4783	1.4116	0.0000	4.1477
^{242}Pu	0.0223	0.0003	0.0000	0.0011	31.0286	0.4771	0.0023	3.1590	0.0223	0.0003	0.0000	0.0011
^{234}U	0.0000	0.0000	0.0000	0.0000	26.0996	0.6018	0.0007	0.0000	0.0004	0.0000	0.0000	0.0000
^{235}U	12.7257	65.1352	0.0048	158.5153	14.1201	72.2723	0.0053	2.4336	12.7551	65.2931	0.0048	158.8995
^{238}U	111.2842	15.2817	0.8708	43.4294	0.8959	0.1230	0.0070	2.8419	111.4871	15.3022	0.8720	43.4876
Zr	0.0000	0.0000	0.0000	0.0000	0.0522	0.0000	0.0007	0.0000	2.6642	0.0000	0.0397	0.0000
O	1.3773	0.0000	0.0000	0.0000	0.0052	0.0000	0.0000	0.0000	4.8477	0.0000	0.0000	0.0000
H + H (H_2O)	0.0000	0.0000	0.0000	0.0000	0.0422	0.0000	0.0000	0.0000	141.2277	0.0000	0.0000	0.0000
^{10}B	0.0000	0.0000	0.0000	0.0000	487.5710	0.0000	0.0000	0.0000	206.7759	0.0000	0.0000	0.0000
Al	0.0000	0.0000	0.0000	0.0000	0.0326	0.0000	0.0000	0.0000	1.3721	0.0000	0.0000	0.0000
Pb	0.0000	0.0000	0.0000	0.0000	0.0246	0.0000	0.0025	0.0000	0.1505	0.0000	0.0032	0.0000
Total	280.8749	359.3510	0.8803	1002.0912					636.7685	359.5294	0.9245	1002.5335

[a]Energy region: from 1 to 299 groups.
Volume = 8.09808E+04.
Flux = 6.11020E+12.
[b]k_{eff} = 1.0040550.
Leakage = 3.107.

5.12 CONCLUSIONS FROM THE CALCULATION OF EXPERIMENTAL BENCHMARKS

(A. M. Tsiboulia)

In November 1996, the U.S. and Russian specialists taking part in this project agreed upon the set of benchmark experiments with plutonium fuel which have been presented in this document. These experiments were to be the basis for the initial validation of various neutronic codes. In the first quarter of 1997, the parties had an informal exchange of analyses of these experiments. Although at least some part of these experiments was of a preliminary character, the data available can be used for a conclusion as to whether the experimental information selected is sufficient for reliable validation of the codes. The results of these benchmark experiments will be discussed in the following sections, and if possible, compared to the results of calculation analysis of analogous experiments with enriched uranium.

5.12.1 Benchmark Experiments Suggested by the United States

5.12.1.1 Jezebel and Godiva

For the metallic plutonium bare sphere (Jezebel—95.5% of ^{239}Pu), results have been obtained and are presented in Table 5.127 together with the data for an analogous assembly from "dirty" plutonium (Dirty Jezebel—76% ^{239}Pu) and enriched uranium (Godiva—94% ^{235}U). All experiments mentioned above have been included in the *International Handbook of Evaluated Criticality Safety Benchmark Experiments*;[2] indices corresponding to descriptions of each of these experiments in this handbook are cited in the title line of Table 5.127.

One can see that the plutonium bare sphere criticality is as described somewhat worse than that of uranium ones. The estimates for plutonium criticality experiments carried out in different countries also differ considerably, whereas critical characteristics of uranium bare spheres estimated in the United States and Russia coincide perfectly.

5.12.1.2 Solutions of plutonium nitrate or high enrichment uranyl nitrate with water reflectors

Cylinders of 9- to 12-in. diam (11.4 to 15.2 cm) with solutions of plutonium nitrate with water reflectors were used for the second series of experiments selected for the validation of calculation methods. The index of this series of experiments (14 criticality states) in the International Handbook was PU-SOL-THERM-010. The H/^{239}Pu ratio was varied in this series from 270 to 850. For comparison, the data on criticality of cylinders filled with solutions of high-enrichment uranyl nitrate with thick water reflectors were also considered. Ratios of H/^{235}U ranged from 60 to 500. These experiments have been included in the International Handbook under the indices HEU-SOL-THERM-14, -15, -16, -17, -18, and -19. Note that in addition to critical parameters of solutions of pure uranyl nitrate, critical parameters were also defined for the solutions poisoned with gadolinium nitrate. Because the International Handbook does not contain

Table 5.127. Calculated values of k_{eff} for metallic bare critical masses

Code	Cross sections	Jezebel PU-MET-FAST-001	Russian analogue PU-MET-FAST-022	Dirty Jezebel PU-MET-FAST-002	Russian analogue PU-MET-FAST-029	Godiva HEU-MET-FAST-001	Russian analogue HEU-MET-FAST-018
MCNP	ENDF/B-V	0.996		0.999		0.998	0.999
MCNP	ENDF/B-VI	0.998				0.999	
KENO	238-group ENDF/B-V	1.000					
KENO	299-group ABBN-93	0.994	0.992	0.995	0.990	1.000	1.000
MCU	DLC-MCU	0.997					

analogous experiments with plutonium nitrate solutions, the data on gadolinium solutions are not considered here.

The comparison of data cited in Tables 5.128 and 5.129 shows that multiplication factors of plutonium solutions are overestimated in the calculations; this overestimation differs when using different calculation tools—from 0.6 to 1.6%. Criticality of uranium solutions are described equally well by both Russian and U.S. calculation tools.

5.12.1.3 Homogeneous PuO_2-polystyrene parallelepipeds with H/Pu = 5

Plutonium used in these experiments contained 11.46 wt % of ^{240}Pu. The composition of the homogenous mixture of plutonium dioxide with polystyrene was the same in all five criticality states under investigation; the parallelepiped size and shape were varied. In four cases the parallelepipeds were surrounded by a thick (more than 15-cm) Plexiglas reflector. The last, fifth critical assembly was a bare PuO_2-polystyrene parallelepiped. The critical masses were varied from 27.7 to 82.9 kg. In the course of this

Table 5.128. Calculated values of k_{eff} for plutonium solutions PU-SOL-THERM-010

Case	$H/^{239}Pu$	MCNP (ENDF/B-V)	MCU (DLC-MCU)	KENO (238-group ENDF/B-V)	KENO (299-group ABBN-93)
9-1	266.9	1.021	1.014	1.018	1.013
9-2	356.9	1.020	1.010	1.015	1.007
9-3	484.2	1.015	1.006	1.010	1.003
11-1	485.0	1.019	1.011	1.016	1.007
11-2	558.1	1.017	1.008	1.012	1.007
11-3	558.1	1.018	1.008	1.013	1.005
11-4	605.9	1.008	1.000	1.006	0.998
11-5	640.6	1.010	1.003	1.006	1.000
11-6	413.3	1.020	1.012	1.020	1.010
11-7	535.2	1.009	0.999	1.007	0.999
12-1	543.3	1.016	1.008	1.016	1.006
12-2	618.3	1.017	1.007	1.010	1.005
12-3	728.1	1.022	1.013	1.022	1.011
12-4	849.7	1.017	1.009	1.016	1.007
Average		1.016	1.008	1.013	1.006
Root-mean-square deviation		±0.005	±0.004	±0.005	±0.004

Table 5.129. Calculated values of k_{eff} for high-enrichment uranium solutions

Case	$H/^{235}U$	MCNP (ENDF/B-V)	KENO (ABBN-93)
HEU-SOL-THERM-014 (Case 1)	405.0	0.997	0.998
HEU-SOL-THERM-015 (Case 1)	278.4	1.004	1.004
HEU-SOL-THERM-016 (Case 1)	175.2	0.999	0.994
HEU-SOL-THERM-017 (Case 1)	132.8	1.002	0.999
HEU-SOL-THERM-018 (Case 1)	86.0	0.989	0.995
HEU-SOL-THERM-019 (Case 1)	54.7	1.001	1.002
Average		0.999	0.999
Root-mean-square deviation		±0.003	±0.003

work, doubts appeared as to whether this bare system could be considered as benchmark. The results of calculations on criticality of the four systems have been presented in Table 5.130.

The results obtained seem to be quite satisfactory: the error with calculation prediction of the systems' k_{eff} with this very low plutonium-to-hydrogen ratio amounts to only 1%, that is, practically the same as that for criticality experiments with solutions. Note that when the 16-group constants of Hansen-Roach were used, which yield an accuracy for criticality experiments with solutions of better than 1% (due to matching the constants), the error in the description of the experiments considered here exceeded 2%. Thus, the use of modern nuclear data gives a possibility for more reliable interpolation and extrapolation of the error estimation in changeover from one spectrum range to another than can be done with a formal matching of constants, even when performed by the highest qualification specialists.

To date, none of the evaluated data for analogous critical systems with enriched uranium have been published, as far as we know. The IPPE department for nuclear safety carried out experiments with pastes of low-enrichment uranium with approximately the same hydrogen-to-fuel ratio as in this case; however, those experiments have not been correctly evaluated, and it cannot be said whether these data will meet the requirements to benchmark experiments. Thus, to date it appears impossible to compare the calculation vs experimental differences for this series of experiments with plutonium with the data for analogous experiments with high-enrichment uranium.

5.12.1.4 Homogeneous MOX-polystyrene parallelepipeds with Pu/(Pu + U) from 8 to 30 wt % in H/(Pu + U) of 3 to 7

Critical parameters of 14 criticality states, which are essentially rectangular parallelepipeds of various shapes with thick Plexiglas reflectors, were taken as benchmark experiments. The parallelepipeds were assembled from small cubes of polypropylene loaded with a mixture of plutonium and uranium oxides. Nine criticality states of various forms were defined for the cubes in which the weight fraction of plutonium in the mixture of oxides amounted to 29.3%, and H/(Pu + U) ratio = 2.80; one state was defined for the cubes in which this fraction amounted to 8.1 wt %, and H/(Pu + U) = 7.30. Depleted uranium was used in all cases. The ^{240}Pu content amounted to 11.5 wt %. Results of the calculations are presented in Table 5.131.

The difference in k_{eff} between the results obtained in the United States and Russia amounts to 1% (as well as that for parallelepipeds with pure plutonium oxide). Note that k_{eff} for all four assemblies with low plutonium content in the U.S. calculations proved to be systematically overestimated by 1.5 to 2%, whereas this abnormality is not observed in Russian calculations. The cause of this difference has not yet been understood.

As noted previously, no results of analogous experiments with enriched uranium are available.

Table 5.130. Calculated values of k_{eff} for PuO_2-polystyrene systems

Variant	MCNP (ENDF/B-VI)	KENO (238-group ENDF/B-V)	MCU (DLC-MCU)	KENO (299-group ABBN-93)
1	1.009	1.004	0.992	0.997
2	1.011	1.007	0.991	0.995
3	1.015	1.011	0.980	0.996
4	1.014	1.009	0.990	0.997
Average	1.012	1.008	0.988	0.996
Root-mean-square deviation	0.003	0.003	0.005	0.001

Table 5.131. Calculated values of k_{eff} for MOX-polystyrene systems

Variant	Pu/(Pu + U) (wt %)	MCNP (ENDF/B-VI)	KENO (ENDF/B-V)	KENO (ABBN-93)
1	29.3	0.999	1.000	0.989
2	29.3	0.995	0.994	0.987
3	29.3	1.004	1.008	0.997
4	29.3	0.996	0.987	0.987
5	29.3	0.994	0.993	0.986
6	29.3	0.993	0.994	0.985
7	29.3	0.999	0.996	0.986
8	29.3	0.996	0.997	0.985
9	29.3	1.001	0.995	0.989
10	15.0	0.986	0.985	0.983
11	8.1	1.021	1.012	0.995
12	8.1	1.016	1.016	0.993
13	8.1	1.019	1.015	0.995
14	8.1	1.018	1.016	0.995
Average		1.003	1.001	0.989
Root-mean-square deviation		0.011	0.010	0.005

5.12.2 Benchmark Experiments Suggested by the Russian Researchers

5.12.2.1 Spheres with solutions of weapons-grade plutonium nitrate surrounded by water reflectors

This series of experiments included five critical assemblies. The vessels with solutions of plutonium nitrate of various concentrations were of spherical shape, about 30-cm diam, and were surrounded by thick water reflectors. Some of the spheres in the critical state were not full; in these cases, the distances between the solution level and upper point of the sphere did not exceed 1.5 cm. The H/Pu ratio in the solutions was varied from ~90 to 800. The content of ^{240}Pu was in all cases below 5%. The results of the calculations are presented in Table 5.132. For comparison, results of calculation of k_{eff} for 11 critical spheres with a solution of enriched uranium oxyfluoride (UO_2F_2), on the basis of MCNP code using the data ENDF/B-V, differed from experimental values on the average by 0.4 ± 0.2%. None of the experiments mentioned above—HEU-SOL-THERM-009 to -012 with volumes of uranium-containing spheres that varied from 6.7l to 91l—had a difference in k_{eff} of more than 0.9%.

Table 5.132. Calculated values of k_{eff} for spheres with solutions of weapons-grade plutonium

Variant	Plutonium content (g/L)	MCNP (ENDF/B-VI)	KENO (ENDF/B-V)	MCU (DLC-MCU)	KENO (ABBN-93)
PU-SOL-THERM-001 (Case 6)	268.7	1.014	1.003	1.003	0.994
PU-SOL-THERM-001 (Case 5)	140.0	1.010	1.009	1.004	1.001
PU-SOL-THERM-001 (Case 1)	73.0	1.012	1.008	0.999	0.998
PU-SOL-THERM-002 (Case 1)	49.8	1.013	1.016	1.001	0.999
PU-SOL-THERM-003 (Case 1)	33.3		1.013	1.006	0.998
Average		1.012	1.010	1.003	0.998
Root-mean-square deviation		0.002	0.005	0.003	0.002

5.12.2.2 Solutions of plutonium nitrate with a high content of ^{240}Pu poisoned with gadolinium

Two series of such experiments have been considered. In the first series, the solution contained 116 g of plutonium per liter of solution, whereas in the second series—363 g/L. The content of ^{240}Pu amounted to 8.4 wt %. Critical configurations were 61-cm-diam cylinders surrounded by a thick water reflector on the bottom and at the sides. The height of the reflector considerably exceeded the height of the solution in the central vessel. In the first series of experiments, the concentration of gadolinium was varied from zero up to 2.4 g/L; in the second one, up to 20 g/L. Results are given in Tables 5.133 and 5.134.

In this case, it was not expedient to calculate the average values of calculated results, it was more important to estimate the dependence of calculation-to-experiment differences on the gadolinium concentration. Evidently, these trends are opposite for low concentrations of plutonium in the calculations by ENDF/B-V and by ABBN-93: in the first case the difference between the calculation and experimental data increases in its absolute value with the increase of gadolinium concentration by about 0.4%, whereas in the second case it decreases by the same value. In a high concentration of plutonium, when both sets of the data were used, the difference does not show a clearly expressed trend toward the decrease in absolute value with the increase of gadolinium concentration.

Note that in the analysis of criticality experiments with solutions of high-enrichment uranyl-nitrate poisoned with gadolinium (HEU-SOL-THERM-014 to -019), the difference between calculated and experimental values of k_{eff} often reaches 2%, the dependence of the difference on the concentration of gadolinium being unstable.

Table 5.133. Calculated values of k_{eff} for solutions of plutonium, 116-g/L concentration, poisoned by gadolinium

Case	Gadolinium content (g/L)	Critical mass (kg)	KENO (ENDF/B-V)	KENO (ABBN-93)
1	0	5.240	1.006	0.994
2	0.48	6.842	1.005	0.995
3	0.96	8.815	1.006	0.993
4	1.42	11.698	1.013	0.992
5	1.92	16.383	1.009	0.991
6	2.38	27.282	1.010	0.990

Table 5.134. Calculated values of k_{eff} for solutions of plutonium, 636-g/L concentration, poisoned by gadolinium

Case	Gadolinium content (g/L)	Critical mass (kg)	KENO (ENDF/B-V)	KENO (ABBN-93)
1	4.40	28.192	1.003	0.988
2	5.28	29.838	1.002	0.991
3	6.28	31.497	1.000	0.992
4	8.21	34.932	0.999	0.989
5	9.88	38.311	0.999	0.990
6	12.58	43.608	1.000	0.992
7	15.55	49.714	0.998	0.990
8	18.4	57.089	0.999	0.991
9	20.25	63.113	0.998	0.989

5.12.2.3 Plutonium nitrate solutions in cylindrical tanks without a reflector

In this series of experiments, two isotopic compositions of plutonium were used with 4.88 wt % and 13.74 wt % ^{240}Pu content, respectively. Critical configurations are provided by the 34- and 45.5-cm-diam cylindrical tanks having no reflector. These tanks are filled with plutonium nitrate solution; its concentration is varied from 50.7 g/L to 226 g/L (H/Pu from 509 to 103) and from 22 g/L to 215.5 g/L (H/Pu from 1186 to 108), respectively, for the first and the second series of tests. The analysis results are given in Tables 5.135 to 5.138. Note that the average difference in the critical system calculation results obtained for 34- and 45.5-cm-diam tanks is 0.8% irrespective of ^{240}Pu content. This makes it possible to affirm the presence of systematic error in the evaluated results. This fact by no means lowers the value of this series of experiments: the similar errors could take place in other series as well, although they could be hidden in the process of comparative data analysis.

For the solutions with the low ^{240}Pu content, the differences exist between the results obtained using two databases: 299-group ABBN-93 and 238-group ENDF/B-V. The difference is 0.5% of the k_{eff} value; while in case of high ^{240}Pu content, this difference increases slightly, achieving 0.7% value. The trend and the scale of difference are the same as those in the experiments with critical spheres considered previously.

Table 5.135. Calculated values of k_{eff} for plutonium solutions containing 4.88 wt % of ^{240}Pu in 34-cm-diam (13.4-in.) tank

Case	Plutonium content (g/L)	H/Pu	KENO (ENDF/B-V)	KENO (ABBN-93)
1	226	103	1.009	0.999
2	165	147	1.003	1.000
3	133	185	1.003	0.996
4	91.4	276	1.006	0.999
5	73.5	347	1.003	1.001
6	60.4	426	1.010	1.003
7	43.3	598	1.004	1.004
Average			1.005	1.000
Root-mean-square deviation			0.003	0.003

Table 5.136. Calculated k_{eff} values for plutonium solutions containing 4.88 wt % of ^{240}Pu in 45.5-cm-diam (17.9-in.) tank

Case	Plutonium content (g/L)	H/Pu	KENO (ENDF/B-V)	KENO (ABBN-93)
1	50.7	509	0.996	0.992

Table 5.137. Calculated k_{eff} values for plutonium solutions containing 13.74 wt % of ^{240}Pu in 34-cm-diam (13.4-in.) tank

Case	Plutonium content (g/L)	H/Pu	KENO (ENDF/B-V)	KENO (ABBN-93)
1	163	150	1.005	0.998
2	114	220	1.000	0.996
3	80.2	319	1.004	0.999
4	65.6	393	1.010	1.000
5	58.6	441	1.011	1.000
Average			1.006	0.999
Root-mean-square deviation			0.005	0.002

Table 5.138. Calculated k_{eff} values for plutonium solutions containing 13.74 wt % of ^{240}Pu in 45.5-cm-diam (17.9-in.) tank

Case	Plutonium content (g/L)	H/Pu	KENO (ENDF/B-V)	KENO (ABBN-93)
1	215.5	108	0.997	0.993
2	174.5	137	0.997	0.992
3	135	181	0.999	0.988
4	102.5	243	0.998	0.988
5	73.0	347	0.994	0.990
6	53.5	475	0.989	0.984
7	43.6	592	0.997	0.991
8	28.5	911	1.007	0.996
9	22	1186	1.005	0.995
Average			0.998	0.991
Root-mean-square deviation			0.005	0.004

5.12.2.4 Solutions of high burn-up plutonium nitrates

This series of experiments was performed in the same facility where plutonium nitrate poisoned with gadolinium was tested. In this case, the isotopic composition of plutonium was ^{238}Pu—0.2%, ^{239}Pu—41.4%, ^{240}Pu—42.9%, ^{241}Pu—10.8%, and ^{242}Pu—4.7%. The plutonium content was varied from 40.6 g/L to 140 g/L. The calculational results are given in Table 5.139. One can see the distinct trend of increase of the calculated k_{eff} values with the increase of solution concentration. The difference in the k_{eff} values from unity calculated using ENDF/B-V and ABBN-93 databases, which are 1% low for the low-concentration solutions, decreases gradually down to zero with the increase of plutonium content.

5.12.2.5 Fuel element lattices containing plutonium and uranium dioxides mixture in water: MIX-COMP-THERM-001

In this series of experiments, square lattices of fuel elements with various pitch values were studied. Fast neutron test reactor fuel elements with 0.5842-cm outer diameter and 0.49403-cm fuel pin diameter

Table 5.139. Calculated k_{eff} values for solutions of high-burnup plutonium

Case	Plutonium content (g/L)	H/Pu	KENO (ENDF/B-V)	KENO (ABBN-93)
1	40.6	458	1.009	0.998
2	46.8	395	1.012	1.000
3	56.3	323	1.016	1.002
4	65.1	278	1.018	1.006
5	75.6	237	1.017	1.008
6	85.5	207	1.020	1.012
7	99.3	176	1.022	1.016
8	116.0	149	1.023	1.022
9	140.0	120	1.025	1.022

were used. A plutonium and uranium dioxide mixture was used as the fuel. The content of plutonium dioxide in the mixture was 20%. The content of ^{240}Pu was 11.5 wt %. Natural uranium was used for diluting plutonium. Lattices were studied with pitches of 0.9525, 1.2588, 1.5342, and 1.9050 cm, corresponding to water/fuel ratios of 3.33, 6.87, 10.88 and 17.53, respectively.

The analysis results are presented in Table 5.140. In the case of ENDF/B-V data, one can see the trend of the calculated k_{eff} value increase with the increase of water/fuel ratio, while there is no such trend in the case of the ABBN-93 database.

Table 5.140. Calculated k_{eff} values for MIX-COMP-THERM-001

Case	Pitch (cm)	V_M/V_F	KENO (ENDF/B-V)	KENO (ABBN-93)
1	0.9525	3.33	0.993	0.991
2	1.2588	6.87	0.998	0.991
3	1.5342	10.88	0.999	0.985
4	1.9050	17.53	1.005	0.990
Average			0.999	0.989
Root-mean-square deviation			0.005	0.003

5.12.2.6 Fuel element lattices containing plutonium and uranium dioxides mixture in water: PNL-30-35

In this series of experiments as in the previous one, square lattices of fuel elements were studied. The outer diameter of fuel element and diameter of fuel pin were equal to 1.4351 and 1.2827 cm, respectively. Three lattices with pitches of 1.77800, 2.20914, and 2.51447 cm, corresponding to 1.19, 2.52, and 3.64 water/fuel ratios, were studied. The critical state was determined for each lattice in both pure and borated water. The fuel was a mixture of natural uranium with 2 wt % of plutonium dioxide containing 8% of ^{240}Pu.

The calculation results are given in Table 5.141. The trend of k_{eff} value increases both with the lattice pitch increase and with the observed boron addition when either the ENDF/B-V or ABBN-93 database was used.

Table 5.141. Calculated k_{eff} values for PNL-30-35

Case	Pitch (cm)	Boron content (ppm)	V_M/V_F	KENO (ENDF/B-V)	KENO (ABBN-93)
PNL-30	1.77800	1.7	1.19	0.993	0.994
PNL-31	1.77800	688	1.19	0.999	0.999
PNL-32	2.20914	0.9	2.52	0.998	1.001
PNL-33	2.20914	1090	2.52	1.002	1.004
PNL-34	2.51447	1.6	3.64	1.002	1.002
PNL-35	2.51447	767	3.64	1.007	1.004

5.12.2.7 Mixed uranium-plutonium solutions: MIX-SOL-THERM-001, -002

In the first series of these tests (87, 95, 97, 99, 108), the critical configuration was the annular tank, surrounded by the water reflector. Inserts of various compositions were placed in the central part of the tank.

In Test 87, the insert was a simple ring of borated concrete (2% of B_4C). In Tests 95 and 97, one more tank was installed with the solution containing 194.92 g/L of plutonium or 5.1 g/L of uranium.

In Test 99, the ring was made of polyethylene, covered with the thin layer of cadmium. The contents of plutonium and uranium in the central tank were 103.36 g/L and 363.3 g/L, respectively.

In Test 108, a borated concrete ring was used again; however, the central tank was similar to that used in Test 99.

The ^{240}Pu content ranged from 7.940 to 8.338 wt %. Either natural or slightly enriched (2.292 wt %) uranium was used (Tests 95 and 97).

In Tests 58, 59, and 61, the critical configuration was provided by only a cylindrical tank; a thick water reflector was located below and around it. The content of ^{240}Pu was 8.312 wt %. In Tests 58 and 59, natural uranium was used. The depleted uranium containing 0.438 wt % of ^{235}U was used in Test 61.

The calculational results are presented in Tables 5.142 and 5.143. When calculating the average value and root-mean-square deviation for the first series, Test 99 was not considered. The average difference is 1.5% between the calculation results obtained using ENDF/B-V and ABBN-93 databases for this series of tests.

5.12.2.8 Observations on results from experimental benchmarks

The analysis of calculation vs experimental data differences is sufficient basis for the conclusion that MOX fuel use in water-cooled reactors is substantiated experimentally to a far less extent than that of

Table 5.142. Calculated k_{eff} values for MIX-SOL-THERM-001

Case	Plutonium content (g/L)	Uranium content (g/L)	KENO (ENDF/B-V)	KENO (ABBN-93)
87	102.19	365.20	1.000	0.984
95	195.61	6.5	1.006	0.988
97	58.30	2.3	1.001	0.989
99[a]	73.64	250.30	1.009	1.000
108	47.08	161.72	1.001	0.987
Average			1.002	0.987
Root-mean-square deviation			0.003	0.002

[a]This test was eliminated in the process of averaging.

Table 5.143. Calculated k_{eff} values for MIX-SOL-THERM-002

Case	Plutonium content (g/L)	Uranium content (g/L)	KENO (ENDF/B-V)	KENO (ABBN-93)
58	11.88	11.05	1.009	0.994
59	11.73	10.78	1.010	0.996
61	12.19	41.04	1.008	0.996
Average			1.009	0.995
Root-mean-square deviation			0.001	0.001

traditional uranium fuel. It is obvious that many critical experiments with plutonium or MOX fuel are beyond the framework of this project. For instance, the American party has proposed consideration of several series of tests on square and hexagonal MOX fuel elements in water with various boron content values lattices; the data are presented, in part, in Vol. 4 of this report. By now, the evaluation of these experiments carried out as far as in the sixties has not yet been completed. Without questioning the expediency of careful evaluation with the subsequent analysis of these and perhaps some other similar experiments, it can be supposed that the result of this work would not make qualitative changes in the state of experimental substantiation of water-cooled reactors with the mixed uranium-plutonium fuel.

Beyond the framework of this project, comprehensive analytical studies were performed concerning plutonium introduction into the reactor fuel cycle (including its recycling). These works organized by the WPPR, OECD, and NEA have not yet been completed; however, it is clear from the preliminary results that in spite of the considerable progress, the current state-of-art cannot be recognized as satisfactory in the areas of analytical prediction of isotopic composition, radiological characteristics of spent fuel, and dynamics of the reactivity effects. Discrepancies in the results of calculations carried out by different specialists using different databases and computer codes are still too large. In the framework of WPPR, simplified benchmark models were analyzed, and one can expect that when comparing these results with the data obtained experimentally on power reactors, the discrepancies would turn out to be even larger. The experimental studies carried out with the real fuel elements in the real reactor lattices at the critical facilities would allow us to significantly simplify the analysis of causes of discrepancies between design-evaluated data and those actually observed when the plutonium is introduced into the fuel cycle of VVERs and PWRs.

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6. OBSERVATIONS AND RECOMMENDATIONS

(A. M. Tsiboulia)

From the analysis of calculation vs experimental differences for the benchmark experiments now available for uranium-plutonium water breeding systems and their comparison with analogous differences for uranium-water systems, the conclusion must be based on the expedience of carrying out additional benchmark experiments for the substantiation of neutronic calculations for VVERs and PWRs with MOX fuel and nuclear and radiation safety at enterprises with out-of-pile fuel cycles.

A review of the calculations documented in this report leads to the conclusion that additional benchmark experiments conducted in critical facilities are required to validate the MOX-fueled PWR designs. This conclusion requires a careful interpretation. It is not a trite observation because the word "require" has a broad spectrum of meanings. In the most direct and strict interpretation, it means that project fulfillment is absolutely impossible until the results of the proposed experiments are obtained. However, the present situation is different: computational uncertainties in the prediction of neutronic characteristics of VVERs or PWRs with a partial MOX loading do not exceed those calculations of the first reactors of these types that were loaded with uranium fuel only. Therefore, the project is possible without additional experiments that use critical facilities. The experience of operating LTAs with MOX fuel in a power reactor would help upgrade the accuracy of computational predictions for many of the neutronic parameters that are measurable in critical facilities. This experience would then be incorporated into planning for subsequent fuel loadings.

However, this approach has three major disadvantages. First, timing must be considered. Neutronic information (in particular, the data on energy distribution in the fuel elements) based on the results of MOX fuel assembly irradiations in power reactors can be obtained, in principle, but would be labor-consuming and incomparably slower than if done using critical facilities. The delay in documentation and reporting of this information would be years when compared to past experience with comparable critical experiment programs. Perhaps, most importantly, the irradiation conditions in a power reactor are not easily and reliably monitored. The second disadvantage is that the uncertainties in the neutronic calculations of pin-and-assembly power distributions (which have been identified in this document) result in the need to incorporate large margins in designing the MOX loading in the fuel assembly. Consequently, this would (or at least could) result in irradiation of fuel elements under unnecessarily "mild" conditions. That is, the most economical use of the fuel is not obtained (the power level of the reactor might be unnecessarily derated because of fueling with MOX). Determination of the limits of fuel element stability under optimal operating conditions (which, essentially, is the main task of a lead loading) would be delayed or perhaps never achieved. Finally, the third disadvantage is that in a power reactor, in contrast to critical facilities, numerous parameters, such as distributions of reaction rates, spectral indices, and reactivity coefficients, cannot be measured. The analysis of these parameters is often crucial for understanding the underlying causes of differences between calculations and experimental results.

Although an absolute requirement of additional experiments cannot be stated, their expedience would be a reasonable consideration. This statement is absolutely true for the requirement of additional experiments for substantiating criticality safety at the external fuel cycle facilities. Thus, in all of the following cases the word "requirement" or "necessity" will be understood as expedience.

6.1 OBSERVATIONS ON THE NEED FOR EXPERIMENTS FOR REACTOR CORE PHYSICS CALCULATIONS

The expedience of additional criticality experiments for substantiation of the use of MOX fuel in VVERs and PWRs will be assessed based on quality considerations. The following factors support the expedience of additional experiments in a critical facility:

- The number of benchmark experiments carried out with plutonium is about 1 order of magnitude less than those with enriched uranium, their errors being, as a rule, higher (sometimes two to three times as

high). Many experiments (e.g., those with distribution of power in assemblies with MOX fuel elements) were carried out only for single configurations. The measurements are not readily accessible (although Vol. 4 of this report is an initial attempt to document some of these data), are not necessarily applicable to currently proposed fuel assembly designs, and have not undergone international expert evaluation. Thus, the reliability of neutronics calculations for water-cooled, water-moderated reactors with MOX fuel is much lower than that of uranium-fueled reactors.

- When results of neutronic characteristics calculations are compared for plutonium-water systems using various libraries of neutronic data, much larger differences are observed than in the comparison of uranium systems. According to the estimations, errors of neutronic data that have undergone evaluation for major uranium and plutonium isotopes do not differ significantly. Therefore, a better agreement of calculation results for uranium systems is evidence that, in the evaluation of neutronic data for uranium, the results of numerous benchmark experiments using critical facilities have been taken into account implicitly or explicitly. No correction of this kind has been made in the evaluation of neutronic data for plutonium.
- All experiments proposed as benchmarks for substantiation of cores of water reactors with MOX fuel have been conducted outside of Russia. No available Russian experiments could be recommended for substantiating the criticality safety in the fabrication of fresh MOX fuel, its transportation, and storage of spent fuel. It is problematic that under such conditions GAN would authorize the work for loading MOX fuel assemblies into power reactors. In France, where MOX fuel has been used already, this use was preceded by a large-scale experimental program, currently still under way. In the United States, where the question of expedience of including plutonium into the nuclear fuel cycle has been considered doubtful until recently, many experiments have been carried out and give grounds to substantiate this option. In Japan, where the use of civil plutonium is planned in PWRs, a special experimental base has been created and developed for substantiating this use (NUCEF).
- If no critical facility experiments are performed in support of the program for the use of plutonium in water reactors, probability of abnormal occurrences would likely increase in the implementation of this program. Increased caution, and therefore increased cost relative to the existing LEU cycle, with the changeover to the loading of power reactors with mixed uranium-plutonium fuel would be required. Consequently, an increase would occur in the length of time to disposition the excess weapons-grade plutonium using water reactors (as compared to the expected time period if adequate measurements are performed). An alternative for this carefulness would be irradiation of MOX fuel assemblies under unreasonably hard conditions, which can involve the breach of clad in fuel elements and contamination of the circuit with fission products, plutonium, and other actinides. One more result of this situation would be the social and political aspects of prolonging the disposition of plutonium. Ultimately, a delay in the disposition of plutonium because of the insufficient experimental substantiation would contribute to the arguments of those who oppose solving the problem of excess weapons plutonium through its use in the nuclear fuel cycle. This opposition to reactor disposition could, in turn, complicate the solution to the international problem of surplus weapons plutonium.
- Although plutonium is a valuable power source, its use in power reactors will not be economically justified in the near future. The expenses for weapons-grade plutonium disposition in VVERs, which can be measured in billions of dollars, should be justified by the decrease of risk of unauthorized proliferation of plutonium, rather than by economic reasons of nuclear power. The cost of the program under discussion for experimental research would amount to only 0.1% of these expenses. Thus, should critical experiments not be pursued that would significantly diminish the chances for a successful and timely plan of plutonium dispositioning, there would be no significant short-term economic benefit.
- The experimental facilities available need only minor improvements to be used for experiments with MOX fuel. Currently, experienced personnel work at these facilities and are qualified to make the necessary modifications for performing MOX experiments. Because the tasks for experimental substantiation of reactors with uranium fuel have been practically solved, canceling the program for MOX fuel substantiation would result in closure of these facilities and the layoff of the staff. Thus, the

solution on the question of expedience of developing the program under discussion cannot be delayed "until a better time." The delay would be equivalent to a negative decision.

The previously stated factors seem to be sufficient for making a decision on the need for experiments in critical facilities in Russia for a physics program to support using plutonium in VVERs. The results of calculational analyses of benchmark experiments are available to support this recommendation.

6.2 REQUIREMENT FOR EXPERIMENTS IN SUPPORT OF CRITICALITY SAFETY ANALYSES AT AWAY-FROM-REACTOR FUEL CYCLE FACILITIES

The out-of-pile fuel cycle includes the fabrication of MOX fuel, its transportation, storage, reprocessing, and the final disposal of radioactive wastes and spent fuel. In contrast to the in-pile part of the fuel cycle, well-understood technological processes will be used in the out-of-pile facilities and will take place under conditions of sufficient subcriticality. The modern knowledge of neutronic data and application of calculation methods is accurate enough (e.g., the Monte Carlo method guarantees that the error in the k_{eff} calculation would not exceed 2% because of the inaccuracy of the neutronic data and calculation methods used). If the maximum admissible value of k_{eff} is accepted to be equal to 0.95, then calculations reported in this document show that this level of subcriticality seems to be ensured with sufficient reserve. This is in contrast to the previously stated conclusion regarding the lack of benchmark experiments with lattices of uranium-plutonium rods in water with the weapons-grade plutonium content characteristic for VVERs (about 4%). The lack of those data would complicate the licensing of the reactor part of the fuel cycle as well as the storage and transportation of MOX fuel assemblies (both fresh and spent fuel). Thus, implementation of criticality experiments with MOX fuel appears rather desirable not only from the reactor physics point of view, but from the criticality safety view as well.

However, note that the calculation-methodical error is not the only reason for the possible difference of calculational k_{eff} and the real multiplication factor for the equipment installed and loaded with plutonium-containing components. The reasons may be in differences of the real structure compared to the designed one, presence of unrelated objects in the equipment fabricated, as well as wastes.

6.3 SUBCRITICAL MEASUREMENTS IN SUPPORT OF CRITICALITY SAFETY

The level of criticality safety of equipment can be upgraded sharply if verification criticality experiments are carried out periodically after commissioning of new equipment. The essence of subcriticality experiments, as it is well known, is that the response of the detector to the neutron source in the subcritical multiplication system under observation can be defined. The measurements can be carried out with both constant and pulsed sources. When the system is far from the criticality state, the degree of its subcriticality cannot be defined, in general by an eigenvalue k_{eff}. This complicates the interpretation of measurement results, but the modern methods of calculational analysis make it possible to obtain enough information from the subcriticality experiments to considerably upgrade the accuracy of calculation prediction of the values and parameters at which the system would become critical. To avoid the situation when the accomplishment of verification subcriticality experiments becomes an unacceptably heavy burden for operating personnel and to make these experiments available for analysis during plant operation, it is necessary that the experimental methods (including the experimental equipment, systems for acquisition, and analysis of measurement results) be developed and designed simultaneously with the designing and development of the process equipment. It would be expedient to include detailed consideration of the possibilities of subcriticality experiments at the newly introduced equipment for out-of-pile fuel cycles (equipment for chemical processing, transportation package sets, etc.) into the task list of the Russian/U.S. Thermal Water Reactor-Based Plutonium Disposition Project.

Concerning the subcriticality experiments that would be expedient for the substantiation of criticality safety in the out-of-pile fuel cycle, it would be desirable to investigate the dependence of the multiplication factors of storage arrays for spent fuel assemblies on the density of water. It is well known that k_∞ for the grid of such storage is maximized at a water density that is much below that of liquid water. At a certain water density level, k_∞ could exceed 1. Although the probability of a decrease of water density within a

storage configuration that is sufficient for the development of chain reaction is very small, the consequences of such an accident could be so disastrous that this problem deserves a careful comprehensive consideration, including the use of experimental methods of investigation. Although the problem of criticality safety of storage facilities for spent fuel assemblies is not specifically characteristic for the case of involvement of plutonium in the fuel cycle of thermal reactors, the prospect of loading the fuel assemblies with MOX fuel in storage facilities now operated or belonging to the same type makes it necessary to call attention to this problem, which is still not well understood.

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